COMPETING THROUGH TECHNOLOGY AND MANUFACTURING:

A STUDY OF THE INDIAN COMMERCIAL VEHICLES INDUSTRY

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Abstract

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The thesis is a detailed study of the technological and manufacturing strategies of firms in the commercial vehicles (CV) industry in India, and analyses the impact of these strategies on the domestic and international competitiveness of the firms. Its focus is therefore different from the usual policy-led explanations of industrial backwardness in the developing world, particularly India. The thesis begins by analysing the competitiveness of the different firms and the CV industry as a whole, both in India as well as in international markets. This is explained by differences in vertical integration and sub-contracting strategies across firms, and relationships with suppliers; by scale economies and manufacturing technology and related issues; and by technological change, in terms of both inputs and outputs , including technology imports. It is found that production organization (vertical integration) is a very important explanation for observed differences in technological capabilities. Scale economies, on the other hand, do not explain much of the inter-firm cost variations, because firms have been able to use different levels and vintages of process technology, suited to their scale of production, to produce acceptable products. But scale does help in terms of marketing, both domestically and internationally. It was found that all firms have been active in their technological search efforts and have responded to the demand for sturdy, cheap and functionally efficient products. The firm with the greatest stress on in-house Research and Development was also the most competitive. However, in responding to domestic demand, Indian CV firms have been ruled out of the major markets abroad, and had to restrict themselves to developing countries with similar demand characteristics.When the level of effective competition in the industry increased, most firms had to accelerate the pace of investment in both product and process technologies and suffered an erosion in their profitability.

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GLOSSARY OF ABBREVIATIONS

ACMA	Automotive Components Manufacturers Association (India)
AET	Automotive Engineer and Trader
AIAM	Association of Indian Automobile Manufacturers
AIMTC	All India Motor Transport Congress
ALL	Ashok Leyland Limited
ANL	Allwyn Nissan Limited
APIL	Automobile Products if India Limited
ARAI	Automotive Research Association of India
ASRTU	Association of State Road Transport Undertakings
BL	British Leyland
BTL	Bajaj Tempo Limited
CAD	Computer-aided Design
CAE	Computer-aided Engineering
CAM	Computer-aided Manufacture
CCS	Cash Compensatory Support
CEI	Confederation of Engineering Industry (India)
CIF	Cost, Insurance and Freight
CKD	Completely knocked-down
CM	Component Manufacturer
CMIE	Centre for Monitoring Indian Economy
CNC	Computer Numerically controlled
CV	Commercial Vehicle
D-B	Daimler-Benz
DCs	Developed Countries
DCMT	DCM Toyota Limited
DFA	Deflated Fixed Assets
DI	Direct Injection
DRC	Domestic Resource Cost
EEC	European Economic Community
EIU	Economist Intelligence Unit
EML	Eicher Motors Limited
ERC	Engineering Research Centre
FERA	Foreign Exchange Regulations Act
FMS	Flexible Manufacturing Systems
GFA	Gross Fixed Assets
GM	General Motors
GOI	Government of India
GPM	General Purpose Machine
GVW	Gross Vehicle Weight
HCV	Heavy Commercial Vehicle
HML	Hindustan Motors Limited
HP	Horsepower
ICs	Industrializing Countries
ICICI	Industrial Credit and Investment Corporation of India
IDRA	Industries (Development and Regulation) Act
IMF	International Monetary Fund
IPR	Industrial Policy Resolution
IPRS	International Price Reimbursement Scheme
JAMA	Japan Automobile Manufacturers Association
JIT	Just-in-time
LCV	Light Commercial Vehicle
LDC	Less Developed Country
MCV	Medium Commercial Vehicle
MHCV	Medium and Heavy Commercial Vehicle

MITI	Ministry of International Trade and Industry (Japan)
M&M	Mahindra and Mahindra
MODVAT	Modified Value-added Tax
MRTP	Monopolies and Restrictive Trade Practices
MVMA	Motor Vehicles Manufacturers Association of the USA
NC	Numerically controlled
OE	Original Equipment
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
PAL	Premier Automobiles Limited
PBIDT	Profits before Interest, Depreciation and Tax
PBIT	Profits before Interest and Tax
PBT	Profits before Tax
PMP	Phased Manufacturing Programme
R&D	Research and Development
SKD	Semi knocked-down
SML	Swaraj Mazda Limited
SMPIL	Standard Motor Products of India Limited
SPM	Special Purpose Machines
SSI	Small- scale Industry
STU	State Transport Undertaking
TC	Technological Change
T.C.	Tariff Commission
TECSAL	Technology to Sales (ratio)
TELCO	Tata Engineering and Locomotive Company Limited
TI	Technology Import
TIA	Technology Import and Adapt
UNCTC	United Nations Centre for Transnational Corporations
VA	Value added
VAP	Value added Productivity
VA/TC	Value added to Total Consumption (ratio)
VI	Vertical Integration
VM	Vehicle Manufacturer
VW	Volkswagen
WB	World Bank

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CHAPTER 1

INTRODUCTION, MOTIVATION AND SCOPE

Introduction

This is a study of the performance, behaviour and strategies of firms within a single industry in a developing/industrialising country. The motivation for this is our inadequate understanding of the determinants of performance and productivity at the level of the firm[1]. This owes partly to the complexity of this phenomenon, but partly also to the relative lack of interest in this subject by economists. In turn, this neglect is due to the economist's preference for secondary as opposed to primary data (usually implying aggregation at least to an industry level), and the

> ...fact that from the neoclassical perspective, there are few interesting empirical questions that can be explored or resolved by studying particular firms or by considering differences among individual firms in similar market conditions (Nelson 1981,p.1037).

Within this perspective, firm productivity is determined primarily by available technology and primary inputs viz. capital and labour. Inter-firm differences in productivity, assuming similar factor market conditions and costless choice of technology, would depend mainly on capital vintage effects[2].

Inspite of recent refinements and advances in the theoretical apparatus, mainstream theory has been unable to accommodate key firm-level variables in its framework .[3] Thus, it is by now widely accepted that strategy, structure and organization within a firm are key influences on firm performance. Williamson (1975) in fact

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1. See, for example, Caves (1980), Nelson (1981), Williamson (1975, 1985), Schmalensee (1989) etc.

2. Nelson (1981).

3. See Schmalensee (1988) and Tirole (1988),pp. 48-50. Tirole points out that amongst the key topics neglected by neo-classical theory are optimizing behaviour, communication and knowledge, and the dynamics of organizations. For related discussions on the new institutional economics, see Langlois (1986), particularly chapter 1.

...anticipate(s) that measures of internal organizational structure will eventually be joined with measures of market structure in attempting to explain conduct and performance in industrial markets and subdivisions thereof (p.8).

Similarly, Dosi (1988) writes that

...any satisfactory theory of the firm must involve also an institutional (and history-based) analysis of how organisational structures affect the accumulation of competences, and the appropriation of specific rent-earning assets (p.234).

Stiglitz (1989) argues that differences between developed and developing countries "...lie largely in matters of economic organization" (p.202), and therefore calls for research on industrial (and rural) organization in developing countries.

Unfortunately, these questions have not received even adequate empirical attention from economists, and relatively few industry case studies (which address such issues) have been done in recent years[1]. There are exceptions, of course, particularly in the work of those studying technological change, especially in developing countries (see Fransman 1985, Dosi et al 1988). By and large, however, these studies focus on technological change as the phenomenon to be explained rather than firm performance (although it is true that the two go together a long way). Other sciences, particularly management, have studied issues of firm organization and strategy very extensively.[2] A critique of such studies from an economist's viewpoint is provided by Caves (1980).

Motivation and Scope

All too often, Government policy and the macro environment are cited as critical constraints on efficiency and exports, particularly in developing countries[3]. While not denying the importance of these factors, our study is an attempt to unravel the influence of selected

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1.Schmalensee (1988).

2.The very well-known work of Porter (1980,1985), for example, discusses the possible impact of competitive strategies on firm perfomance. See also Hayes and Wheelwright (1984).

3.See the World Development Report (1987) for an overall view on policies and growth. For India, Ahluwalia (1985) blames inappropriate policies for poor performance of Indian industry. At a more disaggregated level, associations of industry in India have always blamed Government policy for inadequate performance by firms. See, for example, FICCI (1987). In general, distortions created by Government policies in developing countries are seen to lead to below-par industrial performance.

firm-level factors on firm performance.[1] In order to abstract from industry-specific effects, we have chosen to study firms within one industry -- commercial vehicles in India. Of course, since Government policy is all-pervasive in India, its impact on the firms will be analysed to the extent required to understand inter-firm differences.

Exhibit 1.1 shows the various elements that influence competitiveness or performance of firms. These elements are divided into macro and micro factors, and "hardware" and "software" factors. The various quadrants constitute conceptually distinct areas for analysis and help to put problems of competitiveness in perspective.

Exhibit 1.1 Key Inputs into Competitiveness

	Hardware	Software
	1	2
Macro	Fiscal/tax policies Monetary policies Trade policies Industrial policies Capital markets Political structure Organized labor	Culture(country) Traditions Religion Values Social behaviour
	3	4
Micro (company)	Business market selection Plant & equipment decisions Capacity/facilities Location/specialization Process technology Vertical integration Product technology	Measurement and control systems Workforce policies Vendor relationships Management selection and development policies Capital budgeting/ allocation systems Organization structure

Source : Hayes and Wheelwright (1984), p.393.

1.In this context, recall the Nelson and Winter (1982) argument that "... the most useful form of normative analysis is the detailed comparison of relatively specific organizational alternatives" (p.364).

We have chosen to isolate three specific firm decision variables for detailed analysis -- vertical integration, process technological change (TC) and product TC. All three are crucial elements of the hardware decisions made within a company (quadrant 3 in exhibit 1.1). As we shall see, the three aspects are highly inter-linked, which makes it difficult to discuss one without bringing in the other two. This linkage is also manifested in the fact that there are three different engineering and technical activities which "produce" TC - product engineering, process engineering and industrial engineering (decisions on vertical integration and subcontracting are part of this category) - which are the activity counter-parts of our chosen variables.[1]

We will also discuss some aspects of software such as vendor relationships (related to vertical integration) and briefly touch on others such as human skills and management orientation. Other issues of (micro) software (workforce policies, hierarchies, management selection etc.) are beyond the scope of this exercise. In brief, our focus is on quadrant 3 in Exhibit 1.1 (as an economist, this is also my realm of comparative advantage).

In answering these questions, we will adopt an eclectic approach and draw upon diverse strands of literature, including econometric analysis and case studies, studies of developed and developing (India and others) countries, and empirical work on automotive as well as other industries. Economic theory, both mainstream as well as that at the borderline between management and economics (such as transactions cost), will also be drawn upon. It is hoped that the analysis will shed light on issues relating to technological change and production organization in industrialising countries, and in general on questions of firm behaviour in a regulated economy and by implication on industrialisation strategies and policies. In all of these, we are at a pre-theoretical stage and our study is intended to contribute to the heuristics that will serve as building blocks in eventual theory-development efforts.[2]

1.See Katz (1987), pp.31-34.

2.Katz (1987), develops the theme that literature on TC is at a pre-theoretical stage.

The Commercial Vehicles Industry

The motor-vehicle industry is the world's largest manufacturing enterprise. This, alongwith its very extensive backward and forward linkages, makes it a prime engine of growth. For example, it helps in the development and diffusion of skills in the engineering sector as a whole. In Japan, 10.2% of the total labour force is employed in motor vehicle-related industries[1], which is indicative of the potential of the industry. Its importance is therefore indisputable, and a study (for India) of its competitiveness eminently worthwhile.

Similar characteristics hold for the Indian automotive industry which, although obviously not as important as the developed automotive industries, nevertheless plays a key role in the economy. This includes playing the role of a prime mover, providing gainful employment both in the organized and unorganized sectors (about 8000 small-scale firms act as suppliers to vehicle assemblers, besides 300- odd medium and large scale firms), helping in the diffusion of engineering skills and providing the single largest market to the most critical of engineering sectors i.e. the machine tools industry.

Within the motor vehicles sector, Indian policy has always favoured the development of the commercial vehicles (CV) industry i.e. light and heavy vehicles for public transport of goods and people, as opposed to personal transport vehicles like cars and two-wheelers. It is this industry that we have chosen for detailed investigation. The analysis is centred around the five firms manufacturing CVs prior to the entry of four new firms in 1984-85. The latter firms have not been studied in depth since their plans are still unfolding, they are still in the phase of indigenization and their long-run viability is not yet assured. However, reference to these firms will come up frequently, particularly when we discuss the current state of the domestic market (chapter 3), and in general when we consider their impact on the older firms.

On the other hand, our chosen firms are mature enterprises, having been around for

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1.JAMA (1987), p.18, and Toyota Motor Corporation (1989), p.36.

more than three decades, which is a sufficient time-span to judge their performance and strategies. Besides, unlike in continuous process industries, technology in a batch-production industry like CVs is not rigidly specified. This has been one factor behind the considerable variations between the CV firms in matters of scale, production organization, market shares, export orientation, manufacturing processes and so on. This is particularly so between the light commercial vehicle (LCV) sector and the medium and heavy commercial vehicle (MHCV) sector, as well as between one of the MHCV firms (Telco) and the other four. These variations are very helpful for making deductions and influences. In fact, if there is a tendency on our part to discuss Telco (as also the divergence between Telco and its competitor Ashok Leyland) at somewhat greater length, this is because the

> study of extreme instances often provides important leads to the essentials of the situation (Williamson 1985, p.120).

Performance Criteria

The criteria for defining performance or competitiveness of firms will be critical for the analysis, particularly if different criteria give varying signals.[1] Moreover, firms may have different and even multiple objectives, which may not be easy to infer from actual performance.[2] Of course,

> ...assuming profit maximization provides a good first approximation in describing business behaviour. Deviations, both intended and inadvertent, undoubtedly exist in abundance, but they are kept within more or less narrow bounds by competitive forces, the self-interest of stock-owning management, and the threat of managerial displacement by important outside stockholders and takeover raiders (Scherer 1980, p.41).

In India, where competitive forces have been weak, however, deviations from profit-maximizing behaviour are more likely, a point also acknowledged by Scherer.

1.See Neckermann (1986) and Scherer (1980), pp.42-43, for a discussion on different measures of competitiveness.

2.For a discussion on firm objectives see Scherer (1980), chapter 2, Hay and Morris (1979), chapter 8 and more recently Tirole (1988), introductory chapter.

For these reasons, we will use a vector of indicators of performance:[1]

(a) Domestic market share - since a firm may consciously adopt a niche approach (implying low market share), we will also consider changes in market share over time. This indicator also reflects factors such as past growth rates.

(b) Profit ratios - both price-cost margins as well as rates of return on capital will be used. The pros and cons of different measures are discussed at length in chapter 3. Another problem is that higher profitability may reflect greater monopoly power rather than efficiency, an issue tackled in chapter 6.

(c) Productivity ratios - again, different measures are employed, including indicators of (weighted) physical output and value- added. The denominators include all the three main inputs i.e. labour, capital and bought-in inputs. These measures are used to supplement the profit ratios, but can sometimes give a different signal. For example, a more "productive" firm may be less profitable than a less productive firm owing to lower marketing value added, monopoly power or simply a conscious decision to keep margins low.

(d) Vehicle quality, pricing and product differentiation - this includes quality of output, after-sales service, and geographical spread of sales and service facilities. In the absence of cost data, we shall use price comparisons, which will also put the quality comparisons in perspective (since quality can ultimately be judged only relative to prices). Unlike the other three indicators, the indicators under this head require a great deal of primary data.

(e) Export intensity - as a measure of international competitiveness of the firms, assuming a willingness to export.

1.Caves (1980) also talks of market performance as an "...aggregation over the performance characteristics of firms in the market" (footnote 2, p.64).

(f) Technological change - the introduction of new products. It influences market share so significantly that it is often used as an independent indicator of competitiveness[1], particularly with regard to future competitiveness.

An overall view of competitiveness of each firm will take all these indicators into account and come up with a composite (albeit not quantitative) assessment. We will attempt to guard against any possible short-run deviations in the measures by considering data for a sufficiently long time span.

Data Sources

As is already apparent, the study will rely heavily on primary data and information. This was generated through field visits to all the five firms (Ashok Leyland, Bajaj Tempo, Mahindra, Standard and Tata Engineering) in 1987, again in 1988, and a more selective survey in 1990. The survey included discussions with wide-ranging groups of managers, particularly those dealing with marketing, corporate planning, manufacturing and product development, as well as top management. Tours of factories were also undertaken. More recent information has been obtained via correspondence, the national press and annual reports.

The quantitative data set has been generated mainly from annual reports of the five firms for the period 1977-88. In a few cases, where crucial information was not available in the annual reports (such as R&D expenditure, number of employees etc.), it has been obtained from the firms. Data on production and sales has been taken from the automotive associations viz. AIAM and ACMA.

Although not analysed in-depth in this study, we have also done detailed survey of other firms - Premier and Hindustan (the first to enter the automobile and CV industries), and

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1.Scherer (1980), pp.42-43.

DCM Toyota and Swaraj Mazda (new entrants). Discussions have also taken place with representatives of the other new firms - Eicher and Mahindra Nissan. All this serves to put the main analysis in better perspective.

We have also analysed the vehicle manufacturers from the viewpoint of their suppliers, and interviewed 20 leading suppliers of original equipment catering to our chosen vehicle manufacturers.

Finally, we have also collected some international price data through correspondence with importers in West Asia and personal interviews with importers in Malaysia. A perspective on world-class firms was obtained through first-hand surveys of leading Japanese firms such as Hino, Isuzu, Toyota and Mazda. Leading firms in Korea - Hyundai, Daewoo and Asia - were also visited, as was Tatab, Telco's joint venture in Malaysia.

Organization of the Thesis

The next chapter is a review of relevant literature on the main analytical issues, i.e. vertical integration and sub-contracting, economies of scale and production processes, and technological change. Chapter 3 analyses the domestic market performance of the different firms and gives an overview of the evolution of the commercial vehicle market in India. Chapter 4 discusses international market trends, characteristics of different segments and Indian CV exports, as well as inter-firm differences in exports.

The next three chapters undertake an empirical examination of hypotheses regarding inter-firm differences in domestic and international market performance. Chapter 5 looks at differences in vertical integration and sub-contracting across firms, as well as relationships with suppliers. Chapter 6 discusses scale economies and manufacturing technology and related issues such as capital intensity, and inventory and quality control. Chapter 7 looks at technological change, both in terms of inputs as well as outputs, including the role of technology imports. In all these chapters, the impact of these different manufacturing and technological strategies on costs, prices, exports, profits, quality and technological change, is analysed, and international comparisons are made. Besides presenting the previ-

ous arguments in a synthesis form, the final chapter also brings in some normative issues for the consideration of firms as well as policy makers, and discusses prospects for the future.

Appendix 1 offers a brief account of the historical evolution of the commercial vehicle industry and the important planks of Government policy. Appendix 2 represents an attempt at generalisation by means of econometric analysis, with a 54 observation data set consisting of pooled data for the five firms over 1977-87. Differences in profitability and market shares are sought to be explained by production, technology and other firm-level variables. The objective is to see whether there at least some empirical regularities that can support the very detailed analysis of chapters 5-7.

Possible Caveats

The most obvious caveat is the very small sample size, which limits the scope for generalization. However, this is also a strength, since it enables in-depth analysis and brings to the fore issues and facts that would remain submerged in a more general analysis. The time and effort spent by us in collecting primary data on our small sample makes clear the trade-off between extensive and intensive data collection. This would hopefully result in a richer menu of hypotheses for future research on theories of industrial organization and technological advance. As Schmalensee (1988) writes :

> .... it seems a fair bet that most major substantive advances in industrial economics will come from empirical research ... much of the most valuable and persuasive empirical research in industrial economies employs carefully-constructed data sets. In many cases these are industry-specific (p.676).

Tirole's (1988) observations are also apposite :

> ... IO (industrial organization) theorists have often felt more comfortable with case studies than with statistical analysis - perhaps because it may be easier to recover the industry's basic conditions and behaviour from rich case studies than from selective statistics about profit, concentration, advertising, and so on drawn from a very large sample of disparate industries (p.4).

The other caveat has been mentioned earlier, viz, that of the whole complex of factors that determine firm competitiveness, we will analyse only a sub-set, that within the micro/hardware quadrant in Exhibit 1.1. It is worth mentioning, however, that this quad-

rant has "...traditionally been viewed as the major source of leverage in manufacturing" (Hayes and Wheelwright 1984, p.394). Moreover, since we are concerned with inter-firm variations within one industry, the factors within the two macro quadrants can be assumed to affect each firm similarly. At the end of the day, what is required are acceptable and consistent hypotheses regarding inter-firm differences in performance, and this is the task we have set for ourselves.

CHAPTER 2

REVIEW OF LITERATURE

INTRODUCTION

The purpose of this chapter is to undertake a review of selected literature to do with Vertical Integration, Economies of Scale and Process Technology, and Technological Capabilities and Technological Change. The review will also include surveys of relevant empirical literature. This will set the context for the analysis in later chapters and also generate the hypotheses to be tested, both explicity and implicity. As we shall see, there is substantial overlap and interdependence between these themes. Each of these themes will form the subject of separate chapters based on the Indian CV industry.

VERTICAL INTEGRATION

Transactions Cost

Vertical Integration (VI) implies the replacement of market exchange by an internal transfer within the firm. Every firm, by its existence, replaces market exchange and production by internal transfer and production to some degree. Without VI, firms would not exist. Moreover, it must be that for the transaction that is internalised, the firm finds VI to be more profitable than market exchange(unless it has an objective other than profit maximization). This in turn implies that there is a cost associated with market exchange, generally referred to as transaction cost.

In fact, the most widely accepted theory of VI revolves around the notion of transaction cost, of which the most vigorous exponent is Oliver Williamson. Transaction costs arise not only with pure spot market transactions, but also with short-term and long-term contracts. These include ex-ante costs such as the costs of finding suppliers, inspecting quality of goods, bargaining, signing agreements, and ex-post costs incurred in administering and enforcing the contracts. According to this approach, vertical integration takes place in order to economise on such trans-

action costs.[1] The behavioural assumptions that transaction cost economics relies on are bounded rationality and opportunism. Bounded rationality means that economic actors are "intendedly rational, but only limitedly so"[2] i.e. people have limited information and limited ability to process it. Opportunism is "self-interest seeking with guile"[3] and refers to the incomplete or distorted disclosure of information. Having made these assumptions, Williamson (1985) characterizes asset specificity, uncertainty and frequency as the principal dimensions which distinguish one transaction from another. Of these, asset specificity is the most crucial, and refers to "durable investments that are undertaken in support of particular transactions".[4] Such investments are not easily substitutable, nor are they easily redeployable, and this, alongwith bounded rationality/opportunism and uncertainty, renders contract negotiation very difficult and complex.

The uncertainty that Williamson refers to is of two kinds - primary uncertainty arising from a lack of knowledge of future states of nature, and behavioural uncertainty which is of a strategic kind and is attributable to opportunism. In raising the question of frequency, Williamson asks whether the frequency (and therefore volume) of transactions is high enough to warrant transaction - specific investments. If not, alternative modes of organization, one of which is internalisation, would need to be assessed. Clearly, the question of transaction cost economies vis-a-vis scale and scope economies is being raised.

With the basic terminology having been explained, we can now explore some of the key arguments of the transactions cost literature in support of vertical integration. Williamson (1985, Chapter 4) theorises that when asset specificity is slight, market procurement will be preferred over internalisation because of the

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1. Williamson (1985), pp.20-21, and 85-86.

2. Williamson (1985), p.45, quoting from Herbert Simon.

3. Williamson (1985), p.47.

4. Williamson (1985), p.55.

...incentive and bureaucratic disabilities of internal organization in production cost control respects (p.91).

However, as the bilateral dependency of the relationship between the buying and supplying party builds up, it restricts adaptability. This occurs because besides specific physical capital, specialized human capital as well develops during contract execution. Thus, even if there was competitive bidding for the contract ex-ante, ex post competition at the contract renewal stage may be very limited because of the significant advantage enjoyed by the winner of the initial contract. This transition from precontract to post-contract situation has been described by Williamson (1985, p.61) as the "Fundamental Transformation".

Therefore, when asset specificity is high, the relative disability of markets to adapt to changing situations over-rides their tighter production cost control, and vertical integration is then preferred over market procurement.

If we now allow for economies of scale and scope, the market will be at an advantage because it is able to aggregate diverse demands from various sources. When asset specificity is low, and transactions are standardized, market aggregation economies are high. As asset specificity increases aggregation economies decrease, and internalisation extracts a lower production cost penalty. However, internalisation becomes profitable only at a higher level of asset specificity in this case than in the earlier situation when there were no scale or scope economies.[1] It should be noted that according to the assumptions employed, production cost alone can never be a sufficient reason for internalisation, since the market always has a production cost edge over internal supply (assuming that the product is standardized or at least affords sufficient economies of scope to the market supplier, and that there is a single technology equally familiar to all).

Yet another implication of the model is that as a firm's own requirement increases in relation to the size of the market, the diseconomies of integration correspondingly decline. Thus,

...larger firms will be more integrated into components than will smaller, ceteris paribus (Williamson 1985, p.94).

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1. Williamson (1985), pp.92-94.

Similarly, an increasing degree of uncertainty about future events leads to increasing costs of negotiating a contract and of post-contractual enforcement, and is therefore predicted to be associated with an increasing degree of internalization.

Williamson also predicts that when there is competition between a small number of suppliers - whether because of the initial situation or on account of the Fundamental Transformation - then vertical integration is favoured.[1] In the latter situation i.e. when there are a large number of initial suppliers but very few at the contract renewal stage, the underlying reason is, of course, asset specificity.

So far, the alternative "governance structures" posed have been at two extremes - market exchange or vertical integration. In reality, a number of hybrid alternatives are available, such as franchising and joint ventures. Such arrangements are appropriate at an intermediate degree of asset specificity and where managerial diseconomies of scale do not permit vertical integration. Williamson (1985, Chapter 3) develops a simple framework to predict the different governance structures that would obtain in different situations. For non-specific transactions of both a recurrent and non-recurrent kind, market governance is mainly used. Occasional transactions with intermediate and high degrees of asset specificity require "trilateral" governance viz. third-party assistance in evaluating performance and resolving disputes because the set-up costs for transaction-specific governance cannot be recovered for occasional transactions. For recurrent transactions with intermediate and high specificity, on the other hand, transaction-specific governance is possible.

Two types of transaction-specific governance structures are enumerated by Williamson. Bilateral governance is used for intermediate degrees of specificity, and unified governance (vertical integration) for highly specific transactions.

This framework cannot, of course, generate specific predictions regarding the different types of bilateral structures that will be employed in different situations, nor the range of quantitative

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1. Williamson (1975), p.104.

values of asset specificity and frequency of transactions at which different governance structures are optimal. It does, however, set out the parameters considered important in evaluating transactions and in highlighting the trade-offs between transactions cost economies, on the one hand, and scale and scope economies, on the other. Williamson (1985) himself acknowledges that that

> ...the theoretical apparatus on which transaction cost economics relies is primitive and in need of refinement(p.130).

He also argues for a great deal more research at a microanalytic level so that transaction cost issues may be better understood.

Other Theories of Vertical Integration

Even Williamson does not dispute the fact that there could be non-transaction cost explanations for vertical integration. However, he finds that none of the alternative theories makes "... more than a piecemeal contribution.... some are plainly misconceived".[1] He considers transaction cost economizing to be the central motive for integration, while the other factors play "supporting roles". We shall consider these alternative explanations in turn.[2]

1. The Technological explanation of integration rests on the economies of placing different engineering processes cheek-by-jowl, so that economies in handling, storage, energy etc. can be realised. However, in theory, the adjacent operations can have different owners. Common ownership in such a situation has therefore to be understood "... as a solution to a troublesome bargaining relation"[3]viz. as a transaction cost issue. Perhaps

> ... technology is more usefully regarded as a factor that delimits the set of feasible (organizational) modes - the final choice thereafter turning on a transaction cost assessment (Williamson 1985, p.89).

2. Integration arising from economies of information flow[4] can also be posed as a problem of

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1.Williamson (1985), p.128.

2.Much of this draws on Williamson's (1985) own treatment of alternative theories, pp.123-130.

3.Williamson (1985), p.125.

4.Porter (1980, Chapter 14.

designing efficient contracts and hence transaction costs. The flow of information within a firm is likely to be more accurate and free from obstruction, and informal communication (which can be very important) much more prevalent.[1] To the extent that technological change within a firm is related to the efficient exchange of information, it can be said that technological change is partly determined by transaction cost considerations (See section on Technological Change).

3. Integration could be a strategic decision to pre-empt rivals or to respond to actions of rivals. This could result in raising entry barriers for new firms and "mobility barriers" for existing firms.[2] Transaction cost economising is not the dominant motive in these cases. One example of this is backward integration to foreclose access of rival firms to a scarce raw material. As Williamson (1985) points out, strategic behaviour applies primarily to "dominant firms" or "tightly oligopolistic industries" (p.128).

Another manifestation of market power arises in the use of internalisation to offset bargaining power of suppliers or customers.[3] Clearly, this is not an independent factor but is in fact one element of transaction costs.

4. The life cycle theory of Stigler (1951) predicts high vertical integration both at the initial and late stages of an industry's development. At the initial stage, the product is untried and untested, and many technical and other problems must be overcome. At the late stage, when the industry is in decline, the supporting and complementary industries also begin to decline. For these reasons, integration is favoured at these stages. Williamson (1985) adds a transaction cost explanation. In the later stages of development, as product technology becomes mature and well-known and product reliability increases, service requirements decrease and the transaction cost incentive for a manufacturer to continue forward integration into sales and service decreases.[4] Williamson's

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1.Blair and Kaserman (1983), pp.24-25.

2.See Porter (1980), p.308. According to Porter, mobility barriers are those factors that deter the movement of firms from one strategic position to another within the industry (pp.133-34).

3.Porter (1980), p.307.

4.Williamson (1985), pp.126-27.

explanation, while going along with Stigler's in the initial stages of the life-cycle, predicts, unlike the latter, declining integration in the later stages.

5. Forward integration into distribution and after-sales service arises when product-specific services are required.[1] Even here, Williamson takes recourse to transaction cost factors. He hypothesises that forward integration is never observed in the absence of externalities and asset specificity. The asset specificity argument is obvious: transaction-specific investments have to be made to service complex or unique products. Externalities arise

> ... in conjunction with a branded good or service that is subject to quality debasement (Williamson 1985, p.112).

For example, if inadequate or poor after-sales service by one distributor leads to a decline in the image of the product, this constitutes an incentive for forward integration.

As for the retail sale and service of automobiles, manufacturers the world over have opted for franchised dealerships rather than full integration. This is because in addition to transaction-specific investments, automobile sale and service requires a trading

> ...knack not easy to fit into the conventional type of a managerially controlled scheme of organization (Sloan 1986, p.282).

Full integration, moreover, would pose severe problems of monitoring.

6. According to Blair and Kaserman (1983), uncertainty can create incentives for internalisation independent of transaction cost considerations. An incentive for forward integration exists if the upstream firm feels that it can thereby eliminate demand variability arising from the downstream firm's conduct (p.88). Clearly, however, this is no more than a problem of defining an efficient contract between the two parties and can therefore be posed in transaction cost terms.

However, there is one dimension of uncertainty which can lead to behaviour different from that predicted by Williamson. Since the future is uncertain, firms may not want to make irreversible commitments in capital equipment and increase their sunk costs. Even if the degree of capacity utilisation is the same, a more integrated (and therefore larger) firm is more vulnerable during a demand recession than a less integrated one. Put another way, the downstream firm can adopt a

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1.Blair and Kaserman (1983), pp.36-42.

conscious policy of sharing the burden of demand shortfalls with its upstream suppliers. Moreover, upstream processes usually have a higher percentage of fixed costs which means that demand shortfalls will place a higher burden on upstream than on downstream firms. In such a situation, an increase in parametric uncertainty creates an incentive for disintegration (especially in the case of risk-averse firms) which runs counter to the simultaneously-operating transaction cost motive for integration.[1]As we shall see, uncertainty is an important motivation in developing countries like India.[2]

This brief review of other theories shows that in many cases, there are underlying transaction cost issues involved. Indeed, Williamson (1985) argues that

> ...transaction cost economizing is the previously neglected but key concept for understanding organizational innovation in general and vertical integration in particular (p.129).

In our empirical analysis in Chapter 5, we shall take account of the different theories in order to assess as to which best fits the facts of vertical integration. It should be remembered that in the distorted markets of developing countries such as India, other factors can also play a part, notable amongst which is Government policy.

Our analysis can be looked upon as an empirical contribution to the literature on the study of economic organization. We may find that some of the received wisdom needs to be qualified or modified when it comes to studying developing country institutions. For example, since suppliers and buyers may have very different technological capabilities in developing countries, production cost differentials associated with different organizational structures may play at least as important a role as transaction cost differentials. This will be pursued in ch.5. It is clear that in order to tackle the issues raised in our review of vertical integration theories, a micro-analytic

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1. If vertical integation still occurs, it must imply that the costs of market governance (i.e. transaction costs) override the benefits of lower production costs and of passing on demand adjustment burdens to sub-contractors.

2. In private communication with the author(May 4,1989), Prof. Williamson agreed that introducing risk-aversion may add some explanatory power to the theory.However, he added that risk aversion may be an important issue in countries such as India, but less so in advanced economies where efficient risk-bearing is less of a problem.

approach will be required. According to Williamson (1985)

> ... greater depth is needed and even essential if the study of economic organization is to progress (p.105).

This is an approach we have taken to heart.

VERTICAL INTEGRATION AND THE INTERNATIONAL AUTOMOBILE INDUSTRY

The traditional (Western) notion was that vertical integration offered certain key advantages to an automobile manufacturer, including more direct control over production, greater protection of proprietary technology and lower vulnerability to opportunistic pricing. A statistical analysis of the determinants of vertical integration in General Motors and Ford was conducted by Monteverde and Teece (1982), taking into account 133 component groupings. Using probit techniques to estimate a log likelihood function, they find that the variable used to proxy transaction-specific skills[1] was highly significant. They also find that components that are firm-specific and need to be coordinated with the rest of the system are more likely candidates for vertical integration. They therefore conclude that transaction cost considerations, particularly knowhow specific to a firm, are important in determining the degree of vertical integration, implying that the relatively high degree of vertical integration in GM and Ford was based at least partly on efficiency considerations. This is supported by other literature on automobiles reviewed in Perry (1989), section 5.2. The merger of General Motors and Fisher Body in 1928 owed, according to the study cited, to their close bilateral relationship and the inability to settle their disputes in the context of a long-term contract. Another study on the US industry found that the quasi-rents in automobile components (the cost of converting the tooling to its next best use) was positively related to the probability that the assemblers owned the tooling equipment.

However, not all the studies support transaction cost reasoning. Crandall (1968) argues that backward integration by automobile assemblers allows them to earn very high returns in the market for replacement parts. This allows price discrimination in the sense of optimal pricing of complementary goods (Perry 1989, p.199).

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1. This was the amount of engineering effort required to design a particular part.

Recent studies have employed further refinements, distinguishing between not only the degree of asset specificity but also the type of capital employed. Using primary data made available by General Motors and Ford, Masten et al (1989) find some evidence to support the proposition that investments in specialized technical know-how have a greater bearing than those in specialized physical assets on the decision to vertically integrate. In order to control for problems of opportunism and hold-up associated with transaction-specific physical assets, various forms of quasi-integration may be sufficient. In fact, in the US auto industry, the manufacturers own specialized tooling which is often used by suppliers to produce components for them. Another study, a reconsideration of the General Motors - Fisher Body merger by Klein (1988), argues that if only physical asset specificity were involved, GM could have bought the dies and stamping machines and asked Fisher Body to use them to produce parts for GM. However, since Fisher was required to make considerable human capital investments to produce auto bodies, the relationship between transactors also had to be changed i.e. full integration was required.

In the 1930s, the Japanese also adopted the American approach. They had, in any case, little choice since the supplier base was very weak. However, when automobile demand began to rise in the 1950s, companies such as Nissan and Toyota

> ...departed from one of the most fundamental strategies of automobile manufacturing: they increased their dependence on firms over which they had little or no financial control (Cusumano 1985, p.241).

This practice offered the Japanese certain advantages.[1] They did not have to sink in large amounts of capital to expand in-house operations. Because of specialization and lower wage scales in supplying firms, they were able to purchase components of equal or better quality for lower cost. This also reduced their risk in the event of demand recession. On the other hand, a more integrated structure could have tended to favour sunk capital investments in production equipment over purchase of new technology from outside suppliers. It could also have found the firm locked in to purchase of components from a subsidiary even if better and cheaper parts were

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1.See Cusumano (1985), pp.241-42 and Altshuler et al (1984), pp.146-49.

available outside.

If suppliers however are opportunistic or expensive, as the American manufacturers discovered, vertical integration may be a preferred option. How did the Japanese manage to avoid the problems that confronted the Americans? Besides the cultural and institutional checks on opportunism that Williamson (1985, p.122) mentions, the hallmark of the Japanese approach was a cooperative and symbiotic relationship between supplier and manufacturer.

No doubt, American firms also cooperated with their suppliers, but they preferred to absorb profitable operations as corporate divisions or consolidated subsidiaries. Moreover, they employed a system of competitive bidding in order to get lowest prices.

> This resulted in savings on specific items but did not guarantee stable supplies, high quality or cooperation beyond existing contracts to solve design or engineering problems that often showed up later (Cusumano 1985, p.242).

According to Schonberger (1982, p.173), relationships have tended to be "precarious and standoffish".

The Japanese, by contrast, function as a highly coordinated group. Each of the major assembler firms were surrounded by hundreds of legally separate but operationally coordinated companies. For example, the Toyota group in 1984 included 10 subsidiaries while Nissan had 17.[1]These reported as financially independent companies although they were very much part of their respective groups in operational terms. Even if the suppliers were not affiliated, coordination was achieved, inter alia, by the formation of suppliers' associations which served as communication and planning links and facilitated discussion amongst suppliers and between them and the company. Some of these suppliers were not exclusive to the assembling firms. Toyota's largest supplier organization, the Kyoho Kai, consisted of about 220 manufacturers of parts and components in 1984. According to Williamson (1985, pp.121-22), these organizations serve, among other things, as safeguards against opportunism on the part of either seller or buyer, owing to more accurate and reliable sharing of experiences and reputation effects.

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1. Cusumano (1985), p.248.

Cooperation was also achieved by the Japanese automakers helping their suppliers in every way they could.

> They risked time more than money to help their suppliers, and learned how to control firms, sometimes without investing in them directly, by dispatching executives, providing technical assistance and loans of equipment or money, and arranging purchases of all or nearly all a company's output for extended periods of time (Cusumano 1985, p.242).

Because of mutual sharing of information, vehicle design became a quicker and more effective process. The members of the group also shared research facilities, support staff and production capacity. In sum, the Japanese system

> ...simultaneously attains the scale and coordination advantages of Western-style vertical integration and the flexibility of decentralization... In addition, the system does not incur the cost penalty of high compensation levels in the supplier chain that typifies integrated production systems in the West (Altshuler et al 1984, pp. 148-49).

In terms of our theoretical structure, we can say that the transactions cost of dealing with suppliers was minimised while production cost economies were being realised at the same time.

By the 1970s, when they had begun to make major inroads into Western markets, the advantages of the Japanese strategy had become obvious enough.

> ...Vertical integration may have made General Motors and Ford more efficient when they competed between themselves or with smaller American or European producers. But this strategy offered no advantage over the Japanese in the 1970s and 1980s, once they perfected (their) production systems... (Cusumano 1985, p.213).

The Japanese example even prompted a strategy reversal by American and some European producers in 1979, when they began to buy in even major mechanical components from component suppliers or other assemblers. Moreover, they are in the process of reducing the number of component manufacturers who supply to them and to develop longer-term relationships in the quest for increased quality, reliability and better technology.[1] This is also because the vehicle manufacturers are looking to find reliable suppliers who can fill gaps in their technical capabilities, particularly in the area of electronics. In other words, the Japanese have left most other manufacturers with little option but to follow suit.

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1. See Altshuler et al (1984), p.148 and p.190, and The Economist, 19 December, 1987, pp.61-62.

The degree of integration of Japanese manufacturers can be illustrated in terms of numbers.[1] If we consider only in-house manufacturing and other costs as a percentage of sales less operating profits, the level of integration was 26% in Nissan and 28% in Toyota over 1979-83, compared to 32% in Chrysler over the same period. The figures for GM and Ford in 1979 were 43% and 36% respectively. However, if we include the operating costs paid to affiliates (those where there is a minimum 20% stake), "group" integration was 73% in Toyota, and 78% in Nissan in 1983, and was therefore much higher than General Motors, the most integrated of the American companies. Moreover, this pattern is not restricted to car manufacturers. Hino, Japan's largest MHCV producer, has 16 companies within its group, and has a group integration level of 60-70%.[2]

It is not as if companies with a high degree of in-house integration are not competitive. Daimler-Benz AG's in-house integration was 48.9% in 1987 (Annual Report). Indeed, transaction cost reasoning predicts that highly technologically-oriented companies such as Daimler-Benz may find it efficient to integrate to a significant degree. Nevertheless, if Daimler-Benz could achieve the low Japanese levels of in-house integration alongwith very good coordination with its suppliers, there is little doubt that it would be even more competitive.

The Japanese system is however not without its social costs. While dependence on one manufacturer may have guaranteed a ready market, it also meant the subjugation of the independence of the subsidiary, as is brought out in Halberstam (1987, Ch.26). For example, Nissan imposed its will on its subsidiaries in the matter of the pay scales that they paid to their workers, and even demanded subservience from them. Another cost is the transferring of the burden of adjustment to the supplier, although here Aoki (1984, p.29) argues that this paradigm does not "seem to capture all of the subtleties involved in the subcontracting system". Perhaps it is truer to

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1.These figures are drawn from Cusumano (1985), pp.188-91.

2.Information gathered during visit to Hino in 1987.

say that [1]

> ...the monopolistic and/or monopsonistic power of parent firms may be located in their ability to extract monopolistic and/or monopsonistic gains on the average over the business cycle, while absorbing by themselves a portion of any shocks via variations in earnings (Aoki 1984, p.28)

VERTICAL INTEGRATION AND SUB-CONTRACTING IN INDUSTRIALISING COUNTRIES

Relatively little work has been done in industrialising countries (ICs) in the framework of a cost-benefit analysis of VI at the level of the firm. Rather, the focus has been on sub-contracting by large firms to small-scale firms, which brings in issues relating to development of small-scale industry (SSI). Nevertheless, we will cull out from this as well as other literature the issues that have a bearing on our analysis.

In general, manufacturing firms in ICs are more integrated than their developed country (DC) counterparts. This has been found to be the case, for example, in Taiwan, Philippines, Latin America, India etc.[2]The most commonly cited reasons are a small size of the market (exacerbated by low levels of standardization) and shortages of engineering and entrepreneurial skills. In the case of India, Rosen's (1959) study first drew attention to the fact that the larger engineering firms usually produced all their requirements in-house.[3] This, according to the survey by Nagaraj (1984), was the general situation all over the country at that time, but has gradually evolved towards greater sub-contracting over time.

What are the factors that have promoted the growth of sub-contracting in Indian industry?[4]

1.Aoki (1984) cites a survey by Japan's Ministry of International Trade and Industry, wherein 7.7% of the subcontractors ascribed shock-absorbing as an important reason for sub-contracting by parent firms, whereas 74.5% listed long-run reliable relations. Besides the efficiency motives mentioned earlier, the desire to keep the parent firm's employment structure as undifferentiated as possible is considered to be a primary motive for disintegration in Japanese firms (Aoki 1984, pp.26--29).

2. See Katz (1987), p.28, and his footnote 29 for some references.

3. Based on data for some factories in and around Bombay in 1955-56.

4. This draws from Nagaraj (1984).

Cost competitiveness of small-scale firms is an obvious determinant, based on lower wages and overhead costs as well as economies of specialisation. Another very significant factor is the attempt by firm management to curb the power of trade unions, which have taken deep root in India, by conscious avoidance of additional employment in large firms. Burden of market adjustment is also often passed on to sub-contractors, via delay in payments, refusal to take delivery, and postponing inspection of materials. Also, lay-offs are much easier in small firms since labour is less organized.

Policies to promote small-scale industry originated with the Government of independent India, and gradually became more effective over the fifties and sixties.[1] Corespondingly, the potential for viable sub-contracting also increased. Currently, the most import promotional policies are differential excise duties (important concessions are given to SSI), reservation of products for exclusive production by SSI, and preferential access to credits and inputs. As against these, excise taxes are levied at each stage of production, which results in a cascading tax effect. This, however, has sought to be reduced through the promulgation of the MODVAT (modified value added taxation) scheme. On the whole, Government policies have promoted the growth of sub-contracting in the country. These, alongwith the factors mentioned earlier, as well as the natural evolution of industry and diffusion of skills, have contributed to the growth of sub-contracting in Indian industry.

Empirical Literature on India

Papola and Mathur (1983) undertook a survey of 104 large and 237 small metal engineering enterprises in Kanpur. They found that the main impulse for sub-contracting was a spurt in demand which could not be met within the capacity of the large or medium-size firms. This was particularly the case for the medium-size firms (employing 10 to 50 workers), where expansion would have meant their coming under the purview of the Factories Act, and having to pay additional benefits to employees. For the larger firms, reduction in cost and meeting seasonal excess demand were major considerations in sub-contracting. Older enterprises were found to have

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1. See Little et al (1987) ch.3, for an account of these policies.

greater linkages with small enterprises than newer ones. There was substantial diffusion of skills, two-fifths of the small entrepreneurs in their survey being ex-employees of large enterprises in similar lines of production.

A detailed firm-level analysis of sub-contracting in the electronics industry was done by Annavajhula (1988). The firm concerned, Keltron, was able to sub-contract part manufacture to SSI firms at 60% of what it would have cost to make the item in-house. The numerous problems faced by both buyer and suppliers are documented, and the minimal assistance given by the large firm to the suppliers highlighted. Inspite of these transaction costs, Keltron was planning to expand its subcontracting operations to bolster its sagging market share by cutting costs and penetrating areas of market growth.

Nagaraj (1984) has put together some information on sub-contracting practices by large firms. In a study of 18 member firms by the Bombay Chamber of Commerce, it was found that most of the work given to sub-contractors was labour-intensive and involved simple technology, including machining, fabrication, metal pressings, sub-assembly etc. Another finding was that the firms, which were some of the big names in Indian industry, usually offered technical assistance to their sub-contractors, and in some cases also provided financial assistance, raw materials and tooling.

There are also a few studies dealing more specifically with the automotive industry. Narayana (1989) surveys 60 suppliers of 4 automotive assembly firms in the mid 1980s. Unlike the studies mentioned earlier, he includes both large and small firms in his sample of suppliers. He divides the suppliers into three categories -- parts and component manufacturers (category A), which are older and usually larger firms; parts manufacturers (B), somewhat smaller firms who also supply part of their output to category A; and small firms doing job-work (C). The relationship between the assemblers and suppliers was found to be largely governed by the structure of the supplying segment. In category C, the intense competition arising from low capital requirements and ease of entry results in an unequal relationship -- they sell over two-thirds of their output to one assembler, whereas the assemblers parcel out the same job to a number of suppliers. This con-

trasts with large firms in category A, who sell to five or six assemblers. Also, the prices offered for category C firms were sticky for long periods, but for large firms the increases were fairly substantial.

In another study, Lall (1980) interviewed 36 firms of all sizes supplying to ALL and Telco. He found that technical linkages were extremely widespread. In the case of small suppliers, there was a continuous input from the assemblers in the form of quality control, technological upgradation, sample testing and design assistance. For larger suppliers, there was a two-way interchange, particularly for complex but related technologies like pistons and transmission components.

Two case studies have been reported by Pandit (1984), on Escorts (motorcycles) and Eicher Goodearth (tractors). More than 70% of the value of the motorcycle is bought out, and of 400 suppliers to Escorts, 250 supply more than 50% of their output to the company. Over 90% of the suppliers were reportedly associated with Escorts since 1962. According to the company, large suppliers dictated their own prices, whereas for smaller ones a "fair return" was sought to be provided. The company provides technical but no financial assistance to its small suppliers. In the case of Eicher, the rates of bought out parts to sales (less excise) was as high as 81%, including 40-50% from large and medium firms, 20-25% from castings and forgings markets, and the rest from ancillary units (small scale units supplying more than 50% of output to other industries). Pricing policy was the same as that of Escorts. According to the management, the lower price of its tractors vis-a-vis competitive makes owed to its efficient ancillary development programme. Another reason for ancillarisation is brought out by the Escorts strategy of using it as a means for generating funds - sales are against cash but 30 days credit is given by suppliers, resulting in generation of working capital.[1]

Literature on Automotive Industry in other Industrialising Countries

Watanabe (1983a) and Fujimori (1986) have analysed the automobile industry in the Philippines. As Narayana (1989) found for India, Watanabe (1983a) discovered that in the low-tech-

1. Quoted from an article in India Today by Nagaraj (1984), footnote 23.

nology items, there was cut-throat competition among supplying firms, resulting in a very unstable relationship between buyer and seller. When relatively sophisticated technology was required, larger firms with superior skills and equipment were able to enjoy a secure original parts market. In general, the indigenous parts industry has not developed very much in the Philippines, and its "fragile base of existence" can be explained mainly by the

> ...narrow, unstable market and the way they (the sub-contractors) related to assemblers in terms of transactions between the two (Fujimori 1986, p.363).

Odaka (1985) surveys the nascent automobile industries in Indonesia, Malaysia, Thailand, the Philippines, as well as the more developed ones in Korea and Japan. In the late 1970s, local parts production in the former group of countries was confined to those with relatively lax engineering constraints, or those which had a wide replacement market (which imparted some scale economies). In a more detailed survey of 60 metal-working firms for the Philippines, Odaka finds that the majority of the original equipment suppliers considered that the establishment of a regular subcontracting relationship with their assemblers had contributed to the improvement of their productive efficiency.

It is axiomatic that two of the most highly developed automotive industries in the industrialising world, those of Brazil and Korea, also have very competent component manufacturing industries. According to the EIU (1987a) report, Brazilian assemblers buy in about 45% of their components and 65% of the value added. The Korean industry is less developed than its Brazilian counterpart, and the assemblers are relatively more integrated. However, there are variations between companies. Hyundai and Daewoo motor companies are part of big conglomerates. Besides in-house production, they rely on their respective group companies for many other components. Kia and Dong-A rely more on independent suppliers.[1]

Interpretation

In ICs, sub-contracting has increased over time as the production cost differentials become

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1. See EIU (1987b), p.57 and Sung-Hwan Jo (1988), pp.31-32.

increasingly more important than transaction cost ones. In fact, with the growth in specialization and diffusion of skills, the production cost penalty of VI increases. In addition, with increasing experience and the availability of more suppliers, the transaction cost advantage of VI should decline over time. Of course, the situation can differ across firms and industries.

There is similarity across countries in the kind of output produced by SSI firms -- low-technology, usually more labour-intensive, and less critical as an input for the buyer's final product. The transactions cost of dealing with (less reputed) SSI firms is sought to be controlled by providing them with technical and sometimes financial assistance, and in spreading the demand across a number of SSI firms.

None of these studies, however, makes an explicit attempt to analyse the costs and benefits of sub-contracting/VI. Also, the usual focus, with a few exceptions, is on the sub-contractors i.e. the supplying firms. The analysis in chapter 5 will be a departure from this literature. We will assess the costs and benefits of different levels of buying in for different firms, and do an inter-firm comparison. Moreover, the focus will be on the buying firm, in our case the manufacturers of commercial vehicles, and we will look at the broader question of inter-firm linkages than the narrower one of sub-contracting from large to small firms.[1] In spirit, therefore, our analysis will be closer to some of the firm-level studies reviewed in the earlier section on the international automobile industry.

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1. Lall (1980) and Narayana (1989) have considered inter-firm linkages, but have not considered the costs and benefits. Lall, however, has pointed out the possible costs and benefits of linkages that may accrue to buyers, suppliers and the economy as a whole.

ECONOMIES OF SCALE AND SCOPE AND PRODUCTION TECHNOLOGY

Definition of Economies of Scale

Crudely, economies of scale refers to lower per unit costs arising from increasing size of plants and firms.

As required by static neo-classical theory, the concept of scale increase was restricted to increases based on existing factor proportions. In other words, technology was fixed and the larger plant was essentially an enlarged version of the smaller one. However, as Gold (1981) points out, this is unreasonable

> ... because such restrictions tend to minimize or prevent the benefits whose expected realization is a primary motive for considering increases in scale (p.14).

These restrictions are particularly inadmissible in the long-run where, by definition, all inputs are variable and new and more efficient technologies can be applied. Clearly, it is not possible to satisfy the requirements of this theory in empirical work.

On the other hand, certain minimum conditions must be fulfilled for a valid comparison of scales across plants.[1] For one, the products and product-mixes of the different firms must be in competition with each other. Secondly, the plants must not differ substantially in their degrees of vertical integration. If they do, we may in effect end up by comparing two organizations less dissimilar in scale than orginally intended - a smaller but less integrated plant can buy some components from a specialized manufacturer who may be as large or larger than the corresponding in-house unit in the more integrated plant. These conditions will need to be kept in mind in the course of empirical analysis in Chapter 6.

Scale economies can arise both in production as well as in product development, marketing, distribution and so on.[2] One of the most commonly cited factors responsible for production economies is change in techniques of production. For example, as volume of production of a single product increases, it becomes possible to substitute flow production for batch production.

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1. See Gold (1981), pp.15-17.

2. See Scherer (1980), pp.81-84, and Pratten (1988), pp. 9-14, for a discussion.

Another factor is indivisibility i.e. costs which are wholly or partly independent of output, such as the initial design, development and tooling costs for a new model, pieces of capital equipment setting up a marketing office or a distributor network, and so on. Economies of specialization are also an example of an indivisibility, as are the economies of increased dimensions. As output increases, there are greater possibilities of specialisation of both labour and capital, such as employing staff with more specialized skills. Economies of increased dimensions arise from the fact of initial and operating costs increasing less rapidly than capacity. Labour and energy usage tend, within limits, to rise less than proportionately with scale-up of machines. Economies of massed resources may also be achieved by larger plants owing to the proportionately reduced requirement for spare parts, reserve equipment, final goods inventory, number of repairmen, and so on. Another economy relates to the learning arising from cumulative outputs of products and the length of production runs or "learning by doing".

While the economies from changes in techniques and learning are product-specific, the others mentioned above pertain to the plant as a whole, possibly producing a number of products. Moreover, to the extent that the other products produced are technologically similar (such as cars and light vans), even the technical and learning economies can encompass the plant as a whole. This phenomenon can be referred to as the "economies of scope", which can be formally defined as the situation when for outputs y1 and y2 the cost of joint production is less than the cost of producing each separately i.e.

$$C(y1, y2) < C(y1, 0) + C(0, y2)^{1}$$

In fact, as we have seen in discussing plant-level economies, economies of scope need not be restricted to production costs only, but are applicable to product development, specialisation, indivisibilities, and so on. It would therefore make sense for firms to try and diversify into areas where economies of scope are maximised. According to Teece (1980), however, scope economies do not necessarily explain the degree of diversification of a firm since organizational issues

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1. See Teece (1980).

are usually neglected in discussions on scope economies. He contends that it is only when the common inputs or services are not easily tradeable in the market will they be internalised. Only knowhow and specialised and indivisible physical assets are considered to exhibit such characteristics. Thus, Teece extends Williamson's transaction cost explanation for vertical integration to explain diversification as well.

Vertical integration is also relevant to a discussion of scale economies. Different processes in the chain of production require different minimum efficient scales of production, as we shall see. A firm could therefore achieve minimum efficient scale by disintegrating from scale-intensive activities and focusing on the non scale-intensive ones.

Yet another size-related discussion has focused on the economies of multi-plant operations. The question, as posed by Scherer, is that are there any economies of multi-plant operation beyond those enjoyed by a single plant of optimal scale?[1] Potential advantages lie in serving geographically dispersed markets from different plants to economise on transport costs, and/or to specialise in different products at the different plants. There are also possible capital-raising and pecuniary economies including greater monopoly power, the ability to spread risks, and cost advantages in raising equity capital. Finally, Scherer refers to the economies of large-scale promotion in which concepts such as a possible threshold level of advertising and a far-flung, high-quality dealer network are discussed. The latter

> ...advantage of large size probably persists out to larger nationwide sales volumes than any other scale economy in the automobile industry (Scherer 1980, p.112).

Scherer's empirical work for the U.S.A. does indicate the possibility of the existence of multi-plant economies, with product differentiation and the "....need for sales and production strategies geared to buyers' preferences for broad-line suppliers...." predominating as the source of such economies across a range of industries. Much, however, depends upon the particular market segments that the firm addresses.

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1. See Scherer (1980), pp.100-118. In much of the discussion, it is assumed (on the basis of empirical evidence for the USA) that large size and multi-plant operation go hand in hand.

Scale and Technology in the Automobile Industry

In the automobile industry, there has been an evolutionary sequence of technological developments which has progressively re-defined the level of the minimum efficient scale of production. The most commonly quoted example is that of the Ford Motor Company which was a pioneer in the development of mass-production technology.[1] In the early years, prior to 1907, universal or general purpose machines (GPMs) capable of a wide range of tasks were used. These were fitted with jigs and fixtures to speed up production, to improve machining accuracy and to reduce skill requirements in production and assembly.[2] The layout of machines was functional i.e. by type of machines.

By 1907, output at Ford was high enough (6000 vehicles per year) to permit the use of many GPMs as single-task machines i.e. as semi-special-purpose machines (SPMs). By 1910, SPMs had come into extensive use. Machine layout was also changed from functional to sequential i.e. to type of product. In other words, milling and grinding, for example, were replaced by departments such as axle, gearbox, connecting rod and so on. This reduced dramatically the transportation requirements of materials and components within the factory.

In 1914, Ford moved fully into the era of mass production, by which time output had increased sufficiently to allow the introduction of the mechanized assembly line. To a much lesser extent, flow production methods were also adopted in manufacturing departments. This mass production technology was made possible through product standardisation and a high degree of division of labour.

In the 1950s, automatic flow methods in manufacturing departments became a reality through the combination of SPMs and conveyors and chutes. This required organizing SPMs into lines of "transfer machines" and by automating the transfer of material from one operation to the other. Transfer machines require a very large scale of production.

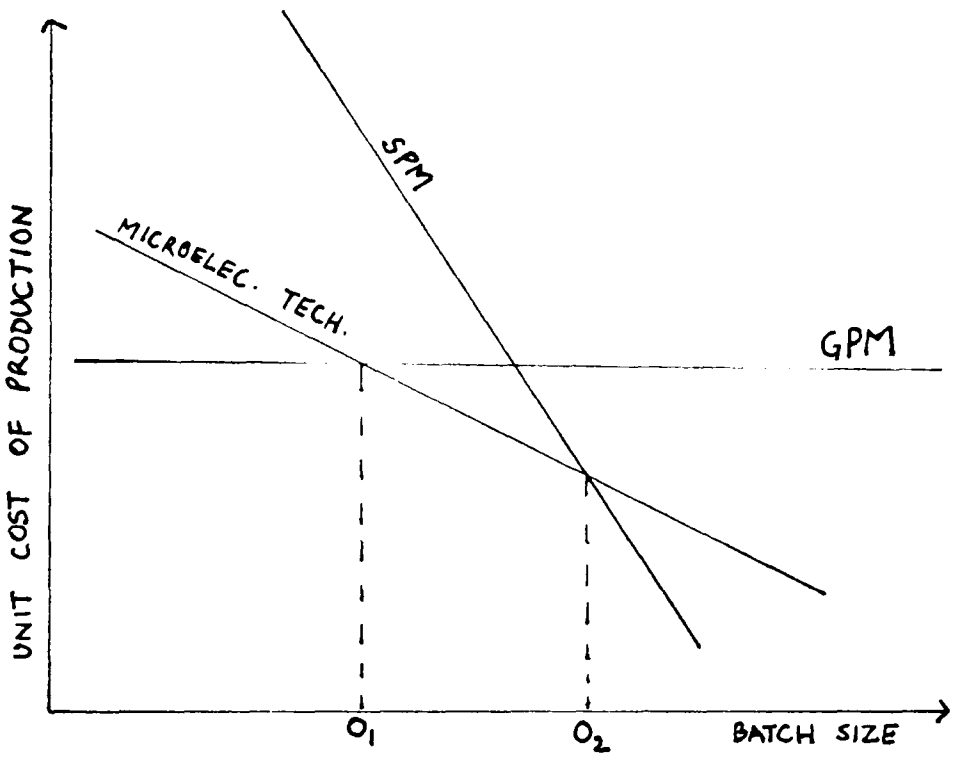
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1. Olds Motor Works were, however, mass producing cars as early as 1901. Ford developed and perfected the innovations of Olds.

2. See Lewchuk (1987), pp.52-65 for an account of production methods in the Ford Motor Company.

More recent developments in microprocessor technology in the 1970s and 1980s have seen the increasing use of numerically controlled (NC) machines. These machines have made it possible to reduce the down-time between change of batches. They are considered to be most efficient for recurrent production of small and medium-size batches.[1] A number of NC machines and robots can be grouped together to form a "machining cell" and "flexible manufacturing systems" (FMS).

Diagramatically, a simplified form of the relationship between unit cost of production and output (size of batch) can be represented as in Figure 2.1.



Upto a batch size of O_1 , GPMs, which are the most flexible, offer the cheapest solution. GPMs are therefore used for very small lots unless the shape of the product is too complex or the tolerances required too exacting. For batch sizes between O_1 and O_2, NC machines and robots are optimal. They offer great flexibility in dealing with different requirements of shapes, batch sizes, materials and tolerances, and also allow easier control of the production process because instructions can be written into a programme which would then be carried out by the machine.[2] The advantage of NC machines is that they can be adopted on a piecemeal basis at relatively moderate cost, and can be used in conjunction with GPMs and SPMs. However, when a group of such

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1. Watanabe (1987), pp.15-16.

2. Watanabe (1987), p.16.

machines is placed together, linked by a complex material handling system - the FMS - the technology is less divisible, and also expensive.[1] Since the initial investment per unit of output in FMS is higher than for conventional GPMs/SPMs, the firm must be large enough to amortize this investment over its different models/products. The relevant dimensions to consider in making the investment decision are overall firm size as well as the size of the individual product/batch.

Beyond O_2, SPMs come into their own. They are specifically designed for a particular operation and are therefore not flexible but are much faster than GPMs and NC machines. Of course, the exact location of O_1 and O_2 depends on a number of factors such as the nature of work, the degree of complexity of the work, quality of workers, and size and weight of the workpieces.[2]

Production Processes and Scale Economies

The automobile industry brings together a large number of production processes viz. casting, forging, machining, stamping, welding, painting and final assembly. Heat treatment is also required between some of these processes. With the growing popularity of plastics, plastic moulding is a new process that has recently been added to the list. As can be expected, minimum efficient scales of production vary significantly depending on the process and the nature of the product.

Different studies have come up with somewhat different conclusions regarding minimum efficient scales of production in different processes, as can be seen in Table 2.1.

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1. Ray (1989), pp. 12-13.

2. Watanabe (1987), p.16.

Table 2.1.

Estimates of Minimum Efficient Scale of Production of Cars

(Thousand units per annum)

	Casting	Machining	Stamping	Assembly	Overall One model	Overall Complete model range
Pratten-1971	1000	250	500	300	500	1000
Rhys-1972	200	1000	2000	400	-	2000
White-1971	small	260	400	200	400	800
University study group	1000-2000	400-1000	500+	200-400	200+	1000+

Source: Bhaskar (1980), p.55.

It should be kept in mind that none of the studies quoted in the table have taken account of the new microelectronic technologies.

For casting, estimates of minimum efficient scale vary from "small" to 1-2 million units per annum. According to Pratten (1971), who puts the figure at about 1 million units, economies in forging are also achieved at a similar level.

For machining of items such as engine blocks and transmission equipment, the estimates vary from 250,000 to 1 million. Stamping of body panels is probably the most scale-intensive process, with estimates varying from half a million to 2 million units. On the other hand, assembly is least susceptible to scale economies because it remains, in a strictly relative sense, the most labour-intensive operation. Efficient scales in this operation have been put at 200,000 - 400,000 cars.

On the whole, the consensus in the 1970s appeared to be that a car manufacturer should have production runs of at least 200,000 for individual models and at least 1 million overall.[1] Earlier, the very influential study by Maxcy and Silberston (1959) had predicted that most cost savings would be exhausted by 100,000 units, but this was prior to the introduction of more automated

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1. Bhaskar (1980), p.54.

techniques in assembly. As we saw, microelectronic technology is optimal at intermediate levels of output. According to Altshuler et al (1984), the increasing use of flexible automation in assembly, for example, will mean that firms would be able to assemble a wide range of products on the same assembly line. A plant may therefore be highly efficient if the cumulative output spread over several models is as low as 240,000 per annum.[1] In some components such as stampings and engine gearboxes, however, large scale of at least 500,000 units per annum will continue to be necessary. On the whole,

> ... scale requirements in general are no longer the driving force for industry concentration they have been in the past (Altshuler et al 1984, p. 182).

As we know from the earlier part of this chapter, no firm is fully vertically integrated. The automobile manufacturer or assembler buys a wide range of components from the highly developed and specialized components manufacturing sector. By purchasing scale-intensive items such as engines and body stampings from outside, even relatively small firms can offer competitively priced automobiles.

Non-Production Economies

In an earlier section, we had outlined the possible sources of economies of scale in non-production activities. These operate mainly at the level of the firm as a whole. One of the most important are those associated with the initial costs of research and product development.[2] Although there is no conclusive evidence to show that larger firms are proportionately more R&D-intensive than smaller firms, it may well be that they can commercialise an invention more effectively. It is certainly true that in industries such as automobiles where R&D outlays tend to be very large, a bigger firm will be able to spread these costs over a larger output. Moreover, as Teece (1980) suggests, the market for knowhow may be imperfect, making it difficult for a small firm to have an effective external substitute for internal R&D.[3]

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1. Altshuler et al (1984), p.182. But see next section on non-production economies.

2. See next section on Technological Change for an extended treatment.

3. This does not mean that firms do not purchase knowhow from outside. Many automobile firms, for example, engage the services of specialist design firms.

The effect of including product development costs in estimating minimum efficient scales of car production can be startling. Without including development costs, minimum efficient scale for car production in the 1980s were estimated at 0.5 million by Muller. Muller and Owen included development costs and estimated the minimum scale at 2 million units per year.[1] In an earlier study, Pratten (1971), using data for the 1960s for the British automobile industry, found that initial costs (including design, testing and tooling) per car declined from £55-80 to £16-26 when output (over four years) increased from 200,000 to 1 million.[2] However, Altshuler et al (1984) contend that new hardware combined with computer-aided design, engineering and tooling is reducing the total number of units that need to be produced to recoup development costs.[3]

The other primary source of economies arise at the distribution and marketing stage. Where the market being served is large, a large firm operating a number of plants could economise on transport costs. As far as marketing is concerned, there are economies of advertising, dealership and sale and service. A widespread dealer network and service centres could be a critical factor in determining the quantum of sales. This implies that the size of the market that a manufacturer chooses to serve (luxury or mass market) is not the only determinant of its sales. A large firm with a wider dealer network could sell higher volumes of a model than could a smaller firm of the identical model. It could also spread the risks involved in style changes because it can adopt a number of styles simultaneously.

For the domestic market in the USA, Edwards, in 1965, estimated a minimum output of 400,000 units to achieve an efficient dealer network.[4]

Other economies relate to specialisation, learning and so on, but these are not as significant as those discussed above. On the whole, non-production economies tend to add to the production-based advantages of scale. It seems that economies of scale are never fully realised in the auto-

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1. Quoted in Pratten (1988), p.49 and p.86.

2. Pratten (1971), pp. 131-37.

3. Altshuler et al (1984), p.182.

4. Quoted in Pratten (1971), pp.145-46.

mobile industry, and potential exists for achieving economies upto an output level of 2 million identical units per year, neglecting possible diseconomies of scale.[1] It is true, however, particularly with the increasing use of microelectronic technologies, that cost penalties for operating at much lower scales have been significantly reduced.

Economies of Scale and Scope in Commercial Vehicles

Our discussion has so far focussed on car manufacture. Very few studies have made separate estimates for minimum efficient scales in commercial vehicles (CVs).[2] The principles and production processes are, of course, very much the same, with the difference that the market size, particularly for heavier CVs, is much smaller than that for standard cars.

At the lowest end, there is the category of compact pick-ups, vans and utility vehicles - very light CVs in our classification. These are generally less than 2 ton GVW, and have substantial commonalities with cars in terms of engine and even body parts. The common objective in both cars and vans is driver and passenger comfort, partly because both are owner-driven vehicles. Such vehicles are produced and sold in very large number. For example, retail sales in 1985 of domestic manufacturers of CVs upto 6000 lbs (2.67 tons) GVW in the USA were 2.4 million, compared to 8.2 million cars.[3] In Japan, 1986 production of "light" vans was 1.2 million and 1.9 million of "small" trucks of upto 2 ton loading capacity. Large manufacturers such as General Motors (USA), Ford (USA), Toyota, Nissan, Chrysler, Mitsubishi and so on manufacture such vehicles in volumes ranging from 0.4 million to 1 million. Besides this, there are also the economies of scope with cars in the production process, which enhance the scale economies of very light vehicle production. Table A.2.1 gives an idea of the production of different US commercial

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1. Bhaskar (1980), p.54. Diseconomies will be treated in a subsequent section.

2. In fact, an exclusive study on any aspect of the commercial vehicles industry is a rarity. Rhys (1972, 1984) has made some of the rare contributions in this area.

3. MVMA Facts and Figures (1986), pp.16-17. Both the figures for CVs as well as cars do not include imports.

vehicle manufacturers disaggregated by weight class.[1] The smallest manufacturer listed in the 0-6000 lbs class is Nissan Motors (USA), selling 96,827 vehicles in 1986. However, this company is importing a substantial part of its requirements from its parent company in Japan, and could therefore enjoy scale economies even at lower volumes.

The next size class in Table A.2.1. is from 6-10,000 lbs (2.67 - 4.5 tons) GVW. Sales range from over 100,000 by Chrysler to over 500,000 by Ford and General Motors. Given the size of these vehicles, there is less commonality between them and cars. By the same token, there is a degree of commonality between light vans and pick-ups and the 6-10,000 lbs class.

In other words, firms who manufacture the range from cars to very light vans to light vehicles will enjoy a good measure of production synergies. In fact, there is no important producer of light or very light CVs in the world who does not also manufacture passenger cars.[2] A reasonable inference from this is that production (and non-production [3]synergies between very light and light CVs and cars must not be insignificant. This synergy would at least partly explain the continued competitiveness of manufacturers with very varying scales of very light and light vehicle production.[4]

In the USA, production in the range from 10-19,500 lbs (4.5-8.7 tons) GVW is relatively insignificant, as Table A.2.1. shows. This is less true for other major producers such as Germany,

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1. The table shows sales, but we can assume that domestic sales represent own manufacture (in the US, Canada and Mexico).

2. See, for example, the listing of the top 40 vehicle manufacturers in the world in MVMA (1988), p.16.

3. Non-production synergies would obviously exist but, as we have seen, these are less specific and are related more to the size of the firm as a whole. See also next footnote.

4. It may be said that the same is true for heavy vehicles, since there are non-production synergies between heavy vehicles and cars. Indeed, Saab-Scania and Volvo are examples of two firms which make (up-market) cars and heavy CVs and do not manufacture light CVs. However, in heavy vehicles market specificities and niches are much more important than for LCVs, and price competition is, to that extent, much less than for LCVs. Therefore, in the heavy vehicles sector, firms of very different sizes have survived (even without synergies with cars), the more so because the total market is much smaller and production methods are more labour-intensive than for LCVs. Moreover, many relatively small manufacturers of heavy vehicles are less integrated. In other words, the heavy vehicle-car synergy is not decisive, unlike the light vehicle-car synergy.

Italy and particularly Japan.[1] Major Japanese producers manufacture vehicles in the 5-6 ton GVW segment in volumes exceeding 100,000. Daimler-Benz of Germany, on the other hand, produced 16,461 4-5 ton GVW CVs in 1986, and corresponding production in Italy was 10,289.[2]

Upto a capacity of 6 tons GVW, we are in the domain of what are generally referred to as light vehicles. The most popular fuel is petrol. All major manufacturers producing light vehicles also manufacture passenger cars. Production techniques are also generally volume oriented i.e. of the passenger car-type. Beyond the 6 ton segment is the exclusive territory of the diesel engine which, although heavier and costlier than an equivalent petrol version, is more fuel efficient and also more durable.[3] Rhys (1984) has presented some estimates for minimum efficient scales in this sector, based on data collected from a number of vehicle manufacturers and component suppliers, in Table 2.2.

Table 2.2:Minimum Volumes for Optimum Production of Medium/Heavy Vehicles(Annual figures)

Cabs	200,000 +
Chassis frames	40,000 +
Axles	40,000 +
Engines	200,000 +
Final assembly	100,000 +

Source : Rhys (1984), p.25.

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1. In 1988, Japan produced nearly 1.5 million trucks in the range of 3-4 ton loading capacity (approximately 5-6 tons GVW) (JAMA 1989, p.19).

2. MVMA (1988), p.157 and 185.

3. A diesel engine relies on heat generated by compressing air in its cylinder which ignites fuel. A petrol engine, on the other hand, relies on a spark plug to ignite the fuel. See OECD (1983), p.57 and The Economist, January 20, 1990.

Table 2.3 Inter-firm Comparison of Typical Commercial Vehicle Output, 1978-80.

Typical output of trucks over 6.0 tonnes gross weight and buses (Medium)		Typical output of trucks over 15 tonnes gross weight (Heavy)	
Large		Large	
Ford (US & UK)	160,000	Daimler-Benz	70,000
General Motors Corp. (US & UK)	130,000	Large-Medium	
Daimler-Benz	150,000	Iveco	40,000
Iveco	80,000	Mack	35,000
International Harvester	85,000	International Harvester	35,000
Medium		Medium	
Hino	36,000	Volvo	25,000
Renault	40,000	Hino	16,000
Mitsubishi	25,000	Renaul	20,000
Volvo	30,000	Scania	18,000
Scania	25,000	General Motors Corp(US)	25,000
Nissan Diesel	35,000	Paccar	22,000
Isuzu	35,000	Ford (US)	25,000
Mack	35,000	MAN	16,000
Leyland	28,000		
MAN	22,000	Small-Medium	
Paccar	22,000	Mitsubishi	11,000
		White	12,000
Small-Medium		Nissan diesel	12,000
Freightliner	10,000	Leyland	12,000
Dodge(UK-Spain)	15,000	Isuzu	12,000
DAF	15,000	DAF	10,000
Enasa	10,000	Freightliner	10,000
		Ford (UK)	7,000
Small		General Motors Corp(UK)	9,000
Sonacome	6,000	Dodge	7,000
ERF	3,000	Enasa	7,000
Seddon Atkinson	3,000	Bedford	7,000
Foden	1,500		
Others	(1,000-250)	Small	
		ERF	3,000
		Seddon Atkinson	3,000
		Foden	1,500
		Other, eg. Hestair Dennis, Mowag, Faun	Below 500

Note:This table does not include commercial vehicle production by licencees of the firms listed here (eg MANs licencees in Hungary and Romania) or various Comecon producers such as the factories supplying Belaz vehicles in the USSR or Ikarus buses in Hungary. Neither does it include the sixty-five or so firms making less than 1,000 vehicles a year. Source: Rhys (1984), p.29.

The information in Table 2.3. on typical CV output amongst major manufactures, when seen in the light of Table 2.2, implies that smaller firms may experience cost penalties even if they bought in to the maximum extent possible.[1]

The volumes in Table 2.2 assume a spread of car-making techniques to the medium and heavy commercial vehicle (MHCV) sector. This has indeed occurred over the last decade. Traditionally, the smaller size of the MHCV market has inhibited investment in new techniques. However, in Continental Europe, for example, some firms invested in massive computerization, rationalization and standardization, new equipment and control techniques, in the hope that the resulting flexibility and lower costs would allow greater volumes. In some cases, a very high degree of standardization has been achieved through ingenious engineering. For instance, Daimler-Benz designs its vehicle cabs on a unitary principle which gives it final product variety with the same basic parts, and reduces the number of parts required at its Woerth factory by 50 percent with similar savings in manufacturing man-hours. Similarly, the same transfer line at Mannheim can machine different engines irrespective of their final size, giving it volumes of around 200,000 units. Even specialist diesel engine manufacturers in Europe fell short of these volumes.

Yet another method by which large firms have sought to enhance their scale advantage is by collaboration. Even Daimler-Benz, the world's largest manufacturer of MHCVs, has gone in for engine design and component manufacture in collaboration with MAN, also of West Germany. According to Rhys (1984), it required about £200 million to introduce a new engine in the early 1980s, of which half were software costs such as research, development and testing. Thus, even collaboration in the research stage alone can yield very substantial benefits.

These developments - new investments, increasing flexibility and wider product range, rationalization and standardization, and collaboration - has put a squeeze on small specialist firms

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1. As annual output of heavy trucks increased from 1,000 to 10,000 to 50,000 to 100,000 the index of unit costs of assembly declined from 140 to 120 to 106 to 100. See Rhys (1984), p.27. The next four paragraphs also borrow heavily from Rhys (1984).

because the larger firms are encroaching on their territory. In the case of passenger cars, income differences and personal tastes do provide a niche for specialist firms. In MHCVs, customers are looking to maximise their revenue to cost ratio in the segments of the market in which they operate. By offering a wide range, the larger firms are able to meet many of the requirements in the different sectors at lower unit cost than the specialized firms, and the latter cannot charge the price premiums necessary to cover their higher cost of production.

Thus, most MHCV firms are on a falling long-run average cost curve and are of sub-optimum size. The market is not large enough to allow all firms to reach the optimum. In the USA, mergers and rationalization have already taken place, and are also occurring in Europe. Japan has only four firms supplying the domestic and export markets. Of the small firms, only the highly specialized (offering custom-built vehicles, or occuping niches such as for fire tenders, super heavy-duty trucks etc.) ones may eventually survive.

MHCVs contain a higher proportion of material inputs than lighter vehicles, which tends to dampen the economies of scale.[1] However, the smaller market for heavier vehicles means that firms producing them employ more manpower per vehicle,although in proportionate terms the share of labour in total cost may be lower than that for LCVs owing to higher material costs. Also, the ratio of capital to labour costs would tend to be higher for LCVs since they are produced with more capital-intensive methods. Nevertheless, with increasing competition in the market, MHCV firms have attempted to improve their competitiveness by adopting car-type techniques and increasing the volume and range of output.

As far as economies of scope between different vehicles are concerned, there is no single pattern in the world of MHCVs. In Japan, Isuzu and Mitsubishi produce the whole range of vehicles, from passenger cars to heavy duty trucks and tractor-trailers. Hino and Nissan Diesel are specialist MHCV producers. However, Hino makes cars and pick-ups on sub-contract from Toyota, its largest shareholder. Hino made and sold more than 80,000 MHCVs in 1988, more

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1. Pratten (1971), p.143. This is because economies in purchase and sale of materials are not as great as in manufacture.

than any of the other three. In Korea, the three largest automobile companies viz. Hyundai, Daewoo and Kia-Asia produce the full range. There are also a number of other specialist producers in the world, such as DAF of Holland, and Mack, Freightliner and Paccar of USA. The largest producers in the world, such as Daimler-Benz, Ford and General Motors, manufacture the whole range of automobiles.

Some firms are part of a bigger group which produces a range of non-automotive products. Daimler-Benz, the largest conglomerate in Germany, produces cars, CVs, information technology, production automation systems etc. (AEG), aircraft (Dornier) and jet and industrial engines (MTU). According to the company, there are many potentially valuable synergies in the group's activities. An

> ...outstanding example of the technical and commercial attractiveness of synergestic growth potential is factory automation (Daimler-Benz Annual Report 1987, p.21).

Another example given is the possibility of producing heat-resistant and lightweight materials as a joint project of the whole group and therefore at lower cost. A number of automakers are evincing keen interest in aerospace technology. GM has bought over Hughes Aircraft, Chrysler owns Gulfstream Aerospace, and British Aerospace has taken over Rover. Saab's executives reportedly credit most of its engineering advances to its aircraft heritage.[1] The increasing use of plastics and composites (reinforced plastics) in automobiles will mean that automakers have much to learn from aircraft manufacturers, who have made substantial progress in the use of these materials.[2]

It is difficult to quantify the extent to which scope economies confer an advantage, but there are certain types which lend obvious benefits. One is a widespread dealer network - the same outlet can be used to sell cars, CVs and even other kinds of vehicles such as tractors. Another is the ability to engineer the product so that it can be used in a variety of models, such as Daimler-Benz's engines and cabs. Spreading of R&D costs over a large output is also an asset, although

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1. Business Week December 15, 1986, p.54.

2. See The Economist, September 17, 1988, p.90.

here the quality and focus of R&D is equally important.

Diseconomies of Scale and other Caveats

Our discussion so far has neglected possible sources of diseconomies of scale. Once the volume of production is large enough, initial costs are no longer important. Learning curve advantages tend to flatten out, and specialization in both men and machines may become so great that they become inflexible. Wage rates are often higher in larger plants or firms, owing to stronger union pressures or otherwise.[1] Material flows lengthen and handling becomes complex. Multiple layers of hierarchy are formed, communication becomes slow and decision-making sluggish. As plant or firm size increases, top management becomes further removed from front-line production and marketing operations. Both these factors contribute to managerial diseconomies of scale. Theoretically, all these factors should contribute to eventually negating the advantages of scale and making the cost curve U-shaped. However, the adoption of of a decentralized, multi-divisional form of management, by decentralizing operating and financial authority to product or territorial divisions, could push back or even stay the onset of the upward-sloping part of the cost curve.[2] The adoption by General Motors of the decentralized form of management in the 1920s meant that the largest private manufacturing enterprise in the world was able to restrain managerial diseconomies and prevent its cost curve from turning upward.[3]

Besides the diseconomies phenomenon, which could arise sooner or later, there a number of other issues that need to be kept in mind, as pointed out by Gold (1981):

i) Economies of scale are seldom readily available for the taking. Achieving scale benefits requires extended, costly and risky efforts, adjustments in product designs, product mix and other equipment. Thus, it requires the firm to go beyond the frontiers of its current experience, and therefore does not guarantee the benefits.

ii) As briefly mentioned above, learning curves tend to flatten out. Beyond early familiarity,

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1. Gold (1981), p.20 and Scherer (1980), pp.84-85.

2. Scherer (1980), pp.86-87.

3. Scherer (1980), p.86.

internal improvement results not from a cumulative repetition of past practice but from an active exploration of alternatives via changes in product design, technology, planning, organization and so on.

iii) There is need to avoid a perspective of scale-determinism. If a firm is adding a new plant to its existing ones, it may be motivated by considerations other than scale, such as changes in product variety and quality, replacement of facilities, changes in input quantities and qualities, and so on. Moreover, a firm interested in profit maximization in a dynamic setting may find that unit cost minimisation does not yield that objective. One reason for this could be demand factors that encourage expansion of output beyond levels currently estimated to yield minimum unit costs. Another objective of the firm could be a minimum weighted unit cost over the business cycle rather than a minimum cost at a particular output level, and the scale implications of the former could be very different.

The central message of Gold's extensive survey is that benefits of scale increases are not achieved costlessly and without effort, and that much more rigorous empirical exercises that try to capture the precise effects on unit costs of scale and other factors such as technology, product mix, organization, etc, are needed.

We have so far discussed the advantages and disadvantages of scale and the associated conceptual and empirical problems. However, small firms too enjoy some advantages that enable at least some to survive in highly competitive environments. Smaller firms can be more responsive to the market, and their management more highly motivated. In industries such as passenger cars where scale can lend important advantages, small firms can differentiate their product and cater to a narrow market segment. One of the best examples of this is Porsche, a firm which makes up-market luxury cars and is able to charge a high premium for its product. In CVs, too, there are small and highly specialised firms such as Seddon-Atkinson and Foden. All these firms rely on their speed of response, high technology and product differentiation to continue to thrive in the market.

Economies of Scale and Scope: a Summing-up

In this section, we shall sum up our discussion on economies of scale and scope. We have seen that there are many different dimensions of scale - volume of output of a single product, the size of a batch or production run, output of a plant (which could be multi-product), and the size of a firm (which could be multi-plant). There are also many types of scale economies, both at the production and non-production stage. Economies of scope arise when there are synergies from the manufacture of related products, and these also occur at both the production and non-production stages. If these synergies are limited, then a large, multi-product firm may enjoy lesser benefits of scale than a much smaller but single-product company.

Although the principles of manufacture are very much the same, the market size for different classes of vehicles is very different. The world market for passenger cars exceeds 30 million units per year, while that for MHCVs (over 6 ton GVW) is less than 1.5 million. Light CVs (upto 6 tons GVW) exceed 10 million.[1] All major LCV manufacturers also produce passenger cars, and there are substantial synergies between them, particularly between very light CVs (upto 2 tons GVW) and cars. Therefore, minimum efficient scales for LCV production must in fact be a joint estimate for LCVs and cars. The three largest car manufacturers in the world - General Motors, Ford and Toyota - are also the largest manufacturers of LCVs. Within LCVs, Japanese producers dominate in the 5-6 ton category, with volumes as large as car production of some of the smaller car manufacturers.

In the category above 6 tons, there are a few dominant firms alongwith a host of small, specialised ones. With increasing flexibility and a wider product range, the larger firms have been able to increase their production volumes and reduce their unit costs, thereby putting pressure on the specialised firms. Specialised firms have to respond by become even more specialised and alert to market demands. Unlike LCV firms, all MHCV firms are not multi-product, although the three largest produce the full range of automobiles.

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1. Figures drawn from MVMA (1988).

Non-production economies tend to increase the minimum efficient scales of firms, particularly in distribution and servicing and product development. Through vertical disintegration, collaboration, and use of microelectronic technologies, smaller firms are able to minimise the negative impact of lower production volumes. They may also attempt to keep the same basic model in production for a longer time so as to derive greater economies. However, where markets are imperfect, buying in may impose high transaction costs, as in the case of knowhow and product development.

It needs to be remembered that diversification decisions are not governed only by the supply-side considerations of scope economies. Profits and therefore demand-related issues are also involved. However, in explaining the multi-product nature of the firm within the automobile sector, economies of scope would certainly be a dominant consideration.

In Chapter 6, we will analyse scale-economy-related issues for the Indian CV industry, and see to what extent Indian firms follow the behaviour and pattern of their international counterparts. We will also assess the importance of scale in the competitive strategies of different firms. We shall see that achieving scale benefits (going for growth) has not been an important issue for most of the firms, at least until the recent past.

TECHNOLOGICAL CAPABILITIES AND TECHNOLOGICAL CHANGE

Definition and Nature of Technological Change in Industrialising Countries

In a broad sense, technology refers to a collection of physical processes that transform inputs into outputs, to the specifications of the inputs and outputs, and to the procedural and organizational arrangements for carrying out the transformations.[1] A narrower definition confines itself to the technical aspects of the transformation. Technological Capability is the ability to make effective use of technology. Technological Change (TC) refers to changes in any of the above-defined dimensions of technology, whether conceived narrowly or broadly.

Save in recent years, economists have been more concerned with TC in developed countries (DCs). The focus was on cost-reducing innovations or major breakthroughs linked with the growth of scientific knowledge at technological frontiers. If these preoccupations had been carried over to research on the industrialising countries (ICs), there may not have been much to document.[2] In ICs, most manufacturing enterprises start off operations by borrowing foreign technology, at least in technologically complex sectors. The technology package, in practice, can almost never be completely specified - it has a certain degree of "tacitness". Two other (related) features are incomplete understanding and inimitability. This means that in the process of operationalising a borrowed technology, an IC firm will need to add to it elements from its own technological capability. Moreover, owing to smaller markets, local-use regulations and the nature of demand, IC firms have to undertake additional TC efforts in order to use different raw materials, scale down plant size, use simpler and lower capacity machinery, diversify product mix, adapt product design and so on. Thus, by the time a borrowed technology is implemented, each firm already has a unique or "idiosyncratic" production function, and this is enhanced as the firm undertakes further TC efforts.

1.See Bell et al (1984), p.107.

2. See Katz (1987) reporting on the results of a series of studies on TC in Latin America. The rest of this sub-section draws to a large extent from this work.

The above description also points to a primary feature of TC in ICs - the fact that "minor" (as opposed to breakthrough) innovations are cumulatively extremely important as a source of productivity growth at the firm and industry level.[1]In fact, this is true for DCs as well, as discovered by relatively recent studies.[2]Another aspect common to DC and IC firms is that from the viewpoint of the enterprise, the distinction between innovation and adaptation is largely irrelevant.[3] A firm may be expert in the technology it is using, and "reasonably" familiar with neighbouring technologies. A shift to an existing technology beyond this would involve as much of a technical effort as developing a new technology on its own. This in fact arises from the tacitness and incomplete inimitability of a technology package.

As may be gathered from our description of the nature of TC, a number of departments within the firm are likely to be involved in knowledge-generating activities. Corresponding to our broad definition of technology, three different engineering and technical activities generate new technical information: (a) product design; (b) process engineering; (c) industrial engineering. It is not necessary that these activities be organized in formal departments, but they will always be present, to a greater or lesser degree, in all firms.

Product design and specification is the first technical activity that an enterprise engages in. On the basis of different design techniques, prototypes and so on, the department produces blueprints of the product in accordance with the company's requirements. The requirement could be for product differentiation and/or cost reduction, or for re-designing parts and components to simplify them or to incorporate different raw materials. In the initial stages, an enterprise implements (and modifies to whatever extent required) a borrowed technology, which involves know-how capability. Later, when the firm can substantially change the product design or introduce new

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1. At least for the Latin American firms studied, including 200 manufacturing firms in Argentina studied by Katz. See Katz (1987), p.46.

2. Katz (1987) cites the work of S.Hollander, N.Terleckij, J.Enos and J.Minasian. These were all done in the 1960s. Two other relevant studies are David (1975) and Rosenberg (1976). See also Rosenberg (1982), pp.3-8.

3.Lall (1987), p.2.

products, we say that it has developed know-why capability. This requires knowledge of the basic principles of the technology.[1] All these TC efforts call for extensive interaction between this department and the other two departments.

The process engineering department selects the equipment, labour force, type of raw materials and components etc. in order to decide as to how, by whom and where should the product be produced, and to indicate the engineering routines and tolerance limits. It looks at the impact of material substitution on the production process, equipment modification and "stretching", energy saving and process improvement. These capabilities often require pilot plant experimental work, time and motion and job evaluation studies, etc. A similar distinction as earlier can be made between know-how and know-why. According to Katz (1987), there is a lot of cumulative learning in the process engineering section since it has to acquire capabilities for registering and interpreting technical information describing the production process under different working conditions (a simulation capability).

The industrial engineering function is a more general one, responsible for planning and control of the overall production operation. It decides on the extent of subcontracting, inventory levels, quality control, size of batch, and also issues a formal production plan, stating when each action should be performed and with which equipment and components etc. In the case of discontinuous or non-process industries, this function of overall coordination, and monitoring can be crucial for cost efficiency.

In practice, there is a high degree of inter-dependence amongst the three different knowledge-generating activities of the enterprise. Successful TC usually involves a joint effort of all the three departments (Katz 1987, p.36).

The picture that emerges is of an evolutionary and incremental build-up of technological capability. TC is no longer assumed to be exogenously given, as in earlier writing on technology, but is endogenously determined by the firm. In industrialising countries, TC efforts arise first

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1.Lall (1987), p.14.

with the need to operationalise a borrowed technology in the context of a country's input and output markets, which means adaptation and modification of product, process and industrial organization. Rather than cost reduction, it was found that product mix diversification, quality and the more effective use of installed capacity were important objectives of technology strategy.[1] Over time, these firms developed product design skills, followed by process and industrial engineering capabilities. Following Teitel (1981), we can classify TC activities in ICs under the following heads: (a) adaptation of local inputs to manufacturing requirements, generally preceding production start up (b) continuous gradual improvement of production processes (c) TC in response to changes in demand, market conditions, supply constraints etc. (d) R&D not directly related to production, but which may have an effect upon it, such as basic research. In ICs, most TC appears to fall under categories (a)-(c).

Contrary to the "learning by doing" metaphor, no TC is accomplished or technological capability developed without very conscious search for new technology and information and the systematic assignment of some of the firm's resources to this effort. Search is costly, carries risk and admits of the possibility of failure.[2] This search is influenced by the micro and macro atmosphere in which firms operate (as we shall see later) and is "highly idiosyncratic of the particular enterprise which undertakes the search".[3]

We have highlighted the firm's role in the process of TC. This does not mean that outside resources such as input and machinery suppliers, consultants and customers do not provide important technical elements.[4] However, it is the firm's job to integrate these elements into its own systems and make complementary adjustments. The ability to make the right choice of technology and source of technology, to make appropriate modifications to the technology, and

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1.Katz (1987), p.38, for Latin American firms.

2.See Nelson & Winter (1982), pp 171-72, for an amplification.

3.Katz (1987), p.15.

4.See Bell et al (1984), pp 120-21.

to provide efficient day-to-day plant operation, cannot be bought in. It thus has the central role in the management of TC.

In sum, not everything is done in the firm, but very little can be done for the firm without its efforts in absorbing, if not initiating, and managing change (Bell et al 1984, p.121).

Technological Change and Economic Performance

It may be almost unnecessary to document the relationship between TC and economic performance (both at a national as well as at a firm level), so pervasive does the influence seem. The fast growing body of research on TC and its determinants[1] also shows that TC is considered to be a crucial phenomenon that needs explanation. However, things were not always this way. In developed countries, intensive economic analysis of technical advance began around the end of World War II. In research on economic development, the focus was more on accumulation of physical and human capital and the shift of resources from less productive to more productive sectors.[2] Cross-country empirical exercises to study the TC-growth relationship began only in the 1960s. In the following paragraphs, we shall review the results of selected empirical literature relating TC to economic performance at the economy level and at the firm level.

At the economy-wide level, Solow's (1957) study has been very influential in highlighting the importance of TC. He found that 90% of the growth of non-farm output in America in 1909-49 was attributable to a residual factor which he labelled as "technical change". Denison (1962) attempted to break down the residual further and found a reduced but still significant (40%) role for TC. Other exercises followed which sought to take explicit account of technology factors.[3] Despite the numerous weaknesses in all such studies,[4]

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1. For surveys of research on determinants of TC see Kamien and Schwartz (1982) for developed countries and Fransman (1985) for developing countries.

2. See, for example, the pioneering contributions of Lewis (1954) and Nurkse (1953).

3. For recent reviews, see Fagerberg (1988),and Stoneman (1987, ch. 4).

4. Stoneman (1987) cautions that all the estimates of the quantitative importance of TC are of the "ball park variety" (chapter 4). Also see Rosenberg (1982), pp.23-29. See Nelson and Winter (1982), chapter 8, for a critique of the neo-classical formulation of TC.

there is a considerable amount of evidence from different economies and different time periods to support the view that technological change is an important factor in the generation of economic growth (Stoneman 1987,p.31).

An important additional contribution was made by Fagerberg (1988), who separates out national technological activity from other components of technological change (imported technology, investment), and finds that it is strongly related to economic growth.

At the level of the firm, which is our main focus of enquiry, a similar scenario holds. Evidence compiled in Stoneman (1987, Chapter 4) indicates that R&D expenditure could be expected to yield rates of return of the order of 20%. When R&D is treated as a stock (lags introduced), rates of return to R&D get reduced, as they do when imported technology is taken into account. For developing countries, Bell et al (1984), surveying case studies of firms in different countries, conclude that most firms have failed to achieve international competitiveness. The failure is ascribed to lack of technological capability, and lack of conscious efforts to develop a technological strategy and invest in resources for TC. Similarly, reviewing the LDC literature, Pack and Westphal (1986) conclude that the "costs of achieving international competitiveness... are the costs of acquiring technological capability" (p.106). The Latin American studies also show that the flow of domestic technological efforts have a very significant impact upon productivity growth.[1]

We can therefore accept that TC is an essential ingredient of many different economic phenomena: productivity growth, economic growth and development, pattern of trade in manufactured goods, and so on.[2] In fact, neo-Schumpeterians would argue that the above estimates underplay the role of TC, and that TC is the "sine qua non of economic development."[3]

Costs of Technological Change

Our two earlier sections on Vertical Integration and Scale Economies brought out both the

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1.Katz (1987), p.46.

2.See Nelson and Winter (1982), p.27, and Katz (1987).

3.Stoneman (1987), p.34. Nelson and Winter's (1982) book is a good example of application of Schumpeterian ideas.

costs and benefits of different decisions. As far as TC is concerned, our discussion so far has implied that there are only benefits and no costs. This is buttressed by the finding that because of uncertainty and externalities, private rates of return to R&D tend to be lower than social rates and this, alongwith indivisibilities, leads to under-investment in R&D, and the policy implication that more R&D should be encouraged.[1]

However, there are costs of TC, and more particularly of national or local R&D effort. The mainly adaptive kind of R&D prevalent in ICs is affected by the distortions and constraints such as local-use regulations, sub-contracting to small-scale suppliers, licensing etc. Where engineering skills are low priced, there could be an excessive effort at adaptation, precluding the introduction of newer equipment [2]. Secondly, it is not always best to undertake TC on the basis of own R&D effort. As Lall (1985) suggests, developing own know-why, for example, will divert scarce technical manpower from assimilating know-how. Moreover, where technologies are advancing rapidly, the know-why acquired may become obsolete. He therefore suggests that know-why development even in the largest LDC enterprises should not be pushed beyond a point.[3] According to him, while many Indian enterprises have developed impressive and in-depth R&D and technological capabilities, much of this has been misdirected and pushed beyond the scale of comparative advantage.

The above point needs to be explored further, for it implies a trade-off between own R&D and bought-in technology. As we saw earlier, own technological capability is required to operationalise a foreign technology. In ICs, there is therefore a significant degree of complementarity between own and imported technology. At some stage, however, when a firm becomes capable of developing its own know-why, the relationship will be one of substitutability. If technology frontiers advance beyond the firm's capabilities, complementarity may again become dominant.

1.See Teitel (1981), Pack and Westphal (1986), and Stoneman (1987), p.33.

2.See Lall (1985) and Teitel (1981).

3.Lall (1985), pp 66-67.

Owing to the ready availability of proven technologies abroad, and the externalities of local knowledge creation, IC firms may under-invest in developing their own technological capabilities. On the whole, there is no simple answer on the relationship between own and imported technology. The decision rule, even if not easily put into operational terms, is whether the

> ...present discounted value of the benefits that would accrue from more suitable locally designed products exceeds the costs of the technological efforts needed to generate the designs (Pack and Westphal 1986, p. 120).

In judging the costs and benefits, the dynamic learning effects and development of upstream capabilities should be included, and the calculations should use the real (shadow) cost of capital and labour. This relationship between own and imported technology will be discussed at length in chapter 7.

Determinants of Technological Change

As in the case of Vertical Integration and Scale Economies, we have discussed the effects of TC on economic performance. However, given the pervasive influence of technology, so that technological dynamism and competitiveness are often assumed to go hand in hand, it becomes necessary to explain the determinants of technology itself. In turn, TC is determined not only by technological efforts but also by technological capabilities.

(a) Developed Countries

To start with, we shall briefly review the literature on DCs. To date, we lack a complete theory on the sources of new technical knowledge. However, this has not deterred a whole generation of economists from exploring empirically the determinants of technical advance. Most of this work has been inspired by the writings of Joseph Schumpeter, particularly Schumpeter (1949). In his characterisation of the modern industrial economy, (a) large firms exploit economies of scale in R&D and unforeseen innovations better than small firms and (b) monopoly power, which often accompanies large firm size, enables the firm to prevent imitation and hence

gives them incentive to innovate.[1]

The results of the empirical studies are not clear-cut. There appear to be increasing returns of R&D output to R&D input upto a threshold level of resources committed to R&D, and non-increasing returns beyond. The threshold level may be a barrier to entry in some industries. Correspondingly, R&D activity (whether measured by R&D input or output intensity) increases with firm size upto a point and then levels off or declines. Both large and small firms could play complementary roles, given the sequential character of modern R&D. Small firms can be the source for ideas and innovations and large firms can develop these towards commercial utilisation.

The second hypothesis also fails to engender definite conclusions. It appears that an intermediate market structure between perfect competition and monopoly may support the highest degree of inventive activity. This is because, contrary to the hypothesis, too much of monopoly power, while allowing appropriability of rewards, dulls the incentives to innovate.

Besides being limited by data availability and consequent choice of indicators for R&D, size etc. (which makes comparison across studies more difficult), these empirical studies suffer from several other limitations. There is little attempt to cope with simultaneity and allow for the reverse causation of market structure and firm size on R&D activity. Secondly, if differences in technological opportunity across industries are taken into account, the relationship between R&D and other explanatory variables tend to become weaker and statistically less significant.[2]

More recent developments, both theoretical[3] and empirical, have attempted to look at the simultaneity aspect: innovation generates transient market power which in turn is eroded by rival innovation and imitation (in the spirit of Schumpeter's "creative destruction"). This simultaneity

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1.See Kamien and Schwartz (1982) for a comprehensive survey of the theoretical and empirical literature regarding the relationship between innovation and firm size, market structure and other factors. Also see Kathuria (1989) for an update on the empirical review. The empirical section that follows is based on these two studies.

2.Scherer (1980).

3.See Kamien and Schwartz (1982), Dasgupta (1986), Nelson and Winter (1982), and Dosi et al (1988).

also implies that market structure and innovation must be jointly determined by more basic factors such as demand conditions, technological opportunities, nature of capital markets, and technological and institutional conditions governing appropriability.

We shall not go into the details of the empirical studies.[1] Suffice it to say that taken together, they cast some doubt on the received empirical wisdom regarding the independent influence of firm size and market structure on innovation. They include the very detailed work by Levin and colleagues in which primary data on appropriability and opportunity conditions (such as patents, secrecy, lead time etc. for appropriability and closeness to science, external sources of technical knowledge and industry maturity for opportunity) was collected from 130 industries. Levin et al (1985) find that when the survey variables are included in their industry R&&D intensity equation, the regression coefficient for concentration falls and becomes statistically insignificant. Similarly, Cohen et al (1987), using the same survey data, find no relationship between firm size and R&D intensity after they control for inter-industry differences in the R&D environment.

There are also other, non-econometric studies within the DC empirical literature. As the complexities of the TC phenomenon have begun to be recognized, the "new view" has recognized concepts such as "appropriability; partial tacitness; specificity; uncertainty; variety of knowledge bases, search procedures and opportunities; cumulativeness and irreversibility" as general features of technological progress (Dosi 1988, p.1164). We shall not attempt a review of these studies here.[2] But it should be added that these studies come much closer in spirit to the literature on industrialising countries. We shall therefore have occasion to look at some of the concepts mentioned above - such as tacitness, specificity, cumulativeness - which form an integral strand of writings on industrialising countries.

1.See Kathuria (1989) for a survey.

2.See Dosi (1988) and Dosi et al (1988) for surveys and articles relating to these new developments.

(b) Industrializing Countries

With a few exceptions, DC literature has tended to ignore the incremental nature of technical advance. In ICs, where breakthrough innovations rarely occur, incremental TC is even more important. Our earlier discussion also implied that a large part of TC (broadly conceived) may not even originate in a formal R&D department. Thus, if we use R&D expenditure as an indicator of inventive activity, this will grossly understate and even be misleading of TC activity in an IC firm.[1]

For all these reasons, it may be better to focus on some indicators of output of innovative activity, since this would reflect the combined capability of all the departments within a firm. Patent data, which is widely used as an indicator of R&D output, is seriously flawed. For one, all patents should not be weighted equally (as is often done), since they reflect minor as well as major innovations. Secondly, a number of patented products and processes are never commercialised. Thirdly, many innovations are never patented.[2]

In order to get around these problems, economists working on ICs have tended to focus on description and analysis of TC of individual firms and industries, relying heavily on qualitative evidence. The trade-off has been the non-generalisability of the findings, but rich insights have nevertheless been generated.

Before we review the findings of the empirical literature, it is necessary to distinguish between own and imported technology. In the DC literature, the focus was on own R&D. However, in ICs, imported technology can be a major source of TC, and the determinants of that, if different from own R&D, need to be spelt out.

We know from our earlier discussion that most TC in ICs consists of the adaptation of im-

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1.This is besides the usual problems associated with use of R&D expenditure - the fact that it does not reflect the composition of the inputs (type of personnel, equipment) or the personnel not directly involved in R&D but who may contribute to innovation. Moreover, treating R&D as a flow measure ignores the accumulation aspect that past R&D expenditure contributes to current knowledge. See Kamien and Schwartz (1982), pp. 50-51.

2.Kamien and Schwartz (1982), pp.49-50.

ported technology. Another way in which imported technology could help [as pointed out in Katrak (1986)] is through division of labour i.e. some elements of the technology package could be imported to complement other elements which the enterprise can generate on its own. The latter complementarity will usually arise after the enterprise has attained some technological maturity. However, this is also the stage at which there can be some substitutability between own and imported technology since the enterprise can now undertake creative R&D [see Blumenthal (1979)]. An empirical resolution is called for.

A number of statistical (econometric) exercises have been done to test the above relationship. Those on India find a mainly complementary relationship between own and imported technology, but there are nuances. Both Lall (1983) and Kumar (1987) find a positive relationship between R&D intensity and license fees paid to foreign firms. But Lall, whose study analyses 100 engineering firms, finds a positive sign for "foreign share of firm's equity", whereas Kumar's more comprehensive analysis at the industry level finds a negative sign for "foreign company[1] share of total industry sales". An obvious reason for this is the difference in definition of the multi-national factor, but there could be others, such as the wider coverage of Kumar's sample. Another aspect brought out by Katrak (1985,1986) and Siddharthan (1988) is that the complementary relationship between R&D intensity and technology imports is stronger in the case of standardized and low-technology goods than for more complex products. In addition, Siddharthan finds a complementary relationship for private sector firms, but a more complex, possibly substitutive, relationship for public sector firms. Katrak (1986) finds that R&D expenditures are higher in technology-importing enterprises than in non-importing ones, that R&D was lower in technology-importing firms that engaged in adaptive as opposed to "other" R&D, and that higher expenditures on imported technologies led to a less than proportionate increase in R&D expenditures.

It should be noted that in all the studies quoted above, technology imports have been treated

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1.Defined as those companies having 25% or more of foreign equity.

as an independent variable in explaining R&D, which is fine if the relationship is a complementary one (import and adapt strategy). However, if own R&D can substitute for foreign technology, then both will be jointly determined as part of the overall technological strategy of the firm. Here, therefore, the reverse causation of R&D on technology imports must be allowed for, which has not been done in the above studies.

We can now re-state our problem. We will list the main determinants of TC in ICs, assuming that own and imported technology are mainly complementary. Wherever necessary, we will distinguish between the two sources of TC.

(i) Size of firm: Econometric evidence for India on the influence of firm size on R&D intensity is inconclusive. Lall (1983) finds a positive relationship at the firm level, whereas Katrak (1985,1986) finds a negative one at both the industry and firm level. On the other hand, Siddharthan (1988), allowing for non-linearity in the relationship, finds a U-shaped curve, with R&D intensity declining initially with firm sales and increasing thereafter. These studies suffer from the same problems as their DC counterparts, mentioned earlier. In any case, our concern is with overall TC, and not merely with R&D expenditure.

More comprehensive statistical exercises combined with case study material, such as the ones by NCAER (1971) and Desai (1984), provide a little more evidence. It appears that there is a minimum scale for doing R&D (in a formal sense) and for importing technology. As opposed to small firms, larger firms had a lower technology import content because of their ability to complement the technology package via own R&D. They also obtained a greater proportion of licenses as compared to other types of production know-how. All this leads Desai (1988) to the conclusion that large firms can exploit the results of R&D and of imported technology more fully than small firms. However, the success rate of technology agreements was found to be unrelated to the size of the firm, but positively related to the number of earlier collaboration proposals, thus exhibiting a learning sequence through import of technology.

An important difference between large and small firms, which explains Desai's conclusion, is that small firms generally cannot afford the internal division of labour required to benefit from

the services of technical departments. Of course, the alternative of hiring technical services from the market is available, but these are not perfectly divisible and, as we saw earlier, the substitution is imperfect.[1] Moreover, even hiring technical consultants requires the ability to ask them the right question and implement their recommendations viz the ability to manage TC.[2]

Thus, larger firm size may confer some advantages, particularly towards more complete utilisation of technology. That it is not a critical advantage is indicated by the many instances of small firms with strong, technically-oriented entrepreneurs being able to develop, productionise and even export new technologies.[3]

Another possible difference relates to the nature of R&D - large firms may be able to devote relatively more resources to basic as opposed to developmental or applied research.

(ii) Nature of firm: Amongst the relationships analysed has been the effect of various types of ownership on technological behaviour. Following the typology of Katz (1984), family enterprises are likely to pay more attention to production skills than to planning and organization. They usually have a high propensity for self-financing. Within this group, we can distinguish between closely-run firms and those that have brought about major changes in their management boards by inducting new generation engineers, lawyers, businessmen etc. The latter group is more professional, but the older generation is probably more risk-oriented and technically-oriented. Local subsidiaries of multi-national corporations (MNCs) differ from domestic firms in that they do not need to develop engineering strength in every field, particularly product design engineering. This is because of the ready availability of new product designs in the MNC headquarters. On the other hand, this access could have a cost in terms of reduced freedom of action and flexibility. Locally-owned large incorporated firms are, in many ways, similar to MNC subsidiaries, including access to technical information. According to Katz, they should, as far as technological

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1.Owing to high transaction costs arising from asset specificity.

2.Recall our earlier discussion. See also Teitel (1981), p.140.

3.See the Latin American examples cited in Teitel (1984), p.43.

behaviour is concerned, be grouped alongwith MNC subsidiaries but separately from family enterprises or public sector firms.

We have already observed the mixed empirical evidence for India on this issue. Lall (1983) found a positive sign while Kumar (1987) found a negative one for the foreign equity influence on domestic firms' (or industries) R&D intensity.

(iii) Company specialization: The extent of specialization determines not only economies of scale and scope, but also technological capabilities. Katz (1984) argues, based on a few Latin American studies, that if small batches of a large number of different products are produced, then dynamic gains from learning-by-doing are reduced.

(iv) Company integration: Analogous to the reasoning above, it could be hypothesized that if a company over-extends its degree of vertical integration, then the technological dissimilarity of the different stages of production reduces technological specialization and dynamic learning economies. In ICs, the limited size of the domestic market and/or shortage of entrepreneurial skills force firms to integrate more than their DC counterparts (Katz, 1987). Thus, IC firms suffer from reduced static and dynamic economies as compared to DC firms.

Given their circumstances, IC firms may have little choice but to integrate. However, there is a positive aspect of this integration also. TC, by its very nature, requires a high degree of information exchange, which is inhibited by market transactions. Moreover, the introduction of new products involves complex inter-stage inter-dependencies in the production process. Owing to the idiosyncratic nature of TC and the firm's production function, such transactions are characterised by a high degree of asset specificity. This, alongwith bounded rationality, means that transaction costs in these circumstances are very high, and may inhibit innovation.[1] Some degree of integration or quasi-integration may turn out to be a superior alternative. Too much integration could however dull innovation incentive because of isolation from competitive pressures. Being difficult to redirect or change, a vertically integrated firm will be at a disadvantage in conditions

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1.For a detailed exposition, see Kay (1984).

of rapid TC or if it wants to diversify, since it has made irreversible commitments in a large number of production processes based on its current range of products.[1] The optimum degree and type of internal control will need to balance these opposing tendencies and also take into account the earlier-mentioned factor of technological specialization.

There is little evidence of research on these issues for ICs. For DCs, Armour and Teece (1980) found a statistically significant and positive relationship between firm-level vertical integration and their basic and applied R&D expenditures. The relationship with development research is much weaker, in keeping with their hypothesis that more focused or problem-oriented research is likely to involve much less technological synergies between stages than more general research.

(v) Human skills: Skilled human resources form the crucial absorptive base for imbibing and generating technology. In a study of different Thai firms, Chantramonklasri (1985, p.346) found that those employees with technical and professional backgrounds were the proximate category of "change-related resources" in the firms. At the same time

> ...it is hard to single out the technical skills, or the way of organizing those skills... that are key determinants of change... The critical technological factor could be an entrepreneur, a hired engineer, an engineering firm, or a plant's research and experimental development team (Teitel 1984, p.44).

Chantramonklasri found that amongst his sample of "efficient" firms, skilled human resources were not exclusively located in specific sections or departments, but were pervasive throughout the firms.

(vi) Other firm-specific issues: The internal structure of a firm - its corporate heirarchy, communication channels, divisional structure etc. - is also relevant to a discussion of TC.[2] There is little hard evidence on such matters, partly owing to the difficulty of finding empirical counterparts for structural variables. A representative finding (for DCs), quoted in Caves (1980), is that firms

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1.Kay (1984), p.55. In the usual situation of incremental TC, particularly in industrialising countries, the disadvantage will be much reduced.

2.See, for example, Caves (1980) and Nelson (1981).

employing large-batch and mass-production technologies tend to employ more "mechanistic" systems of management, with well-defined responsibilities and specialist functions laid down from the top. Katz (1987) attempts to discover a pattern in the case of the Latin American studies. He finds that there was a discontinuity in the technical history of most of the firms, which involved a major change of attitude towards process engineering and production planning. This change of attitude was in many cases related both to a change in the administrative structure (including creation of new departments such as Quality Control, R&D, Tooling etc.) and to a major increase in the size and complexity of the firm's output mix. Concomitant, often radical changes occurred in organizational structure, data gathering and interpretation efforts, in the ratio of indirect to direct labour inputs etc.

Another relevant factor at the firm level is the orientation of top management. This is partly related to and influenced by the nature of the firm referred to earlier. However, management orientation certainly has an independent effect on the nature and direction of the firm's TC efforts. It can in fact be classified as one of the idiosyncratic factors motivating TC.

If we were to sum-up this sub-section on the determinants of TC at the firm level, we could only say that

> it is not easy to discern...the characteristics that make a firm in a semi-industrialised country more prone than another to engage in TC activities and be successful... (Teitel 1984, p.43).

There are no factors with simple or uni-directional effects on TC. However, the fruits of micro-level research can provide building blocks towards an eventual theory of TC, and our own analysis in the forthcoming chapters can be seen in this light.

(vii) Competitive conditions: Turning now to industry-level variables, we find that the Schumpeterian factor viz. market structure (more broadly, competitive conditions), has been a pervasive theme in most of the writings on TC in ICs. In interventionist economies such as those of most ICs, Government policies play a crucial role in determining the competitive atmosphere.

It has been argued that protection of domestic industries may be required for a long period to complete a cycle of technology transfer, adaptation to local conditions, and learning to

improve quality and productivity (Westphal 1982). Moreover, local TC activities not directly a by-product of production may also require protection until they can be exposed to competition from imported technologies (Teitel 1984). The first point relates to protection from imported goods while the second refers to imported technology. After a period of protection, trade in goods can be liberalized while imports of technology can continue to be restricted in order to protect know-why development (see Fransman 1984).

Beyond the consensus that promotion of learning requires an initial phase of protection, however, there are few definite conclusions. For example, at what point should industries be exposed to competition? How far should domestic learning be allowed to proceed? And so on. There is little doubt that TC activity takes place in all sorts of environments, but its nature may vary. In Latin America, monopolistic situations were seen to be more associated with "output-stretching" TC efforts, whereas more competitive environments led to cost-reducing and product-differentiating TC activities (Katz 1987). For India, Desai (1984) found that competitive pressure is greatest and technology search more active when there are a small number of roughly comparable size firms in an industry. S.Lall's (1985) finding on the nature of Indian TC is similar to the Latin American cases. According to him, the policy regime (quantitative restrictions on imports, industrial licensing, local use regulations etc.), while generating impressive design and project execution capabilities, has also generated a lot of wasteful technological effort rather than motivating improvement in productivity through building up of more efficient technologies.

In short, much TC in ICs occurs as a by-product of production, but would nevertheless be influenced by the competitive conditions including Government regulations. The next stage of TC, viz. improvement in technologies, is influenced more strongly than the earlier stage by the competitive conditions. TC activity occurs under any regime, but its magnitude and direction could depend partly on the extent of import restrictions, industrial licensing, local use regulations and so on.

(viii) Macro-economic factors: A host of macro-economic variables condition TC activities.[1] These include interest rates, capital subsidies (including tax concessions), demand conditions, availability and cost of skilled personnel, tax incentives for R&D activities, Government participation in research programmes, scientific advancement at the world's knowledge frontier etc. The hypothesized effects of these factors are intuitively appealing, e.g., capital subsidies leading to plant modernization, cheap skills leading to "over-engineering" and stretching of life of capital, and so on. Some of these factors will be brought up during the course of our analysis.

To sum up: we have reviewed the major findings of the empirical literature on TC in industrialising countries. The approach adopted by the economists working on this issue has enabled them to address some fundamental questions regarding the basic determinants of technological activity, including institutional conditions, Government policies, organization of firms, and so on - questions that most of the DC studies except a small minority, have ignored. However, most of the conclusions that have been reached are somewhat tentative.

In Chapters 7 and 8, we shall analyse the TC efforts of the different firms in the Indian CV industry, and also attempt to explain inter-firm differences in these efforts. In doing this, we shall see to what extent the findings reviewed above are applicable, whether some factors need to be highlighted more than others, and whether any additional factors need to be brought in.

TECHNOLOGICAL CHANGE AND THE AUTOMOBILE INDUSTRY

(a) Nature of Technological Change in Automobiles

As we have seen earlier, TC can occur through a change in the product, process and/or in the organizational arrangements and routines followed. There is substantial interdependence between the three; product changes are often the catalyst for changes in process and in organization, but autonomous changes also occur in each of the three departments.

1.See Katz (1987), pp.42-44.

A product designer can make changes in one or more of the vehicle's systems and parts, including the body, power train, brakes, suspensions, transmission, steering and so on. Any change must blend harmoniously with the rest of the vehicle, a difficult task considering the complex and increasingly modular nature of the modern automobile.[1]

The various stages in product development can be described as follows.[2] Concept generation involves a translation of customer needs or problems into a written statement of the product concept. Product planning occurs when detailed targets for performance, cost and styling are developed from the product concept. These targets are then translated into detailed engineering drawings by product engineering, using engineering prototypes and computer-aided design. Process engineering then converts these drawings into process design, such as process flow charts and plant layout, tool and equipment design, work design and parts programming. Using pilot runs and start-up activities, this process design information is then converted into actual elements of the production process, such as tools, equipment and operator skills.

All this takes time, being essentially a process of iteration and trial and error. For example, prototypes are tested in test beds and laboratories, and the information generated may start the cycle all over again. Incorporating a new component system from the prototype to the final output stage could take around 4 years, and the concept to prototype interval is even longer.[3] Even after a new model reaches the consumer, feedback may necessitate further fine tuning.

The objective of any product development exercise would be to meet the targets relating to quality and manufacturability of the designs while minimising costs and lead time.[4] Given the very high cost of developing a new model, it must have a long life in the marketplace in order to recoup these costs. Even if there are few doubts about technical feasibility in the development of

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1.See Altshuler et al (1984), chapter 4. The description that follows is based partly on this chapter.

2.This is based on Clark et al (1987), p.734.

3.Altshuler et al (1984), pp 78-79. The time intervals relate to new car models, but similar figures are relevant for CVs.

4.Clark et al (1987), pp 733-34.

a product, there are still major risks associated with its ultimate performance and acceptability. In order to minimise risks and wastage of funds vehicle manufacturers tend to introduce new developments incrementally, building step by step on past experience. This does not mean that they cannot choose from the shelf of available technologies and put together a very different package (such as the Model T in 1914), or even build a new vehicle around a radically different technology (such as Mazda's rotary engine). However, Altshuler et al (1984) feel that the dominant pattern of innovation in the next 15-20 years will continue to be one of incremental introduction of new technologies and systems in seemingly traditional vehicles. Over time, this can result in a dramatically different vehicle.

With any change in the final product, complementary investments are required in manufacturing operations (process technology). Not all such investments generate an actual change or improvement in the manufacturing technology. For example, a change in body design simply calls for new sheet metal dies. However, major process innovations become possible and often necessary once material substitution occurs in the final product.[1] Thus, increasing use of plastics instead of steel stampings has led to the development of reaction injection moulding methods and the consequent production of plastic stampings at competitive cost. Increased application of electronics in automobiles could lead to major savings in material inputs through the development of an entirely different manufacturing technology. Moreover, one of the mandates of product designers is to develop a product that makes possible innovation in process technology leading to lower cost of production.[2]

Autonomous changes in process technology can also occur in order to reduce costs and/or improve quality. These changes can also occur incrementally, such as small changes in layout, sequencing of operations, or step-by-step replacement of machines. But major process TC also takes place, such as the replacement of SPM operations by a transfer-line. While the source for

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1.See OECD (1983), pp 63-64.

2.According to Altshuler et al (1984, p.133), producers are pursuing product-design that make more automated manufacturing possible.

incremental innovations can be either the automobile firm (through learning by doing for example) or the machine tool industry, major process changes usually emanate from the machine tool sector, which in turn has been making liberal use of advances in electronics technology. In a subsequent section, we shall list some of the major advances in both product as well as process technology.

Product changes can also originate in-house or from external sources such as component suppliers. The change can also be conceived in-house but physically implemented by the suppliers in association with the in-house units. Suppliers can themselves push for change on the assumption that they can convince automobile firms to incorporate the suppliers' new technologies in their products.

(b) Investments in Technical Change in the International Automobile Industry

All the leading automobile manufacturers world-wide have a strong technological orientation. The greater the intensity of competition, the greater is the likelihood of increased technological innovation by the producers, implying that technology is seen to be a key factor in the performance of a company.[1] This observation is consistent with the increase in innovative activity in the 1970s in all the major automobile-manufacturing centres in the world (Altshuler et al 1984 p.101), and this trend has continued into the 1980s with the application of new materials and electronic technologies.[2]

By way of illustration, let us look at the R&D expenditures of some of the leading manufacturers. Table 2.4 shows that R&D intensity (R&D expenditures as a percentage of net sales) of successful automobile companies tends to be above 3%. Even in an industrialising country (and successful automobile exporter) such as Korea, R&D expenditures have been rising in the 1980s

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1.See Altshuler et al (1984), pp 88-89, and 101-05.

2.For example, the annual report of the German automobile manufacturers association points to a trebling of R&D expenditure in the period 1978-88 (see VDA 1988, p.30). In Japan, R&D expenditure in the automobile industry rose from 523.5 to 797.2 billion yen over 1981-85(Toyota Motor Corporation 1987, p.37).

and were expected to exceed 3% by 1986. On the other hand, the low level of investment in R&D and excessive concentration of public R&D support in the defence sector have been widely attributed as causes for the decline of the British car industry.[1] Indeed,

innovation should be seen as a central part of the normal rhythm of activities required from an automobile firm which intends to survive. [2]

Table 2.4
R&D expenditure and additions to fixed assets as a percentage of sales of selected companies and industries

	R&D Expenditure	Capital Investment
Volvo (1988)	5.3%	4.1%
Saab-Scania (1988)	7.5%	7.2%
Daimler-Benz AG (1987)	5.3%	5.7%
Chrysler (1986)	3.2%	7.0%
Toyota (1988)	4.0%	5.0%
Korean motor vehicle manufacturers (1986)	3.4%	-
Honda (1986)	4.5%	6.2%
UK Motor Industry (1984)	1.5%	-
Renault (1984)	4.5%	-
Ford Group (1984)	3.7%	-
General Motors (1984)	3.7%	-

Sources : Annual Reports
Chanaron & Spagni (1987)
Sung-Hwan Jo (1988)

Investments in new plant and equipment tend to be somewhat higher than R&D, being generally greater than 5% of sales (See Table 2.4). The figure is higher when major product design changes are made. It is true, of course, that balance sheet figures for additions to fixed assets overstate actual investments in process technical change, since property acquisitions are also included and some new equipment could be a mere duplication of existing facilities.

1.See Chanaron and Spagni (1987).

2.Whipp and Clark (1986), pp 198-99, following a similar argument by Abernathy (1978).

However, it is an adequate index for comparative purposes.

Technological strategies have in some cases been very clearly identified as the basis for national comparative advantage. For example, the Japanese success in automobiles was based on its mastery of production technology wherein they rethought the fundamentals of manufacturing organization. This resulted in low cost and tremendous manufacturing accuracy. On the other hand, European firms such as Daimler-Benz, BMW, Volvo and Saab have continued to develop distinct and up-market cars that have enabled them to survive the Japanese onslaught.

So far, we have considered expenditures on TC relative to sales. Absolute figures are also relevant to the extent that there are economies of scale in R&D. Our earlier discussions have shown that beyond a point there appear to be non-increasing returns to R&D input. However, there does exist a minimum scale of the firm for having a formal R&D department and for allowing it to successfully exploit an innovation. Certain minimum facilities are also required in order to test the results of innovation at various stages of the process. These include test beds for engines, anechoic chambers (noise-testing), wind tunnels, road circuits with different driving conditions, facilities for testing collision, stability and vibration, and so on. A small firm will not be able to afford all these facilities.

Today, technological change is a costly process. The following table has been put together by Rhys (1984) on the basis of interviews with three vehicle firms and two suppliers of components. The figures show that capital costs for designing and developing a new truck are in the region of £120-200 million (1982 prices) and a new engine £150-200 million, an optimum sized assembly plant would cost £150-300 million and a research and design centre £40 million.[1] Larger firms would certainly be in a better position to raise and absorb the capital expenditure involved, which is required over a long-term period. Since larger firms are more likely to be producing a range of CVs as well as cars, there would also be synergies in R&D activity. Extensive TC activity is also required to meet diverse regulations in different markets. For CVs, the complicated nature of the

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1.For developing an entirely new car model with a new engine and mechanical components, Altshuler et al (1984, p.141) mention a figure of $3 billion.

product allows for more wide ranging and detailed regulations than in the case of cars, which limits the markets for smaller firms (Rhys, 1984). Thus, when TC (of both the product and process variety) is costly, the minimum economic scale of a firms tends to increase.

Table 2.5.

Capital cost of facilities for medium and heavy vehicles

(1982 prices)

Cost of designing and developing	£ Million
all new truck	120 - 200
truck with existing components	50
new cab	60
new axles	80
new engine	150 - 200
new gearbox	50 - 100
Cost of assembly plant	150 - 300
Cost of sub-assembly plant	150
Research and design centre	40
Company-wide investment on new CV range (using existing components)	350

Source: Rhys (1984), p.26.

Nonetheless, small firms continue to survive partly through sub-contracting of production and even R&D.[1] Moreover, many of the small CV firms are part of larger groups, which enables

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1.Here we are talking only of MHCV firms, since there are no small LCV manufacturers.

them to reap benefits of group backing including development and testing of new products. Thus, Seddon-Atkinson and Foden of U.K. are part of International Harvester (USA) and Paccar (USA) respectively, and there are many such examples.

The viability of small and specialised firms is however being questioned by recent events in the CV industry. In the USA, Freightliner, White and Mack have been taken over by Daimler-Benz, Volvo and Renault respectively. Leyland and DAF have merged, and further rationalization is likely in Europe. Even the large firms have been cooperating in designing and producing components - witness the links between Daimler-Benz and MAN, MAN and Volkswagen, and lately between Daimler-Benz and Mitsubishi, to name a few. All these developments appear to be raising the threshold size for new entrants while putting the existing manufacturers on a downward-sloping production curve.

(c) Current and Future Developments in Product and Process Technologies[1]

Some of the key determinants of changes in product technology are governmental regulations relating to safety, emission and axle loads, and continuing competitive pressure to improve fuel economy, reduce maintenance costs, increase vehicle life and reduce purchase costs. A necessary condition for change is however the availability of suitable technologies to match the requirements.

The increasing application of microelectronics to automobiles is likely to be a high payoff area. Over the next two decades, the full application of microelectronics will make it possible to eliminate most of the skidding during braking, acceleration and turning. Anti-skid braking systems are already available, and anti-slip acceleration systems are in an advanced state of development. Advances in microelectronics may also make possible passive passenger restraints. Safety levels can also be increased by the introduction of new plastic and composite materials

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1.This section is based on Altshuler et al (1984), Chapter 4 and OECD (1983), Chapter 3.

that could raise survivable crash speeds. The actual extent to which these will be introduced will depend very largely on public policy towards safety.

Microelectronics have also been applied in engine and electronic control devices, including devices for regulating fuel carburation, exhaust emissions, speed controls and alternators/regulators. Continuously variable transmission enables the engine to be operated at its most efficient output according to the requirements. The same microprocessor that allows continuously variable transmission can also be used to supply only as much effort as required for water and oil-pumps, and power steering and braking systems. Most of these developments are aimed at better fuel economy or driving comfort.

Fuel economy is a dominant consideration in TC decisions. This can be achieved by increasing the power from a given amount of fuel, or reducing body weight and wind resistance. Improvements in diesel engines, which are more fuel-efficient than petrol ones, is one way. Turbocharging, aftercooling and improved combustion techniques have resulted in fuel savings of 25%. Further improvements are likely with the development of advanced electronics to control diesel fuel injection, as was done in Leyland's TX 450 concept truck.

Increased attention to aerodynamics can lead to substantial fuel savings. Given the large surface area of CVs, potential economies from more aerodynamic designs are large. The new concept trucks being unveiled by manufacturers such as Isuzu, Nissan Diesel, Leyland etc. have a very different body design as compared to their predecessors.

Material substitution is another promising area. Use of higher strength steels in place of ordinary carbon steel allows less steel to be used for a given body weight. Similarly, aluminium and plastic can substitute for steel. One estimate shows that 1 kg of aluminium can substitute for 3.2 kg of steel (OECD 1983, p.60). It is however, possible to make much greater use than at present of non-ferrous metals, plastic and fibre composites, which requires greater knowledge of durability and increased ability to design and fabricate these materials at low cost. This substitution is possible not only in external body materials, but also in wheels, tyres, gas tank, and the power train. Materials such as ceramic would not only allow lighter but also more efficient

engines because they can withstand higher operating temperatures.

Other possible innovations are the use of alternate fuels, the self-diagnosis of faults by micro-processors, use of plastic 'snap-on' body panels and longer-life lubricants, and so on.

As far as changes in process technologies are concerned, these have been mentioned earlier in the section on Scale Economics. Unlike in the past, an increase in automation levels is now possible along with an increase in flexibility of equipment. In the late 1970s, microelectronics technologies began to be applied to machining, stamping, welding and painting operations. More lately, these technologies have begun to be applied to the more difficult tasks of assembly and sub-assembly. Robots, which are devices with artificial limbs and a degree of mobility, have been used mainly in the tasks of welding and painting. In other operations, more conventional machine tools, albeit computer-controlled, have been used. All these developments, apart from reducing or eliminating tedious and dirty jobs, have also been able to increase the consistency and accuracy of manufacturing operations. Further developments in automation are likely to affect material handling and quality inspection.

We have seen that such techniques have now begun to be applied to the MHCV sector also, although to a lesser extent than for cars. The divisible nature of much of the new process technology has made it possible to introduce the technology incrementally.

Changes have also occurred in the design process. We saw earlier that there is a lengthy interval between conception and introduction of a new product, requiring several iterations of engineering drawings, prototypes, testing etc. Computer-aided design (CAD) and computer-aided engineering (CAE) are already being employed to reduce the time and resources required for this process.

> (CAE) assists the engineer in calculating structural loads and choosing appropriate materials... CAD... rapidly generates detailed 'electronic drawings' of the vehicle and its components .. CAM... transfers the design engineer's work directly to the microprocessor-controlled flexible process machinery, and which may eliminate the need for any paper drawings at all (Altshuler et al, 1984, p.96).

The Japanese have been particularly successful at reducing lead time for developing a new car

model from 5 to 3 1/2 years,[1] although this has required substantial organizational innovation as well. Further sophistication is likely in the future with corresponding implications for time and cost.

(d) The Japanese Method

It is necessary to at least briefly describe the method by which Japanese companies have used process technology in such an innovative manner.[2] In order to be able to produce a variety of models in small volumes and yet keep costs low, Toyota pioneered the "Just-in-Time" (JIT) system of production in the 1950s and 1960s. The key elements of JIT are small batch sizes, reduced material handling, mixed final assembly, low inventory levels, and production control by "kanban" cards. Investments in quick changeover tools and concomitant procedures reduced setup times and allowed smaller batch sizes as well as minimum inventory levels. Machinery was organized sequentially and the distance between processing steps was minimized in order to reduce material handling. Multi-machine manning brought about high worker utilization and thus improved productivity.

Owing to lack of coordination among parts and sub-assembly production and deliveries from suppliers and final assembly, stockpiling and bottlenecks were occurring in Toyota inspite of the above changes. In the 1950s, it reversed the process-information flow, setting the schedule for final assembly only. Upstream units manufactured only when they received kanbans (production cards) from downstream units. This not only eliminated stockpiles, but also helped to pinpoint the slack and waste in the system.Toyota also began mixing its final assembly by arranging its daily production of different models in the same ratio as its monthly demand pattern, thereby ensuring against inventory build-up and allowing quick adjustment to demand changes. Mixed

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1.See for example, The Economist, April 14, 1990, and Jones (1987).

2.This is based on Cusumano (1985), Chapter 5, and Abegglen and Stalk (1987), Chapter 5. See also Abernathy et al (1983), Chapter 6.

assembly also required fewer assembly lines, thus saving on floor space and inventory, and making it easier to coordinate different work stations.

Unlike other manufacturers in America and some in Japan (Nissan, for example), Toyota rejected computer-controlled production coordination and parts procurement in favour of kanban control and this, according to the architect of its JIT system (Ono Taiichi), was one of the most important benefits of Toyota's techniques. For him, the kanban pull system was cheaper, more flexible, and allowed inventories to be kept lower than with the best computer-coordinated systems. In the 1960s, Toyota's suppliers also started using the kanban system to regulate their deliveries according to its JIT requirements. Since the JIT system required a very high degree of coordination between different shops, factories and suppliers, the geographic concentration of Toyota's facilities and suppliers helped it to implement JIT more effectively and quickly than other Japanese automakers.

The low inventories in Toyota and some other Japanese companies can be seen with reference to the inventory turnover rates (sales/average inventories).[1] As Table 2.6 shows, Toyota's inventory turnover rose from 11 in the 1950s to 26 in the mid 1960s to 36 in 1983. In contrast, GM, Ford and Japanese manufacturers such as Honda and Isuzu had ratios between 10 and 13 in 1983.

Hino and Daihatsu, two Toyota group companies, adopted kanban systems in the 1960s and improved their inventory turnover rates substantially. Mazda instituted Toyota-type systems only by the late 1970s, while Honda and Isuzu had not effected controls over inventories even by the early 1980s (Cusumano 1985, pp.300-02).

1.Cusumano (1985), p.300, refers to inventories/sales as the inventory turnover rate. An increase in this ratio implies growth of inventories. Clearly, the data in Table 2.6, which shows substantial increases in inventory turnover rates and is correlated with increasing efficiency by Cusumano, actually refers to sales/inventory.

Table 2.6 : Inventory Turnover Rates

Company	1955-59	1960-64	1965-69	1970-74	1975-79	1980-83	1983
Toyota	11	15	26	23	26	-	36
GM	7	7	7	6	8	-	12
Ford	9	8	7	7	9	-	11
Hino	-	-	10	16	20	21	-
Daihatsu	-	-	17	20	32	36	-
Isuzu	-	-	12	10	10	10	-
Honda	-	-	11	12	12	13	-
Mazda	-	-	13	10	14	20	-

(-) indicates not available

Source : Cusumano (1985), pp.302-03.

Finally, the Japanese production system has adopted the approach of defect prevention rather than cure - the focus of quality control moved from inspection to process control. Production workers were given the skills and responsibility to diagnose problems and repair the defects. Ideas for improvement of the production process also emanated, to a large extent, from these workers. This improved productivity and reduced downtime (time when machines are idle).

Overall, the Japanese approach stressed not volume but quality of process and product. Once the rule of working only for the next process came about, overproduction was viewed as wasteful. The JIT system put a premium on efficiency and coordination and enabled problem areas to be quickly identified and removed. Many of these concepts are now being borrowed and applied in the Western automobile industry.

CHAPTER 3

THE DOMESTIC MARKET

INTRODUCTION

In this chapter, we shall analyse various aspects of domestic market competitiveness of the chosen firms. This will include analysis of market shares, profitability and productivity ratios, and vehicle quality, prices and performance. This will be preceded by an overall picture of the growth and evolution of the market. Finally, we shall make an overall assessment of the competitiveness of the different firms.

As a background, we shall briefly highlight the policy framework governing the industry. The CV industry was one of the priority sectors that were promoted as part of the Government's policy of import substitution. Only licensed firms could enter, and all imports of technology and capital goods also required permission. CVs were given priority over private transport vehicles. Expansion of existing firms also required Government clearance, but CV firms did not find their growth constrained by this requirement. In the initial years, seven firms were licensed to manufacture CVs, out of which two gradually dropped out of the race. In the 1980s, licensing policies were considerably eased and four new firms entered the industry, and some of the existing ones opted for fresh collaborations. Firms were allowed to go in for "broad-banding", i.e. produce any four-wheeled vehicle that they desired. Import constraints of all kinds were relaxed, although these were still binding on all firms. Ordinarily, imports of components were banned, but firms with fresh collaborations were permitted to import these for a period of five years under an approved manufacturing programme. Component manufacturers also took active part in the changes occurring in the 1980s, and a very large number of new firms with foreign collaborations entered the industry.

EVOLUTION OF THE DOMESTIC MARKET

Growth Trends

The world over, railroads were established well before the advent of road transport. [1] India was no exception to this trend.[2] Upto World War II, long-distance freight was carried almost solely by the railways. Railways also dominated passenger transport, although to a lesser extent than for freight. Motorisation of intra-city transport also progressed slowly, owing to narrow streets and competition from human and animal driven transport. All this is reflected in the lack of steady growth in imports (i.e. demand) of vans, trucks and buses - up from 480 in 1922-23 to 15,306 in 1929-30 and then declined to 2676 by 1932-33. Average annual imports in the three years prior to World War II were about 11,000 CVs.[3] After 1949, when built-up imports were banned, imports began to taper off.

Table A.3.1. shows the production of CVs from 1950 onwards. Although output has increased, it has been marked by prolonged periods of stagnation. The decade from 1950-60 was the best period for the industry (in terms of growth rates), with output going up from 1891 in 1950 to 27518 in 1960, and marred only by the foreign-exchange-constrained year of 1958. Positive factors in this period included the rapid growth of heavy industry and the increased nationalisation of bus transport. Growth slowed down considerably after 1960, and recessionary conditions in the mid 1960s led to virtual stagnation of CV output between 1965 and 1969. Another period of zero growth followed immediately, from 1971 to 1977. The next four years were heady years with total CV output in 1981 (89752) more than double that in 1977 (41702). A major factor behind this turnaround was the poor performance of the railways - total traffic

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1.See Barker (1987) for an analysis of the spread of motorisation.

2.See Desai (1989) and HML (1968) for an elaboration.

3.T.C. (1953), pp 48-49. All figures relate to undivided India.

declined from 162.7 to 158.5 billion ton-kilometres from 1977-78 to 1980-81 (Economic Survey 1982-83, p.103). Growth again petered out thereafter, although there have been encouraging trends in 1987 and 1988, with output increasing by nearly 12000 (12%) vehicles in 1987 and more than 10,000 (9.7%) in 1988. Through much of the last four decades, the Indian CV industry has been constrained from utilising its rated capacity owing to shortages of power and essential inputs. On the other hand, demand has been the constraining bottleneck in the mid 1960s recession and also in more recent times, since 1982-83.

The overall growth trends given above mask some important differences amongst different types of CVs (our remarks are confined to the period 1971 onwards), as can be seen in Table A.3.1. In the LCV segment (upto 6 tons GVW)[1], the general upturn of 1978 has continued till date. With 1977 as the base, 1981 output had more than trebled, and by 1988 was nearly six-fold. On the other hand, trucks and buses (more than 6 tons) have been stagnant around their 1981 output levels except in 1988 when truck output crossed 50,000 vehicles. Over the years, the truck-bus production ratio has roughly averaged 2:1.

A composite indicator of growth in the different segments has been calculated in Kathuria (1990). Between 1972-81, the trend growth rate[2] in number of LCVs sold was 8.2%, compared to 7% for MHCVs. Over 1981-89, LCV growth rose to 11.4%, and the MHCV rate dropped to 1.7%. The growth rate in Jeeps over the two periods was 3.4% and 11.9% respectively.

Structural Trends

The 1953 and 1956 Tariff Commissions had recommended progressive dieselisation of CVs on the grounds of better fuel economy and conservation of foreign exchange. Heavier vehicle

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1.Unless otherwise stated, all weights are given in terms of gross vehicle weight (GVW).

2. Calculated as $Y=a(1+r)^t$ where Y is number of vehicles sold, r is the growth rate, and t is time.

manufacturers such as Telco and ALL made only diesel vehicles. Over time, the share of diesel vehicles for other manufacturers has also steadily increased, particularly after the oil shock of 1973. In 1950, only 9% of all CVs produced were diesel-powered. By 1987, 99.8% were diesel-driven.

Priority to CVs has been another facet of policy. One indicator of this is the relative production of cars and CVs. In 1952, CVs formed 56% of total CV and car output. Through most of the 1960s and 1970s, in a situation of excess demand for both cars and CVs for much of the period, CV output exceeded that of cars. In the late 1970s boom, CVs reached a more than 2:1 production ratio, forming 68% of total output in 1981. However, once cars became an Appendix 1 (i.e. priority) industry in 1982, the situation changed rapidly, and by 1988 CVs formed only 42% of total CV and car output. This change was almost entirely due to the output of Maruti Udyog which began producing cars in 1983, and by 1988 produced more than 95,000 cars (and also more than 5000 jeeps). Of course, the ratio of 42% is still a long way off from a world-wide ratio of 25%-28% or a 1:3 - 1:2.6 CV-car production ratio.

The Indian CV industry also differs from world-wide trends in terms of the ratio of heavy and light CVs produced. World-wide, MHCVs (over 6 tons GVW) account for approximately 10% of total CV production.[1] Even in Brazil, another developing country, MHCVs account for 25% of CV production. In India, MHCVs have dominated CV production since the mid 1950s, accounting for 78% in 1972 and as much as 84% in 1975. However, given the steady growth of LCVs in the 1980s, this ratio has been reduced to 60% in 1988 (See table A.3.1.).

Another change has occurred recently in terms of "spread" of weight classes. In the 1950s and 1960s, the presence of a large number of firms meant that a variety of vehicles of different

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1. In 1985, world MHCV output was 1.1 million and total CV output was 12.5 million. Total CVs include minivans and car-derived CVs. See MVMA (1988), pp. 9, 25.

payloads were on offer. With the steady decline of PAL and HML in both the LCV and MHCV segments, the market became polarised at two extremes by the mid to late 1970s -- either 3.5-4 tons GVW or 12-15 tons GVW. The major consideration was that both segments should be very cost effective. Light vehicles needed to be low-priced. Heavy vehicles were required to be capable of massive over-loading. This polarisation also suited the manufacturers, who enjoyed scale economies by producing just one basic model each. In the 1980s, with the market turning from a seller's to a buyer's market, the range of vehicles as well as the number of models increased. By 1988, vehicles had also been positioned at 2,4,5,6 and 8 ton GVW segments as well, with the 5 and 6 ton classes coming into particular prominence, as we shall see.

Data is also available for regional sales of vehicles over time.[1] For trucks over 6 tons, the North and West Zones are dominant markets. North Zone alone accounted for 33% of trucks sold in 1987 (24% in 1984), owing largely to recovery in Punjab and increasing industrial activity in Delhi and Uttar Pradesh. The share of West Zone, especially Maharashtra has declined in the 1980s, and was 25% in 1987 (32% in 1981). On the other hand, South Zone has come to occupy the foremost place for buses over 6 tons with 38.4% of the market in 1987. This is because its public transport system is more organized and extensive than in other parts of the country. Tamil Nadu is the largest market, both within South Zone as well as in the country (13.7% in 1987). Another extensive transport system exists in Maharashtra in the West, accounting for 12.2% of the market in 1987. LCV sales are relatively more dispersed, 1987 shares for North, West and South being 30.8%, 26.9% and 26.1%. Maharashtra is the single largest market, although its share has declined after 1983, whereas that of Punjab and Haryana (North Zone) has more than doubled between 1981-87.

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1. From ACMA's annual "Facts and Figures".

MARKET SHARES

A bird's-eye view of the different firms and their product range is given in Chart A.3.2. The definitions of light, medium, heavy and so on in the Chart are our own and are intended to divide the market into different segments within which competition takes place. However, available data is not so disaggregated, and our discussions throughout this study will use the official difinitions, unless otherwise stated.

Medium and Heavy Vehicles

Official statistics classify MHCVs as those above 6 tons GVW.[1] Currently, the market is a virtual duopoly, shared between Telco and ALL. In the early 1950s, PAL and HML enjoyed similar dominance, but not for long. Over the period 1956-60, the respective market shares of Telco, PAL, HML and ALL were 51.7%, 24.4%, 15.6% and 8.2% (using data on production). Thereafter, there has been a steady erosion of PAL's and HML's shares, as can be seen in Table A.3.4 and A.3.5. In 1972, the respective shares were 74.4%, 7%, 5.1.% and 13.5%. In 1988, HML accounted for only 1.3% (PAL was out of the race), whereas Telco had 73.6% and ALL 25%. Thus, Telco and ALL had very contrasting approaches in reaching their current market positions. Telco moved in quickly and established its dominance from the beginning, and recorded fast improvement in its market share. ALL, in contrast, was a slow starter, and over time too its market share increased only gradually.

Various reasons have been put forward for the decline of the two pioneering firms in the CV market. Government asked them to use Perkins diesel engines, manufactured by Simpson & Co. in their Bedford (HML) and Dodge (PAL) vehicles. According to HML, the Perkins engine was

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1. This may not be true for earlier years. According to the T.C. (1968), PAL and HML were only producing models less than 3 tons GVW and 3 to 5 tons GVW (pp.36-37). Undoubtedly, the latter would have been classified under "Medium-duty" CVs in the statistics. Later, in the 1960s, they began producing heavier vehicles.

unsuitable for its Bedford vehicle, and PAL contended that they were not getting enough engines from Simpson & Co.[1] HML, in fact, began producing its own Bedford engines in 1968, but these developed problems with the rotary distributor pump used in fuel injection. A more fundamental problem appears to have been lack of adequate demand for HML and PAL CVs. Over time, with the market demanding increasingly heavy vehicles,[2] PAL and HML did not keep pace. Telco and ALL, on the other hand, upgraded their vehicles (including engine, axles, gear box, leaf-springs etc.) frequently. Also, inspite of the clear market preference for diesel vehicles, PAL and to a lesser extent HML stayed for too long with both petrol and diesel engines. Unlike HML and PAL, Telco and ALL have, from the beginning, offered only diesel-driven CVs. Finally, there was greater competition in CVs than in cars, and PAL and HML may have preferred to take the easy option of concentrating on their main product line (i.e. cars) and allowing the more competitive ALL and Telco to carve out the CV market.

At this point, it is necessary to consider the market for medium and heavy passenger and goods vehicles separately. In the passenger or bus segment, ALL performed much better than in MHCVs as a whole. Over 1966-70, its share in total sales was 30.5%, but had crossed 40% by 1978, and rose to a high of 45% in 1986 as well as 1987 before going down to 41.5% in 1988. Telco's share in 1972 was 66.4%, but it yielded some ground to ALL thereafter, and was 58.3% in 1988 (See A.3.4). Over the 1980s, the market has been apportioned between Telco and ALL in the approximate ratio of 3:2.

In the goods or truck sector, Telco has been particularly dominant, and increasingly so over time. Over 1966-70 (upto 1966, bus figures were included in truck production), Telco's market

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1. PAL's claim was contested by Simpson & Co. See the MRTP Commission's (1971) Report, pp. 254, 276-78, 344.

2. See, for example, WB (1973), p.5. Because of truck shortage and increasing tax burden on road transport, the demand was for heavier vehicles in order to reduce the per tonne-km costs of freight. Overloading of vehicles was also endemic.

share was 67.6%. Continuing the pre-1966 trend, its share kept rising steadily before peaking at 83.2% in 1985. ALL's share picked up in the mid 1970s with the decline of PAL and HML. From a level of about 12% in the late 1960s and early 1970s, it fluctuated around 18% - 20% over 1976-84. It dropped somewhat thereafter before recovering to 18.8% in 1988. The ratio of Telco to ALL truck sales in the 1980s was roughly 5:1. Simpson & Co. made an attempt to enter the market through a collaboration with Ford (UK) and sold about 1400 assembled trucks in 1980 and 1981. It could not, however, sustain its sales and currently sells a few hundred vehicles annually. It failed because of its higher price (Rs.75,000 more than competing vehicles), its inability to handle overloading (axle shafts would break), its tilt-type cabin which Indian drivers were uncomfortable with, and inadequate sales and service.[1] HML has also made a bid to re-enter the market with a new vehicle, the Isuzu FVR, CKD production of which began in 1986. But it does have major problems on its hands with the Isuzu's high price, low volume and the yen appreciation (which increases CKD import prices), and the vehicle has not been a success.

Within the MHCV segment, a wide range of vehicles are produced, as A.3.2. shows (however, the 6 ton GVW vehicles are shown as LCVs in the official statistics). The largest chunk (perhaps more than 90%) is the conventional heavy duty truck, rated at about 16 ton GVW (named 1210 for Telco and Comet for ALL) and the corresponding bus (the truck and bus chassis is the same in India). Heavier trucks have to be multi-axle (24-26 tons GVW) or articulated (25-100 tons gross trailer weight), in both of which ALL, with an extensive range of models, has a near monopoly. There are also the medium-duty vehicles, such as Telco's 807 and 909, HML's Bedford and PAL's Roadmaster (no longer produced). The Bedford no longer has a market in India, while a few hundred are sold in Bangladesh every year. The 807 and 909 were failures. In the bus range, ALL has a complete monopoly for the 200-odd double-decker, articulated or

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1. See Indian Auto Journal, March 1989, pp.24-25.

vestibuled, and integral bus market.[1] Similarly, ALL dominates Telco in the special application vehicle category which includes fire tenders, oilfield trucks, aircraft refuelling trucks, earthmoving vehicles, defence vehicles and so on. Unfortunately, published statistics do not permit us to calculate market shares in the individual sub-segments.

Light Vehicles

The market for light vehicles (upto 6 tons) was dominated by PAL and HML upto the mid 1950s. Thereafter, they lost ground to M&M and later to BTL, although PAL remained the market leader upto the mid 1960s. Over 1961-65, PAL's share in total production was 47.8%, BTL's 21.2% (including 3 wheelers), HML's 16.%, M&M's 14.9% and SMPIL's 0.2% (A.3.4). The success of BTL's "Matador" in the late 1960s ensured for it the largest market share, a position it has maintained till date. By 1975, PAL was producing less than 1000 LCVs (share in sales 11.4%). It declined still further, and was insignificant by the 1980s.

HML's decline in LCVs was more gradual because in 1974, it successfully developed the "Trekker", useful as a light utility vehicle, and which continues to sell today, although in lesser numbers. It also sold the car-derived "Porter" (cabin and bare chassis) as an LCV, as did PAL. BTL's three-wheeler "Tempo", an ancient light-duty vehicle, also falls in this category of car-derived/very light vehicles. Quantitatively, these very light vehicles were never very significant (highest share was about 12% of total LCVs over 1978-81), and have declined in the 1980s. In 1988, however, Telco brought in a new, 2 ton pickup whose sales promise to increase. This, alongwith the Peugeot 504 pickup that M&M intends to introduce in 1991, means that the 2 ton class of vehicles will become relatively more important in the near future.

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1. Integral buses are those where the construction is of monocoque type (as in a car), where the body also absorbs part of the vehicle load.

In Table A.3.5., these very-light vehicles are excluded in the LCV category of 2.5-6 tons, since their competitive segment is different. This shows that from a high of 55.9% in 1980, BTL's market share had dropped to 28.5% in 1988 (41.2% if we consider 3-5 tons only, see A.3.6). From three in 1980 (excluding PAL and HML), the number of LCV manufacturers had increased to eight in 1986. The most successful of the new entrants was Telco, whose 4.8 ton 407 is now the second-largest selling LCV after the Matador. The Japanese vehicles, viz. Eicher's "Canter", DCM's "Dyna", Swaraj's "T-3500" and Allwyns's "Cabstar", have also increased their share steadily, and together accounted for 31.2% in 1988. Of these, the least successful has been the Cabstar, primarily because of its lower GVW of 4.9 tons, placing it in direct competition with the 407 and SMPIL's "Micro-lorry" (see A.3.2.). Following this, the vehicle was upgraded into the Cabstar 576 model (payload 3.5 tons compared to 3 tons earlier), and in 1988 its takeover by M&M was finalised.

BTL was the only existing firm whose sales showed a positive (although fluctuating) growth in the 1980s. M&M's FJ series (3.9 tons) peaked at a level of 6000 plus vehicles in 1982[1], while SMPIL's mini-lorry (3.8 tons) and micro lorry (4.8 tons) reached a high in 1984. These vehicles were heavier than the Matador, and suffered more because of competition with the 4.8 ton 407. SMPIL suffered additional problems because in 1986 its new Rover cars were alleged to have passed the fuel-efficiency tests fraudulently, a charge from which it was absolved in 1987. This adverse publicity as well as defects on its new car led to a shortage of working capital and eventually a lockout in February 1989. Of the three firms, BTL was the only one to introduce a completely new model, in 1987, the 3.8 ton Tempo-Traveller (Daimler Benz's T1 Transporter).

Ideally, the 6 ton class of vehicles should be classified under MCVs, particularly since in

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1. In 1981, M&M introduced the NC series, essentially an extended version of its Jeep. This was classified as an LCV so that the company could enjoy concessional duties under the phased manufacturing programme (PMP) scheme for LCVs. More than 6000 were sold in 1985, but sales have declined rapidly since then, since the 5 year PMP concessions are over. Table A.3.5 classifies these vehicles for what they are - utility vehicles (jeeps).

India they are often overloaded to 8-10 tons GVW. Currently, this class is the only one occupying the MCV segment as we have designated it in A.3.2 (6-12 tons),since slightly heavier vehicles such as Telco's 807 and 909, and HML's Bedford have faded out. Telco does, however, have one vehicle in the 6 ton category - the 608, launched in 1987. This has not performed as well as its lighter counterpart, the 407. It has been possible to get separate data on Telco's 407 and 608 sales. In the 6 ton class (see A.3.6), total sales have increased faster than in any other segment of the Indian CV industry, from 1386 in 1985 to 12853 in 1988, and from 1.6% to 11.3% of all LCVs (above 2.5 tons) sold. Eicher's Canter, with 33.6% of the market in 1988, leads in this segment, with the 608 (14.5%) at the bottom.

Under the Motor Vehicles Act of 1988, heavy penalties have been laid down for overloading vehicles. As an interim measure, 15% overloading was permitted till 31st March 1990. It is to be seen whether or not strict enforcement of permitted loads will reduce somewhat the attractiveness of 6 ton vehicles since they cannot then be used, as they now are, as a partial substitute for HCVs. It may also force the manufacturers to upgrade their vehicles to take heavier loads. Judging by more recent statistics, the growth of the 6 ton vehicles has slowed down, but is still high enough for the manufacturers to feel optimistic about future prospects.

Competitiveness and Market shares

We can now consolidate our findings on market shares to indicate the relative competitiveness of different firms. For reasons mentioned earlier, the CV ventures by HML, PAL and Simpson & Co. did not succeed. Sustained success has been enjoyed by Telco, ALL and BTL. Of our five firms, Telco alone has been able to increase its share in the total CV market after the onset of the new collaborations (from 54.3% in 1985 to 55.8% in 1988) on account of its ability to move rapidly into the LCV sector. If we consider MHCVs only, ALL has, since 1976, been accounting for roughly 25% of the market, up from its 13.5% in 1972. Telco's share has also hovered around 75% since 1983, up from 65%-70% in the earlier decade. Thus, since 1983, ALL

and Telco have been in a kind of "competitive equilibrium" in MHCVs.

In LCVs, BTL is still the market leader, but its market share has been eroded heavily in the 1980s, even if we consider only the 3-5 ton range of vehicles. This is equally true for M&M and SMPIL. Given the entry of new firms, some decline in shares was inevitable, at least for some if not all the firms. However, even in absolute numbers, M&M and SMPIL have declined, and BTL's Matador sales stagnated since 1984. This, alongwith Telco's rapid growth to the second position, needs to be explained.

A potential problem with use of market shares to measure competitiveness is that in the short run, a less competitive firm may increase market share while that of the more competitive one may decline, if demand increases rapidly. This would happen because the latter may be at or near full capacity utilization, while the former may not. In our case, this is not a problem since we have considered a long enough time span and, moreover, all firms except M&M were demand constrained and suffered from capacity underutilization in the 1980s.

PROFITABILITY

Profit Ratios and Return on Capital

Market share cannot by itself define competitiveness. A high market share may be achieved at the cost of low profit margins, whereas a low market share may be accompanied by high profits. This relates to corporate strategy and objectives, but the data will reflect objectives as well as actual performance. Profitability is therefore another relevant indicator of competitiveness. An advantage of this measure is that it is a composite figure, and we do not have to take account of the different market segments that the firm operates in, as we need to for market shares. This can,

of course, be a disadvantage as well.

There are many different measures of profitability. Derived as they are from accounting data of companies, they provide "at best noisy measures of real, economic profitability" (Schmalensee 1989, p.340). To get around this problem, we shall use more than one measure, much in the manner of Schmalensee (1989).

Tables A.3.7 and A.3.8 show profits as a share of sales and gross fixed assets (excluding capital work in progress). Three variations of profits are used - profits before tax but after deducting interest and depreciation (PBT), profits before interest and tax but after depreciation, i.e. operating profit (PBIT) and profits before interest, depreciation and tax or gross profits (PBIDT). Gross profits are also given as a share of net fixed assets (gross fixed assets plus capital work in progress less depreciation). The data, which is drawn from balance sheets, pertains to the respective financial years of the companies, although we refer to these in their abbreviated format (1986-87 is simply referred to as 1987). The financial years for ALL, BTL, M&M, SMPIL and Telco begin in January, October, November, July and April respectively. Market share data, however, refers to calendar years.

Our preferred measure is gross profits to sales, since that abstracts from differences across firms (and also over time) with respect to capital valuation practices, the time profile of capital investments (which affects the value of gross fixed assets since book values are used to value capital investments), debt-equity ratios (which affect the quantum of interest payments) and depreciation practices. Even so, major problems remain. Ideally, expenditure on intangible assets such as advertising and R&D should be capitalised, but it is treated as current expenditure. Differences in these expenditures across firms will bias the comparisons. Similarly, different levels of inventories create problems when prices are changing, even assuming that all the

companies use the same method to value inventories.[1]

In the case of the Indian firms being compared, there is an additional complication. Alone amongst the five companies, Telco has a full-fledged in-house machine tool division where it manufactures its own special purpose machines (SPMs) and dies, press tools and jigs and fixtures. The cost of these SPMs is considerably lower than in the market since there is no mark-up and no extra charge for designing the unique equipment that is an SPM.[2] Thus, there is a bias to under-value the capital base relative to other companies, and the corresponding depreciation charged to the revenue account will also be lower. On the other hand, Telco has great scope for (legally) charging certain expenditures to its revenue account when they should in theory go to the capital account, particularly when there are some grey areas such as repairs and reconditioning of tools and tooling. Moreover, it has invested heavily in R&D, for which 100% write-off is permitted. All in all, its high investment policy, combined with its machine tool division and growth shop (where it makes certain tooling and material handling equipment), has given Telco a measure of flexibility in its accounting that other companies do not have and have probably not even strived very hard for.[3] The overall effect of this would be to smoothen fluctuations in its profit rates and perhaps an overall tendency towards a downward bias in the balance sheet profit

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1. See Benston (1985) for a detailed discussion of problems relating to accounting profits.

2. Substantiated by Telco company sources.

3. In 1987, which was a bad year for Telco, it reduced its depreciation from Rs. 34 crores in 1986 to Rs.21.6 crores by changing its accounting method. Its Annual Report (1986-87, p.32) states that depreciation would have been greater by Rs.18 crores had the earlier method been followed. Its scope for jugglery is also evident from the fact that it alone had a consistently high figure for expenses capitalised, of a magnitude comparable to its pre-tax profits. Similarly, its repairs to plant and machinery as a share of sales are higher than any other company. These are adjustments in its revenue expenses, prior to arriving at the figure for gross profits (before interest, depreciation and tax). But not only has Telco been able to adjust its gross profits according to its needs, it also pays relatively lower tax than other companies. For example, during 1977-83, Telco's gross profitability to sales ratio was higher than any company except BTL. Yet, it paid no taxes during these 7 years. In fact, an article in Business India, January 5-18, 1981, provides an estimate of the very substantial tax savings generated by Telco's policies during the period 1975-79. On the other hand, M&M and BTL paid out an average ratio of 28% and 42% respectively (taxes to pre-tax profits) during these years. ALL paid little or no taxes in the 1980s, but over 1977-79 it paid an average of 49%. SMPIL did not pay any taxes at all because it had accumulated losses and a very large debt burden.

figures. However, when the profits/fixed assets ratio is considered, the probable downward bias in both the numerator and denominator means that the net effect is uncertain.[1]

Overall, BTL is seen to be by far the most profitable company (A.3.7), with gross profits to sales going up to over 20% in the 1980s, but declining somewhat after 1984 (average over 1977-87 is 18.6%). This decline is very marked in 1987 if we look at the PBIT and PBT measures owing to a steep increase in depreciation and interest because of heavy investments in BTL's new plant at Pithampur. Next in line, in terms of the PBIDT to sales measure, is Telco, whose ratio is generally higher than that of the other three companies (average 1977-88 13.1%). However, since Telco's interest and depreciation charges are (usually) proportionately higher than for others, M&M is most profitable (after BTL) if we consider PBIT and ALL if we look at the PBT measure. If we compare ALL and Telco, Telco has outperformed its rival even in terms of PBIT and PBT measures through most of the 1980s, unlike in earlier periods. This is because ALL's profitability (particularly PBT and PBIT) has been declining steadily since 1977, although there has been a recovery in 1987 and 1988. In 1988, especially, a substantial increase in the number of vehicles sold (by 13%) improved the capacity utilization and profitability.

M&M whose dominant product is jeeps, has a fairly steady gross profitability between 11% - 13%, between 1977-87. PBIT fluctuates between 8-11%, but PBT is more erratic and also displays a downward trend, falling below 5% after 1982. SMPIL's profitability in general, is the lowest of all, with PBT turning negative in 1986, continuing a downward trend that began in 1982. However, for a period between 1977 and 1984, SMPIL was earning reasonable profits, and its PBT-sales ratio was higher than ALL's over 1981-85, owing to low interest and depreciation and its ability to make use of very old and depreciated equipment (and also because of ALL's

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1. If in any year an expenditure which should be capitalised is written off as revenue expenditure the downward bias in profits will be temporary. But underutilization of fixed assets in one year would be cumulative. Over time, therefore, it is possible that the downward bias in fixed assets dominates the bias in profits. If this is true, there may be a slight upward bias in the profits/fixed assets ratio.

poor performance in this period).

Table A.3.7 also shows the coefficient of variation of the different profit measures. Between Telco and ALL, the former has clearly managed to have substantially lower variations in its profit ratios, as we hypothesized earlier. Only M&M had lower variation than Telco (in PBIDT and PBIT), thanks to the relative steadiness of the jeep market, M&M's dominant product line.

With all its problems, it is still necessary to consider the return on capital (fixed assets in our case). Whatever the numerator, BTL continues to be the most profitable company. Its PBIDT-fixed assets ratio displays a similar tendency as in the earlier case. But Telco's return on capital turns out, more often than not, to be the lowest (unlike for profit-sales ratios), implying that its sales-fixed assets ratio is very low. After BTL, M&M's PBIDT-fixed assets ratio is the highest, never falling below 30% in the period 1977-87. ALL performs better than Telco save for the three years 1984-86. Even SMPIL outperforms Telco over 1980-84, as it does ALL over 1981-85. Expectedly, the PBT measure is more favourable to SMPIL, as we saw in the earlier case.

If net fixed assets is used as a denominator, this becomes relatively more favourable for SMPIL and Telco, both of whom have very high ratios of accumulated depreciation to gross fixed assets.[1] BTL has the highest ratio of gross profits to net fixed assets for most of the years. SMPIL's ratio is even higher than M&M's in 1977, 1978, 1983 and 1984, and more than Telco's over 1977-84 and ALL over 1980-84. Telco now has a higher ratio than ALL from 1980-86.

A partial correction has also been attempted in order to take account of price increase in capital goods. Using the wholesale price index of non-electrical machinery as the deflator, the

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1. SMPIL on account of its aged stock of capital and Telco because it has been a high investment company right since its inception, so that its accumulated depreciation is very substantial.

gross fixed asset profile has been converted to constant prices, with 1976-77 = 100. However, no correction has been made for the period prior to 1977.[1] The conversion formula applied is:

$$DFA_t = DFA_{t-1} + \frac{FA_t - FA_{t-1}}{WPI_t}$$

where DFA_t is the deflated value of fixed assets in year t, FA_t is the corresponding book value, and WPI_t is the wholesale price index in year t relative to 1976-77.

The profit ratios were recalculated with DFA as the denominator, but the essential conclusions remain unaltered. If anything, it increases the divergence between BTL as well as M&M (particularly BTL, whose large investments in recent years, relative to its fixed assets, result in a correspondingly greater reduction in DFA and hence increase in profits/DFA) and the rest.

Ideally, a correction should also be made for the increasing efficiency of more recent capital equipment. This would imply greater value to modern equipment, counteracting the above deflationary effect. However since it is not possible to estimate the actual change in efficiency of equipment, this has not been done.

Competitiveness and Profitability

Our implicit assumption in relating profitability to competitiveness has been that a more profitable firm is more efficient, via lower costs and/or better products that ensure higher prices. Unfortunately, higher prices can also result from monopoly power, and from excess demands (in the 1970s and early 1980s), and it becomes difficult to separate these effects from that of better

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1. Done in Chapter 6.

products. To the extent that all firms (except SMPIL) have been subject to excess demand, the excess demand effect may be relatively less important in inter-firm comparisons. Another problem is that firms may strive for some objective other than profit maximization, such as tax minimization (subject to a profit constraint). These, combined with the problems relating to profit measures themselves, imply that our assessment of profitability and competitiveness must be a guarded one.

BTL is unarguably a highly profitable firm, making efficient use of its assets and enjoying comfortable margins on sales. On the other hand, SMPIL's profitability is quite low, but its relative performance is better if we take capital, particularly depreciated capital, into account. In terms of gross margins on sales, Telco outperforms its rival ALL as well as M&M and SMPIL. However, its return on capital is poor, as is ALL's in the 1980s. This is because of the stagnation in MHCV demand in the 1980s, resulting in lower realizations per unit of fixed investments but which have not affected gross margins on sales. With demand for LCVs (and jeeps) growing more steadily, the return on capital for BTL, M&M and SMPIL is usually higher than ALL and Telco in the 1980s. Thus, comparisons based on sales margins are relatively more favourable to the HCV firms as compared to the LCV manufacturers than those based on return on capital. Only BTL and M&M perform consistently well when judged by either set of measures.

If we look at changes between 1977 and 1987, gross margins on sales have been relatively stable, although there is some downward tendency since the mid 80s. However, there is a marked decline in profits before tax to sales beginning 1982 or 1983 (1984 for Telco) for all firms except BTL (sharp fall in 1987) on account of higher interest and to an extent, depreciation, in order to service debts occurred to meet new investments. Return on fixed assets (whether gross or net), however, peak in the period 1980-83 for all firms (except ALL) and decline thereafter, again owing to fresh investments that have not yielded commensurate increase in sales. ALL made major investments in capacity expansion over 1979-81, somewhat earlier than the others. This

did not coincide with expected sales increases, resulting in major declines in return on fixed assets after 1978, and stagnancy after 1980. In general, the changed environment in the 80s had a much more immediate impact on assets (upward pressure) than on profits (downward pressure), which explains the contrasting behaviour of the profits/sales and profits/assets ratios.

Thus, in terms of profits, BTL is the most competitive firm, followed by M&M. Telco's high investments have not been productive when judged in terms of return to capital. In its case, there appears to be a trade-off between growth (as reflected in its high investments) and return to capital. Also, it has strived for high cash flow by minimizing its taxes and thus using internally generated resources for maintaining high investments. On the other hand, ALL has sought to maximise profits while maintaining a relatively conservative investment rate. Inspite of this, Telco's profits/sales are higher, but ALL's return to capital is higher till the mid 80s. On the whole, given its objectives, Telco may be considered more competitive than ALL when judged by profits. SMPIL was quite competitive in terms of return to capital upto 1984, which was a vindication of its limited goals.

PRODUCTIVITY RATIOS

Yet another indicator of competitiveness is provided by different indicators of productivity of inputs. Perhaps the best-known index in the automobile industry is production per man. We have weighted the subsidiary production of all firms on the basis of their value relative to the main product.[1] Table A.3.9 shows that BTL has the highest ratio of 3.38 vehicles per employee in 1987, a position earlier occupied by M&M for much of the 1980s. SMPIL's ratio of 1.74 in

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1. For M&M, the production figures are in jeep-equivalents, while for all the others they are in CV-equivalents. The equivalents are re-calculated for every year based on unit values as given in the balance sheets. Subsidiary products are engines for BTL and ALL, excavators for Telco, cars for SMPIL, and LCVs, tractors and c.k.d. jeeps for M&M.

1985 is almost one-half of BTL's 3.33.[1] The ratios for HCV firms are much lower which could be partly explained by the larger manpower required to produce heavier vehicles (see chapter 2). ALL's ratio is the higher of the two, but Telco has closed the gap over time.

In terms of growth over time, all firms except ALL have shown an improvement in their output per man. M&M's growth is the steadiest, while BTL's is the highest over the period 1977-87. In ALL's case, the initial productivity of 1.64 (1977) was comparable to BTL and M&M, but it has stagnated at that level till 1987.

Although widely used, the above ratio suffers from major biases when inter-firm comparisons are made. Firms with lower integration levels can make more vehicles because they perform a lesser number of tasks in-house. We have taken care of this by adjusting the productivity figures for a uniform level of integration viz. 26%, which conforms to the Japanese standard (Cusumano 1985, p.190). The results are shown in Table A.3.9. The most striking change, as expected, is for Telco, whose adjusted productivity is now greater than ALL's throughout the period and, from 1983 on, it exceeds 2. Similarly, M&M exceeds BTL for most years except 1982, 1985 and 1986. All companies, including ALL, now show an upward trend in output per man.

Moreover, since a HCV sells for more than double the price of an LCV, the actual monetary contribution of an employee must be taken into account by using value of output instead of quantity. These considerations result in our use of value added/employee (VA/L).[2] A further refinement would use expenditure on labour in the denominator (VA/VL) i.e. VA per rupee spent on labour, since wage rates are different across firms. Both ratios are shown in Table A.3.10.

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1. The 1986 ratio of 2.07 for SMPIL is unrepresentative because it represents 18 months output owing to a change in the financial year.

2. VA is defined as value of production less total bought in materials.

As expected, the comparisons are no longer unfavourable to the HCV firms. Over 1978-80, ALL's VA/L is the highest, but M&M takes over in the 1980s. Over time, the divergence between firms has reduced, with all except SMPIL having a VA of more than Rs. 1 lakh per employee by 1987. SMPIL, in 1986, had a VA of only Rs.43,000 per employee.

If we use the VA/VL ratio, firms with lower costs per employee would be better off in comparison. BTL and SMPIL have the lowest average costs per employee, while M&M has the highest (A.3.9), owing to higher salaries and high over-time payments resulting from over-utilization of rated capacity. Per rupee of expenditure on labour, BTL's value added is the highest almost throughout the period, exceeding 4 in 1984 and 1987. There is a decline or stagnation in this ratio for all firms in the 1980s, with peaks in 1983 for ALL, 1984 for BTL, 1977 for M&M, 1982 for Telco and 1981 for SMPIL. Telco and ALL ratios usually fall between 3-3.9, with ALL exceeding Telco in 6 of 11 years.

In calculating productivity, it is not enough to consider only efficiency in use of labour. In fact, the dominant "input" for any automobile firm is bought-in material and components. The other is capital. These different inputs can substitute for each other to an extent; for example, a larger share of bought-in will imply a lower requirement for capital and labour.[1] We therefore consider the ratios GFA/VA (gross fixed assets to value added), S/GFA (sales to gross fixed assets, an output-capital ratio), VA/TC (value added to total consumption of bought-in material),[2] and VA/NFA (value added to net fixed assets) - see tables A.3.9 and A.3.10.

In terms of GFA/VA, M&M is unambiguously the star performer. Throughout the period 1977-87, it required less than Re. 1 of fixed assets to add value of Re.1, although the ratio went

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1. See Chew (1988) on the importance of taking a multi-factor perspective.

2. In the abbreviation VA/TC, TC is total consumption of bought-in materials, and is not to be confused with TC as used throughout the thesis as technological change.

up from 0.5 in 1981 to 0.82 in 1987. Even BTL's ratio goes beyond 1 in 1983 and increased to 1.53 by 1987. Since fixed assets are most vulnerable to decline in demand, the demand bottle-neck of the 1980s shows up prominently in this ratio. For Telco and ALL, the peak efficiency years in the 1980s are 1983 and 1982 respectively. However, the GFA/VA ratio for Telco has been U-shaped, whereas for ALL it has followed an upward trend over 1977-87. SMPIL has also observed a U-shaped curve. This shows that there is a substantial decline in value added per unit of fixed assets for all companies in the 1980s. The ratio of S/GFA throws up more or less a similar picture, although there is a period of 1977-79 when ALL outperforms all others. Telco's sales never exceed twice the value of fixed assets, giving it the lowest ratio in all years except 1983 and 1984 when it exceeded ALL. This is unlike the GFA/VA ratio where Telco performs better than SMPIL and, for 6 years, ALL. The difference arises on account of Telco's greater vertical integration (see chapter 5).

If we consider VA/NFA, M&M continues to have the highest ratio. As in the earlier case of profitability, the NFA measure is relatively more favourable to SMPIL and Telco. Telco has a higher ratio than ALL for 7 years (1980-86), and SMPIL exceeds ALL for 1980-84 and Telco for 1977-82 (except 1979). BTL's ratio is considerably lower than M&M, and falls substantially after 1984. For all companies, VA/NFA declines in the 1980s - after 1984 for BTL, 1982 for M&M and SMPIL, and 1983 for Telco. For ALL, the decline begins in 1977 itself, with signs of a partial recovery since 1985. M&M also recovers partially over 1985-87, but the absolute values are far lower than in the early 1980s.

Finally, the VA/TC ratio. This reveals the value added by labour, capital and other inputs for each rupee of material and components bought. It reflects, inter alia, efficiency and scale economies in buying and bargaining power vis-a-vis suppliers, efficiency in production and marketing as well as market power. ALL's high disintegration results in a very low ratio, even lower than SMPIL over 1978-81. Conversely, integrated firms such as Telco enjoy a much higher ratio,

exceeding ALL's 0.35 thrice over in 1978 and more than double from 1979-81. M&M and Telco vie for the highest productivities, with Telco exceeding M&M 6 times out of 11. For none of the firms is there any evidence of a secular increase in this ratio. On the contrary, there is a decline in the 1980s for Telco and SMPIL, and a "fluctuating" stagnation for the others. M&M also declines when considered over 1977-87: from 1.32 to 0.79. Considering the importance of bought-in materials in total cost, the lack of improvment in VA/TC should be of some concern to CV manufacturers.

To sum up, there is a distinct improvement in physical output per employee for all firms except ALL in the decade 1977-87, and even for ALL there is an upward trend if we adjust for changing levels of integration. However, in most cases improvements in the value of output have not kept pace with increases in expenditure. Thus, VA/VL declines in the 1980s for all firms except BTL where it levels off. VA/GFA (inverse of GFA/VA) and VA/NFA decline in the 1980s for all companies, and for ALL the decline begins in 1977. VA/TC is less clear-cut, although there has been no increase over the decade, and a 1980s decline for SMPIL and Telco (the decline implying that cost of materials rose faster than value of production).[1]

As between firms, the picture is mixed. Per unit of labour, M&M's value added is the highest, but BTL's is higher per rupee of labour expenditure owing to lower average personnel expenditure (including all benefits). This implies that although M&M employees have a high productivity, it is not high enough to compensate for their higher wages vis-a-vis BTL. Per unit of fixed assets, M&M has the highest value added. As compared to BTL, its value added to total consumption is higher, but the difference has narrowed over time. SMPIL's value added ratios are usually the lowest of the three LCV manufacturers, and usually also lower than Telco. However

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1. VA/TC = (Q-TC)/TC = (Q/TC)-1 where Q is value of output, TC is bought-in materials.

it exceeds ALL in terms of VA/GFA and VA/NFA in the 1980s and VA/TC from 1977-81, and also Telco in terms of VA/NFA over 1977-82. Between ALL and Telco, ALL produces more vehicles per employee, but the position reverses if we correct for its lower vertical integration. ALL usually exceeds Telco in terms of VA/L and VA/VL, but Telco exceeds it by a wide margin in terms of VA/TC. For VA/GFA and VA/NFA, Telco exceeds ALL in the 1980s. Thus, ALL's employee productivity is higher but material and capital productivity (in the 1980s) is lower.

VEHICLE PRICES AND QUALITY, DEALER NETWORK AND PERFORMANCE

Quality of output and after-sales service is an important dimension of competitiveness. It can also be used to explain market share of the firm. Moreover, it can also shed some light on future competitiveness, particularly when there are new entrants, since the effect of new entrants is not fully reflected in market share and profitability indicators. We shall be relying heavily on qualitative and quantitative information gathered during our field survey. Further details on products and product technology will be found in Chapter 7.

Heavy Vehicles

We shall first compare the HCV manufacturers' main models, the 1210 vis-a-vis the Comet. The 1210 has a lower unladen chassis weight, better acceleration and smaller turning circle. These are obvious advantages in hilly conditions, with the result that in states such as Jammu and Kashmir where hill roads predominate, ALL sells a negligible number of trucks or buses (in 1986 and 1987 it sold 25 trucks and buses in J&K compared to 1995 by Telco). Another important edge that Telco enjoys in goods operations is that it offers a semi-forward truck, where the engine is in front of the driver cabin. In India, this gives psychological comfort to drivers who

fear a head-on collision. ALL did not have a semi-forward truck until 1990, when it introduced one on an experimental basis. On the other hand, the ALL product is over-designed and can therefore withstand rougher usage. Its engine and vehicle life is also longer. In intra-city bus operations with constant stoppages, ALL appears to have an edge, whereas Telco is preferred on the inter-city routes. These rival claims in passenger operations are reflected in a near-equal buying of ALL and Telco vehicles by State Transport Undertakings (fleet strength is in the ratio of 52:48 in favour of ALL).

In the premium haulage sector, we have seen that ALL is overwhelmingly dominant. This is because ALL can offer engines with very high torque (pulling power), upto 90 mkg @ 1400 rpm and a BHP of 240 @ 2200 rpm. It is even planning to extend its range upto 300 BHP. As opposed to this, Telco's most powerful offer develops only 44 mkg @ 1800-2000 rpm and 160 BHP @ 2800 rpm. Even when the horse-power of the engines are comparable, ALL engines have more torque - the Comet's 110 BHP engine develops 38 mkg @ 1600 whereas the 1210's 112BHP engine develops 30 mkg @ 1800-2000. Thus, even on comparable vehicles ALL products can carry heavier payloads. We have already seen that only ALL caters to the specialised bus market in the form of double-deckers, articulated buses and integral buses, partly because of higher torque engines and partly because it employs full air brakes, unlike Telco, which has air-cum-hydraulic brakes. Air brakes are safer and more powerful than hydraulic ones, and are therefore particularly suitable for heavy vehicles.

Besides the above, a dominant consideration in the buyers' purchase decision is the quality of after-sales service, particularly when one vehicle has no fundamental advantage over the other. ALL is very poorly represented in the North Zone which accounts for 33% of the truck market and 22% of the bus market - only 11 of its 85 dealer and sub-dealer offices, or 13%, are located

in the North.[1] According to North-based truck operators, the main reason why they don't buy ALL trucks is because of lack of spares and service centres and also the consequent difficulty in re-sales. Telco, on the other hand, has a vast and far-flung dealer network embracing all parts of the country. It has 195 dealer centres, of which 55 (28%) are in the South zone, which is ALL's main sphere of activity. Yet, in absolute terms, its 55 dealers outnumber the 31 dealers ALL has in its own stronghold. After-sales service conditions also explain a peculiar phenomenon in the metropolis of Delhi: the fact that the state-owned Delhi Transport Corporation (DTC), with its own spare parts depots as well as mechanics trained for Leyland vehicles, has 3300 ALL buses out of a total of 4000 in its fleet, whereas the private buses run under DTC auspices are almost totally Telco vehicles.

A related issue that needs to be explained is ALL's better performance in buses than trucks, inspite of the fact that the power train and chassis was the same for both. One reason is that ALL's principal, British Leyland, was also strong in the bus segment, and moved quickly to equip bus depots with spare parts and trained mechanics, particularly in the South, which also happens to be the largest market for buses. Moreover, 60-70% of all buses sold are bought by state transport undertakings for whom, as we have seen for the DTC, lack of widespread servicing facilities is not a handicap. Telco itself was more preoccupied with trucks, which was a much larger market (2.2:1 on an average over 1980-88) and where, until the early 1980s, there was always a long waiting list of customers.

Price of the basic ALL vehicle has almost always been somewhat higher than the comparable Telco product, at least until 1987.[2] Non-price considerations such as those mentioned above,

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1. These and subsequent figures for dealer networks are drawn from Motor India, Annual Number 1988.

2. AL 3/1 176" compared with Telco 1210 SE/42. In January 1980, the respective net dealer prices (excluding excise) were Rs.1.28 and 1.08 lakhs, but the disparity has since reduced and in fact ALL was marginally lower in September 1989.

coupled with the fact that the market was a seller's market until the early 1980s, have thus been more important in determining market shares of the two manufacturers.

The Hindustan Isuzu is now being posed as a challenge to the established manufacturers. In terms of vehicle specifications, the HML vehicle appears superior to the standard ALL and Telco vehicles. Its engine is capable of 130 BHP @ 3000 rpm which is greater than ALL's and Telco's standard fitments. It is even greater than the heavy haulage premium versions in the same weight class (16.2 tons), employed in ALL's Tusker (120 BHP @ 2400 rpm) and Telco's 1612 (120 BHP @ 2800 rpm) vehicles, although the Tusker Super offers 135 hp. At 38 mkg, its torque is the same as ALL's standard engine (but less than the Tusker's 41.5 mkg engine) and more than Telco's. Its turning radius is 20% less than the 1210 (greater gap for the Comet) and its gradability (climbing ability) better than either. Thus it combines the pulling power of the Comet with better speed and acceleration than the 1210, which would be obviously preferred in hill-driving. Moreover, based as it is on contemporary Isuzu technology, its 6 BDIN engine is certainly more fuel efficient than its competitors'. On the whole, the vehicle is more fuel-efficient, gives a better turnaround time and it is also reported that its running costs are lower. While we do not have exact quantitative data on performance, it is learnt that the vehicle has already run more than 300,000 kms with several operators in South India (it has not yet been introduced elsewhere) without any problems. This is in keeping with international standards since, unlike India, vehicle repairs are very expensive in most countries.

Besides the functional dimensions, the Isuzu scores overwhelmingly on aesthetics (finish, cab and so on), ergonomics and driver comfort, since these factors are very important in international markets. However, one major question remains - how the Isuzu performs over its life-cycle, particularly in the North where the roads are much rougher and overloading more prevalent than in the relatively friendlier South? Perhaps the latter may not remain an issue with the implementation of the Motor Vehicles Act of 1988, but rough roads are there in plenty. As against this, a

strong point about "Indianised" vehicles such as the 1210 and Comet is their durability in adverse road conditions. This gives them a niche in many African countries with rough road conditions even in the face of strong international competition (see also next chapter). The relative durability and maintenance costs of the Isuzu vis-a-vis the ALL and Telco vehicles under adverse conditions thus remains a question mark (although it has been strengthened to suit such conditions), accepting that it performs better under normal load and good road conditions.

Even if we were to accept that the Isuzu performs better, this does not guarantee sales. For one, the market price (includes excise and sales tax) of over Rs.3.26 lakhs (October 1989) is about 12% more than its competitors, although it includes a cab whereas the competition does not. Moreover, even this price is a highly subsidised one, owing to very low volume of operations and appreciating price of yen-denominated CKD kits. The real test (both price and quality) will arise after the company indigenises (if it does), as it must under the Phased Manufacturing Programme. Moreover, as our interviews with North-based truckers bring out, the market is highly resistant to change, because of availability of parts, serviceability, and familiarity of mechanics and resale values. HML will need to be very persistent and also establish a good dealer network if it is to improve its sales. Currently, it has 14 dealers, 13 in the South and 1 in the West - most of whom are also a part of its vast Ambassador car sales network. If all the Ambassador dealers were to also service Isuzu vehicles, the Isuzu network would exceed even that of Telco. Potentially, this is an important synergy that HML could exploit, although it would involve substantial re-training of the Ambassador dealers.

Light Vehicles

Until 1984, there were only 3 LCV manufacturers in the market (discounting PAL and HML). In the early 1980s, all of them introduced more powerful and fuel-efficient engines via

fresh technology collaborations. Earlier, in the 1970s, the most powerful engine amongst the three basic models was M&M's P4 used in its FJ 460D model. Being a rear-wheel drive, and fitted with the 55 HP and 18.5 mkg torque of the P4, the FJ 460D was relatively the best suited for heavy (overloaded) load-carrying operations, well beyond its rated 2.2 ton payload. Moreover, a 4 wheel drive version was also available for cross-country operations (based on its Jeep commonalities) which gave and still gives the FJ an assured niche market of about 500 vehicles/year.

Like M&M, SMPIL also offered a rear-wheel drive "mini-lorry", but with 48 HP and 12 mkg, it could not pull overloads. BTL's front-wheel drive F 305 vehicle also offered 48 HP and 10.8 mkg. Both vehicles were therefore more suited for passenger applications and light load (upto 2 ton payload) intra-city goods applications. SMPIL, for instance sold 70% of its LCVs in passenger versions. Also BTL and SMPIL offer factory-built bodies for different passenger applications (or other built-up versions) such as minibuses, ambulances, station wagons etc., which gives them a price edge over M&M who get these executed under sub-contract. BTL, in particular, has the widest range on offer partly because of extensive press tooling and also because it is technically easier to execute different variations with a front-wheel drive vehicle.

In the early 1980s, M&M brought in the Peugeot's renowned XDP 4.90 engine of 60.5 HP and 12.3 mkg torque. For load-carrying applications, however, it usually continues to offer the P4 engine version because of its torque. BTL offered Daimler Benz' 65 HP and 12.8 mkg OM-616 engine, and SMPIL brought in Austin Rover's 2.5 litre engine with 65 HP and 15 mkg. While the rated payload of BTL and M&M remained 2-2.3 tons, SMPIL used its powerful engine to offer a 1 ton increase in payload to 3.2 tons. Until the arrival of the Allwyn Nissan Cabstar in 1985, SMPIL's micro-lorry was the only vehicle in its weight class.

The new vehicles, however, did not change very much the relative competitiveness and

market niches of the three manufacturers. A very large chunk of the LCV market continued to be of the short haul, low-load kind where the tariff is determined by the number of trips rather than any concept of ton-kms. BTL's lower prices as compared to M&M and SMPIL have often proved decisive in this market. Indeed, a low price on its full range of vehicles has always been one of BTL's competitive strengths. This, alongwith its in-house execution of a large number of variations, a relatively good finish (thanks to pressed sheet-metal), operational economy and a reasonably good network of 112 dealers has guaranteed for it the No.1 position in the market. Through much of the 1970s and until mid 1984, in fact, demand for the Matador exceeded its supply. For the heavier load applications, SMPIL closed the gap between itself and M&M owing to engine upgradation and a larger loading area (5.5 sq. m) in its micro-lorry than the FJ (4.1 sq. m). However, the overall market for such vehicles remained limited, and in any case SMPIL was a South-oriented company, with 56% of its sales in 1981-85 occurring in the South zone, and 27% in just one state-its home state of Tamil Nadu. Because of its niche in the South, SMPIL has been able to avoid too much head-on competition. Its dealer and service network numbers 103, of which one-third are in the South, and one-fifth in UP and Maharashtra.

M&M's FJ vehicles have usually been more expensive than their competitors'. They do enjoy an edge, as we have seen, in situations of heavy loads and also in cross-country and rough-road situations. In Bihar, where rough roads are the rule, the FJ easily outsells the Matador. This also owes partly to M&M's very strong representation in the East zone compared to the other companies. M&M's dealer network of 143 is in fact a major plus point; it is also well-spread out, with 27%, 28%, 23% and 22% based respectively in the East, West, North and South. This network is the same employed by the company for its highly successful "jeep", and is thus a valuable source of synergy. It has helped to sustain sales of a product (the FJ) whose looks have not changed since 1963. Even a much smaller company like SMPIL had changed its body styling in 1982-83.

Unlike HCVs, the LCV situation changed dramatically with liberalisation in Government

policy. The first new vehicle to enter the market was ANL's Cabstar in 1985 powered by a 75 HP and 16.2 mkg pre-combustion chamber (PC) engine. With a payload of 3 tons, this competed directly with SMPIL's micro-lorry and M&M's load-carrying FJ albeit with a 40% higher price tag. Before it could make much headway, Telco introduced its indigenous 407 (2.6 ton rated payload) with a 65 HP and 16 mkg engine. Designed as a direct injection (DI) engine where valuable energy is not lost in a pre-combustion chamber, it is highly fuel efficient (it has passed the Government's fuel-efficiency norms) and remains to date the only DI engine in India in a less than 6 ton GVW vehicle[1]. Over time, both the 407 and Cabstar have upgraded their rated pay-loads by 0.5 tons, but the 407 is distinctly preferred, owing to better fuel-efficiency, lower price (although the gap has narrowed considerably since 1986) and superior service network. Like SMPIL, ANL is South-oriented, with 70% of its sales and 56% of its 67 dealers in 1987 being accounted for by the South zone and Maharashtra. The 407 has also taken away some of the top end (heavier payload applications) of the Matador, FJ and SMPIL sales but the latter vehicles enjoy a very distinct price advantage that has widened over time, with prices as of September 1989 of the 407 being more than 50% higher. With M&M's takeover of ANL in February 1989, the former's expertise and dealer network may help ANL, but only time can tell.

The maximum change has occurred in the previously dormant 6 ton class of vehicles. The three new Japanese vehicles have similar specifications, with rated GVW 6 tons and payloads in the range of 3.5 tons. Until recently, Eicher's Canter, with 92.5 HP and 22.5 mkg torque, had the most powerful engine as compared to DCM's Dyna (90 and 22.5) and Swaraj's T-3500 (86.5 and 22.9). In January 1989, the Dyna was fitted with the new 14-B engine from Toyota with 94 HP and 24 mkg torque. Technically as well as in terms of performance, there is not much to choose between the vehicles, except in terms of some differences in engine power. All of them perform

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1. Higher fuel-efficiency is achieved at the expense of greater noise and smoke levels. Also DI engines are low rpm engines and are usually not used in lighter vehicles. See Altshuler et al (1984), p.91 and Commercial Motor, April 1989, p.11.

as one would expect from contemporary international-class vehicles - highly fuel-efficient, good finish, high speed and acceleration, driving comfort, and low maintenance costs. Even the prices are similar, and continue to be so over time, inspite of regular increases in the prices. Eventually, what will differentiate the vehicles from one another are, inter-alia, their quality and price after complete indigenisation (currently, they are implementing their respective phased manufacturing programmes), their service network and the quality of management.

Unlike its lighter counterpart, the 407, the 6 ton GVW 608 does not stand comparison with competing Japanese vehicles. Although specification-wise its engine, at 90 HP and 26 mkg, is quite comparable, it is not as fuel efficient as the Japanese, and its dry weight is also greater (it is a 6 cylinder engine compared to 4 for Japanese vehicles). Its GVW - dead weight ratio (including chassis, cab, load-body) is only 2.07 as compared to 2.27 for the Dyna and 2.45 for the T-3500, and its loadbody platform area is also the least (7.9 sq. m compared to 8.03, 8.05 and 8.7 for the T-3500, Dyna and Canter respectively), as is its gradability. Even in the rough road and overload conditions of North India, the Japanese vehicles, which have been changed substantially to suit Indian conditions, have not given any trouble[1]. All these factors have resulted in poor sales of the 608 inspite of its price advantage (net dealer price was lower by more than Rs.30,000 i.e. by at least 14% in September 1989) and Telco's established service network.

OVERALL ASSESSMENT

An overall assessment of the competitiveness of each firm is made difficult by the often conflicting signals emanating from different indicators. Such an assessment nevertheless needs to be

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1. All the Indian counterparts of the original Japanese vehicles have developed "India-Spec." vehicles that are over-designed in comparison. All of them have strengthened their chassis, suspension, axles etc. and also taken account of higher temperatures and dusty conditions.

made. It needs to be stressed that the comparisons are strictly relative, in the context of competitiveness in the domestic market, circumscribed by Government policy. If we make a limited comparison with other Indian industries, it will be seen that except for BTL, profits made by CV companies are not more than the average of 417 public limited companies.[1]

Telco dominated the MHCV market from the beginning, inspite of being the last to enter. In the three decades prior to 1983, its market share rose steadily. Since 1983, ALL and Telco have maintained a competitive equilibrium in the ratio 1:3. In LCVs, the share of the market leader, BTL, has decreased considerably since 1985, and this was not arrested inspite of its introducing a completely new vehicle, of Daimler-Benz origin, in the 3.8 ton class. SMPIL's decline has been precipitous, that of M&M more gradual. Telco, on the other hand, has moved quickly into LCVs, as a result of which it is the only one of our five firms to increase its share of all CVs since 1985.

We have noted the problems with accounting data, particularly as it relates to capital. These create biases in most of the profitability and productivity ratios that we have used. In terms of the data, BTL is the most profitable company, but its declining market share after 1984 corresponds with declining profitability. In terms of our preferred measure (gross profits to sales), Telco's profitability is next only to BTL's, with 1987 being the only poor year. Between Telco and ALL, Telco is more profitable in terms of profit/sales, and its return to net assets is higher in the 1980s.

M&M, whose profitability is more a reflection of its performance in its primary product line, the jeep, has faced lesser pressure than other firms since the jeep continues to dominate a steadily growing domestic market. Its profit ratios therefore tend to be steadier than others. SMPIL has a relatively better return on assets, particularly net assets, than on sales.

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1. For 1981-82 to 1985-86, their gross profits to sales ratio was 13.7%, 13.5%, 13.4%, 13.6%, and 14.1%. For 19 automobile ancillary manufacturers, the ratio in 1984-85 and 1985-86 was 18.3% and 18% [calculated from ICICI (1987), pp.61 and 113].

The picture is slightly different when we look at productivity ratios. Per employee, M&M produces more vehicles than BTL, and Telco more than ALL (adjusted figures). But value added per unit of labour expenditure is higher for BTL and ALL. Again, asset and material productivity (in terms of value added) is higher for M&M and Telco (in the 1980s for asset productivity comparisons between ALL and Telco).

In terms of product quality and service, we have seen that each manufacturer has an output line that has certain advantages vis-a-vis its competitors in the respective markets. To a large extent, these two dimensions also help to explain the market shares of the companies.

An analysis of the competitiveness of each company must also include some assessment of its future competitiveness. More light on this will be shed in chapters 5-8, but we shall attempt a partial assessment based on evidence presented so far.

BTL is undoubtedly the most competitive of the three LCV manufacturers. It is very profitable, is the market leader in LCVs and offers a large number of product options at a cheap price. This enables it to be a broad-based company. It has also introduced two entirely new products, one (the utility vehicle "Trax") based on its own R&D. Neither has, however, been successful to date. Yet, with no direct competition in its Matador class from the new entrants, BTL continues to prosper. Its low price, which can certainly not be matched by any new entrant, will continue to be a major competitive weapon, at least until a completely new model range is designed and produced. At the same time, there is a decline in its pre-eminence, and it can no longer take its success for granted, nor hope for the high profits it has enjoyed before the mid 1980s.

Telco's success is the most broad-based of all firms, partly because of its comprehensive service network. Besides being the market leader, it is also a very profitable company, particular-

ly if we consider the probable downward bias in its reported profits, and its objective of high growth and investment. On most counts, its productivity is also greater than ALL's. The 1210, still its mainstay, is well-suited to market demands in the country. It has also proved itself capable of reacting speedily to changing maket conditions, as witnessed in its introduction of 3 different LCVs in 1986, 1987 and 1988. This ability to design and produce new products has enabled Telco to increase its share of the CV industry after 1985 inspite of the entry of many new firms, and should stand it in good stead in the increasingly competitive CV market. Unlike BTL, Telco looms larger than ever in the Indian CV industry.

ALL falls somewhere in-between a broad-based and a niche-oriented company. Its product range is unrivalled in the Indian automobile industry, but it has always had a Southern orientation. Its profitability and return on capital has been lower than Telco in the 1980s. Its prices have usually been somewhat higher than Telco's, which may be more difficult to sustain in the more competitive market conditions. In the market stakes, the individual strengths of ALL and Telco have been reflected in a near equilibrium situation of 25% and 75% share of the MHCV market since 1983. Its experience in low volume but relatively large variety of production will be an asset in the increasingly demanding markets.

M&M is a more important producer of jeeps and tractors than of LCVs. Its LCVs, in fact, are an offshoot of its jeep. Its LCV market share has declined and the absolute numbers sold have also fallen since 1984. In jeeps, too, its share has fallen with the advent of Maruti's "Gypsy" in 1984, but in this case its sales volume continues to grow steadily, and it still commands over 80% of the utility vehicle market (A.3.5). For the firm as a whole, profitability as well as return on capital are lower than BTL. However, its asset and material productivity is higher, but labour (expenditure) productivity lower. So far, the FJ has survived comfortably, but it is coming under pressure from newer vehicles such as the 407. M&M will certainly need to upgrade its LCV line if it intends to keep its share of the market. Here it will face some problems since competitors

such as BTL and Telco have already made the investments and brought in newer products.

Like M&M, SMPIL (currently under lock-out) also needs to upgrade its LCV, but it does not have other products to fall back upon (its car having failed in the market)[1]. The decline in its market share has ben drastic, but would certainly not have been so great were it not for extraneous problems. Its ability to use an old and depreciated capital base has enabled it to earn reasonable profits for a certain period (1977-84), particularly if we consider return on net assets. However, its gross profits to sales ratio is the lowest of all firms. Its marketing strategy is highly niche-oriented, with most of its sales coming from within a 100 km radius of its plant. Fresh investments, which will be necessary to meet heightened competition, will put great strain on so small a company, which enjoyed a good run upto the mid 1980s because it did not need to make such investments at that time.

In a sense, all the five firms are or were domestically competitive, although this was destined to be ephemeral in some cases. All of them have product and/or geographic strengths that have enabled them to survive and make reasonable profits. The most strongly competitive are Telco, ALL, and BTL, not just in current terms but also because they are well-placed to meet the challenge of the changing market situation. M&M's competitiveness, at least in the LCV market, has been eroded, and SMPIL's probable decline been hastened by extraneous circumstances. In chapters 5-8, we shall attempt to explain the competitiveness of different firms as documented in this chapter, including market share, profitability, quality, productivity and costs and prices. In doing so, we may also be able to elaborate further on other dimensions of competitiveness, and shed more light on future competitiveness of the firms.

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1. Throughout the study, for ease of exposition, we usually refer to SMPIL as if it is still active in the vehicle market, although it has been shut since February 1989.

CHAPTER 4

INTERNATIONAL MARKET COMPETITIVENESS

INTRODUCTION

This chapter reviews the export performance of the CV industry and also the individual firms. It also offers an explanation for the overall distribution of markets (primarily developing countries) and products. Besides price, quality and after-sales service are arguably the most important ingredients in determining automobile sales. The chapter discusses the role of these factors in export performance alongwith export credit which, given the mix of markets, is often critical to success. Thereafter, there is a discussion on the international CV market including broad trends in world trade and the characteristics of different product segments. This section will serve as a backdrop to the analysis in our final chapter where export prospects will be briefly discussed. Finally, there is an assessment of international competitiveness of the firms and the industry.

While explaining the export performance of the CV industry as a whole, the chapter does not attempt to explain inter-firm differences in exports. That, alongwith the varying performances in the domestic market, is what the next three chapters will attempt to answer.

The indicator that we shall adopt for measuring international competitiveness of firms is export intensity of sales[1]. At the industry level, this will be supplemented by price and domestic resource cost figures.

1.Ideally, we should also use data for market share in international markets. But this is unfortunately not available at the level of disaggregation required.

INDIAN VEHICLE EXPORTS

Macro Performance

While a handful of vehicles were exported in the late 1950s and early 1960s, CV exports crossed the 100 mark in 1963-64 (T.C.1968, p.277). The increase thereafter was steady if not spectacular, going up from 208 vehicles (including chassis) and Rs.0.5 crores in 1964-65 to 4841 vehicles and Rs. 53 crores in 1981-82 (A.4.1.). Thereafter, there was a decline in exports, down to Rs.34.5 crores in 1986-87, the last year for which official figures are available. This decline owed itself to:[1] (a) high degree of over-capacity in the early 1980s in the European and North American truck industry, leading to a scramble for the smaller developing country markets; (b) oil-price induced depressions in some of the major markets; (c) entry of Korea as an exporter of heavy vehicles and a renewed thrust by Japan in the early 1980s; (d) failure of Indian CV manufacturers to upgrade their vehicles, particularly the engines, in response to these threats. However, it appears that the situation may have changed somewhat in the last two years owing mainly to the continued currency appreciation of India's main competitor, Japan. According to one source, CV exports are slated to rise from Rs. 59 crores in 1987-88 to an all-time high of Rs.110 crores in 1989-90 [2] (although if we adjust for inflation and rupee depreciation, the figure will be lower than the 1981-82 peak).

Of the total exports of the automobile and components industry of Rs.156 crores in 1985-86, CVs accounted for 24%, components 50%, cars and jeeps 8% and diesel engines 10% (ACMA 1988 p.62). Within CVs, trucks or lorries were the mainstay until the mid-seventies. Buses have dominated in the 1980s, although in 1986-87 they were exceeded by exports of chassis with engines. Other elements of CV exports include three-wheelers, special purpose vehicles such as

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1.See World Bank (1987), pp.17, 24 and Financial Times Survey on the World Truck Industry, 1989.

2.Dalal Street Journal, September 25 - October 8, 1989, p.87. This is corroborated by individual company performances (see next section).

dumpers, and tractors for tractor-trailers.[1]

In effect, the CV exports have been confined to MHCVs. World trade data, however, is available only for all trucks as a whole, and it is therefore not possible to calculate India's share of MHCV trade. If we compare with the developing world's largest exporter of HCVs, India's export performance is quite poor. Brazil's exports of heavy trucks and buses doubled from 10047 in 1976 to 21368 in 1980, declined drastically in 1982 and 1983, but recovered strongly to 21455 by 1987.[2] It would not be unfair to say that India's CV exports could have been much better than they have, in tune with the overall below-potential performance of the country's export sector. We shall attempt an answer to this during the course of the chapter.

Major Markets and Indian Vehicle Characteristics[3]

India's CV exports have been directed very largely towards developing countries, falling either under (a) oil exporting countries such as Saudi Arabia, Kuwait, Algeria, Malaysia etc. or (b) low income countries in the neighbouring South Asian region or in Africa. Calculations from DGCIS data show that the major markets have been constantly changing. In 1977-78, most important were Uganda (23.5% of exports), Sri Lanka (20%), Indonesia (18.5%), Kuwait (8.3%), Malaysia (7.1%) and Tanzania (5.6%). Other oil exporters such as Algeria (18.5%) and UAE (15.3%) gained prominence in 1984-85, with other markets being Ghana (14.6%), Kuwait (6.9%), Kenya (6.3%), Nepal (5.9%), Sri Lanka (5.7%), and Zambia (5.5%). However, by 1986-87, there were no oil exporters in the list of major markets (except for USSR, which in any case has a bilateral rupee trade agreement with India), with India's neighbours Bangladesh (23.7%)

1.Tractors have not been included in A.4.1. In 1986-87, only 25 tractors worth Rs.70 lakhs were exported, mainly to Uganda (DGCIS).

2.Data from Statistical Yearbook on the Brazilian automotive industry, ANFAVEA (1986), p.97 and data sent by ANFAVEA.

3.This and the following sub-section rely heavily on our field interviews, both in India and abroad.

and Sri Lanka (21.9%) being two of the most important, others being Uganda (15.3%), USSR (13.9%), Mauritius (4.5%), Zambia (3.6%) and Ghana (3.4%). Egypt, which was once the largest market for India (in the late 1960s and early 1970s), imports only a few vehicles at present.

It is evident that there have been very few stable markets for India, owing to the volatile oil revenues and international commodity prices and increasing competition from other producing countries (more on this later). Exports to many low-income countries have depended on erratic Government-to-Government credits, or Exim Bank credits (see also later section).

This total dependence of exports on the developing country market needs to be explained. Some of the reasons were hinted at in Chapter 3. It appears that the domestic demand pattern has imposed certain characteristics on Indian vehicles. A concern for functional rather than aesthetic features, low price and short-term economy of operations has been paramount for the consumer. This, combined with poor and congested roads, has resulted in vehicles that are rugged and uncomplicated, are relatively easy to repair and can take a lot of abuse. As we have seen, Indian vehicles have been progressively strengthened over time in order to increase their attractiveness to the customer by way of heavier axles, stronger frames and leaf-springs, bigger gear-box etc. Similar road and (over-) load conditions, driving habits, and hot and humid climate, combined with geographical proximity, have created a demand for Indian vehicles in Asia and African countries in certain kinds of uses. Also, the most popular CV size in developing countries is the same as that in India (12 -16 t GVW).

At the same time, engine power of Indian vehicles has lagged well behind international standards, so that speed and acceleration suffer in comparison. This is a handicap in export markets, particularly in the case of trucks where the laden weight of the vehicle is far higher than in passenger applications. Since Indian manufacturers use a common chassis and engine for both buses and trucks, the power-to-weight ratio is higher for laden buses than laden trucks, although the former is still less than internationally prevalent standards.

Simple calculations show that a regular 60-seater bus (Tata 1210) carrying even 40 extra passengers will weigh at most 11 tons fully laden (assuming 5 ton bare weight of bus, and 6 tons

passenger weight of 100 passengers @ 60 kg each). The same vehicle in its haulage version is rated at 16 ton GVW i.e. to carry more than a 10 ton payload, and overloading adds anything from 2-5 tons.[1] Buses are therefore more acceptable in particular applications abroad than trucks. For example, relatively undemanding uses like school buses, where high speeds are not required, distances travelled are not too great, and functional characteristics are more important than comfort, have created a niche for Tata buses in places such as Ghana, Kuwait and Zambia. A similar application is that of ferrying migrant labour from their homes to construction sites in the Gulf areas. In poorer countries of Africa and Asia, Indian buses have a wider range of applications, as in India, both for inter-city and intra-city use. On the other hand, in oil-rich and other relatively high income countries, Indian buses would rarely ply on inter-city routes where comfort, speed and low noise are at a premium.

The relative success of buses can also be explained by the fact that building bus bodies is a highly labour intensive job. Given the lower wage rates in India as compared to competitors such as Korea, Brazil, Japan etc., this implies that customers would get a relatively greater price advantage from buying Indian buses (or, for that matter, special purpose vehicles such as tankers, fire-engines, sanitary vehicles) as compared to trucks.

Nevertheless, Indian trucks have their markets too, particularly in conditions of bad or narrow roads where vehicles cannot move very fast. According to a recent news report, Tanzania has ordered 500 Indian trucks (mainly Tata) in 1988 and 1989 because "their performance in local hot and humid conditions is considered to be at par with trucks made in Japan".[2] In the same report, transport ministry officials of Uganda and Tanzania have said that Indian-made trucks were more suited to African conditions and that the Indian companies had set up better after-sales service facilities as compared to the Japanese. Another news item reports on the barter deal

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1.See Motor Transport, May 1989, pp.12-13, and Planning Commission (1988) report on Transport Development, p.150. According to these, the overload ranges between 25%-75% of the permissible limit of 10.2 tons,and 25-30% of vehicles surveyed exceeded this limit.

2.Motor Transport, August 1989, p.19.

whereby Telco would supply 1500 trucks to Uganda over 1989-93.[1] In Malaysia, Tata trucks have sold because of their ability to handle overloads.[2]

The suitability of Indian vehicles for selected developing country markets has, by the same token, made them unsuitable for much larger markets, both in developed and developing countries.[3] One of the major deficiencies relates to engine power. In Malaysia, the Tata S1313 cargo carrier develops only 130 hp, whereas the best-selling Hino GF Series has 165 hp and Nissan CPB 183 hp. Again, in buses, the best-seller is Hino with 165 hp. In general the hp to gross weight ratio in Indian MHCVs is at best 8 hp/tonne (it could go down to 6 if overloading is considered) whereas it should be at least 10.[4] These low ratios result in excessive wear and tear of engine components, shorten engine life and cause higher fuel consumption during the latter part of their lives. Other engine-related problems are to do with the higher specific fuel consumption (160 to 165 gms/BHP/hour as opposed to the standard of 150), and the greater level of pollution.[5] In buses, some specific deficiencies are the front engines, manual transmission and heavy steering.[6]

Ramachandran (1988) suggests the following changes on efficiency grounds: (a) changing to synchromesh or automatic transmissions (synchromesh is currently provided as an option) to provide optimal ratios for road conditions; (b) introduction of light weight materials such as

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1.See Economic Times, 18th August 1989, and Financial Express 23rd December, 1988.Also confirmed by our field survey.

2.From field interviews in Malaysia. 14 ton GVW trucks are apparently often loaded to carry a 14 ton payload!

3.This paragraph draws on our field interviews and also the unpublished note by K.Ramachandran (1988).

4.While ALL can offer higher output engines, as we have seen, these are normally fitted only onto tractors and multi-axle vehicles. In any case, these are low-speed engines which cannot achieve international speed and acceleration standards.

5.Telco's R&D Director acknowledged in a public interview that high emission levels were the norm in India and had affected exports. See Motor Transport (September 1989), p.16.

6.See article on bus transport in Bahrain in Gulf Daily News, 29th July 1988. As compared to Telco buses, Nissan buses were considered more comfortable because of their rear engine and power steering. Telco has developed rear engine buses, but these have not been successful. They also offer power steering as an option.

aluminium and plastics in order to reduce dead weight; (c) have maximum speeds of at least 100 kmph; (d) popularise use of multi-axle and articulated vehicles to improve efficiency and reduce road damage. Other deficiencies relate to comfort and ergonomics, aerodynamics and safety features. If some of these suggested changes are brought about, it would bring Indian vehicles closer to international standards. Also, the availability in India of cheap repair services has allowed the manufacturer to neglect factors such as trouble-free performance and life of engine. In Malaysia, the Tata vehicle requires an engine overhaul between 100,000 - 200,000 kms, whereas Hino and Mercedes - Benz vehicles easily go up to 500,000 - 750,000 kms.[1] Such overhauls and repairs mean that a life-cycle cost comparison could be less favourable to Tata vehicles than a straight-forward price comparison.

LCVs and Exports

Why have CV exports been confined to MHCVs? Firstly, Indian LCVs are manufactured at a very low scale compared to world standards, with little benefits of synergies with cars. This low scale reflects the demand pattern in India which is unusually skewed towards MHCVs (see Ch.3) Secondly, like the MHCVs, Indian LCVs (except the more recent collaborations) have focused on functional performance to the exclusion of comfort and aesthetics, but this is a greater disqualification in the international market for LCVs than MHCVs (see Ch.2). Most of the deficiencies of MHCVs enumerated above also apply to Indian LCVs vis-a-vis international standards. Thirdly, Japanese manufacturers are highly competitive in LCVs, and have made most developing country markets for LCV imports their own. Potentially, all LCV manufacturers can compete in every market around the world, and make use of marketing and servicing synergies with their car divisions. Thus, LCVs, like cars, are a more global market than MHCVs, and the possibilities for finding a regional niche are thus more limited (see also next section). More light on this

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1.The EIU (1987a) report points out that Brazilian conditions do not demand as high a quality as that in OECD countries because service facilities are cheap and efficient; environmental temperatures are moderate, influencing the choice of plastics, oils and greases, and ventilation is more important than heating in the passenger compartments.

subject of LCV exports will be shed in later chapters.

Micro Performance

The most successful exporter in the Indian automobile industry (as well as in India's engineering industry for many years) has undoubtedly been Telco. As Table A.4.2. shows, it has accounted for more than half of the exports of the five firms put together, and frequently more than two-thirds over 1977-88 (equally true for the 1960s and 1970s).[1] As such, the instability in aggregate exports is reflected in Telco's performance. Its exports rose almost continuously upto 1981-82, but have been erratic thereafter, although there was an all-time high export of Rs.81.4 crores in 1988-89.[2] In terms of export-intensity (exports/sales), too, Telco is usually ahead of others (except 1982-84 and 1987), which means that it dominates exports even more than it dominates domestic sales of the CV industry. However, this intensity has declined from a usual level between 9-12% over 1977-82 to 4-6% since 1984.

M&M, the next best both in absolute exports as well as export-intensity, has had a relatively less fluctuating export performance because its main export has been Jeeps rather than MHCVs. In 1980, it received an order for 15,000 Jeeps from Iran, exports against which are still continuing. This doubled its exports to over Rs. 20 crores in 1980-81, which peaked in 1982-83 at Rs.29.3 crores, after which they have stagnated at Rs.19-22 crores annually.[3] M&M also exports a certain number of LCVs, primarily to international orgnisations in India against foreign currency ("deemed exports"). In 1987-89, it exported 2944 vehicles including 1920 CKD units to Iran. Deemed exports were 1242 in 1987-89, 812 in 1986-87 and 1150 in 1982-83 (various Annual

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1.It will be seen that Telco's exports alone are almost always greater than the aggregate exports given in A.4.1. This could be on account of differences in classification, product coverage and possible non-inclusion of "deemed exports" in the aggregate DGCIS figures.

2.In physical or real terms, however, the exports were greater in 1979-80, when 3529 buses and trucks were exported, compared to only 3228 in 1988-89 (Lok Sabha starred question no.806, 21 April 1982, and Economic Times, 25th October 1989).

3.Its exports of Rs.32.5 crores in 1987-89 are for a 17 month period ending March 1989 on account of a change in its financial year.

Reports), but the break-up into Jeeps and LCVs is not available. Like Telco, export-intensity of M&M was as its peak upto the early 1980s. Since 1985, it has remained below 5%, down from an average of about 7% over 1977-83.

ALL's peak exports were in 1982, worth Rs.28.3 crores, of which Rs.18 crores were supplied locally under global tenders floated by the World Bank. ALL has won three such tenders, in 1981, 1987 and 1989 for supply to organizations such as Pallavan Transport Corporation, Calcutta Municipal Corporation etc.[1] The irregularity of tenders, which is natural, has caused violent fluctuations in ALL's exports (in 1988, of its exports of Rs.14.5 crores, only Rs.2.6 crores was local supply). Its export intensity is much lower than Telco, and has been at a lower average level since 1983 than in the late 1970s, falling to an all-time low of 1.9% in 1986, but recovering to 4.3% in 1987.

BTL and SMPIL are marginal exporters. BTL exports its Matadors and a few 3-wheelers to neighbouring countries such as Bangladesh, but even this small volume has declined in the 1980s (211 Matadors in 1977-78 to 87 in 1985-86), reflected in its export-intensity that has remained at or below 0.7% since 1982. Since 1984, SMPIL's exports have exceeded BTL's in relative and even in absolute terms, because SMPIL exports not LCVs but engines and components, mainly for London taxi cabs (about 200 engines per year). This followed its collaboration with Austin Rover for a 2.5 litre diesel engine. SMPIL is the only one of the five companies whose export-intensity has been higher in the post 1983-84 period.

Other than these five firms, HML also exports its old Bedford MCVs to the Bangladesh market. As we have seen in ch.2, the Bedford was not a success in India, and its production line is being maintained exclusively for the Bangladesh market. HML has had a presence in Bangladesh for a decade, and has been consistently exporting 700 - 800 vehicles annually. In 1988-89, its exports were Rs.10.2 crores or about 2.5% of total sales. This relative success in exports is due to the extensive network of water ferries which does not permit overloading of vehicles and

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1.See Motor India Annual 1989, p.52.

therefore erodes much of the competitive edge of the ALL and Telco vehicles vis-a-vis HML. Other factors are the easy availability of spares thanks to the established presence of Bedford (UK) in Bangladesh[1], geographical proximity, and a lower price (arising from fully depreciated equipment).

For the first time, more than just a handful of LCVs have been exported from India following the Japanese collaborations, with Eicher and DCM being the most active. For example, Eicher had exported 497 Canters as of October 1989. These exports are mainly to neighbouring markets such as Sri Lanka, Bangladesh and Nepal, where the high yen and geographical proximity have helped Indian-made Japanese vehicles to be price competitive.

In terms of relative international competitiveness as revealed by exports and export-intensity, Telco ranks above all others. ALL stands a decided notch lower, and M&M is in between (exporting mainly jeeps). The older-generation LCV manufacturers (BTL and SMPIL) export a negligible number of LCVs, and are therefore uncompetitive internationally. Over time, there has been a discernible decline in the export intensity of sales, owing partly to recession in the important markets and partly to a decline in the relative quality of Indian MHCVs (owing to lack of sufficient technological renewal, see ch.7). In using export intensity as a measure of competitiveness, one should also note the possibility that a firm may have the ability but not the willingness to export more, as is likely when it has a large and protected domestic market. Yet, MHCV export-intensity, particularly of Telco, was highest precisely when domestic sales were growing phenomenally (1977-81). And the intensity has declined thereafter, while the domestic market has also turned soft. Thus the ability and willingness distinction does not invalidate the use of export intensity to measure competitiveness.

In the following section, we shall look at prices and costs of Indian vehicles to understand better the extent to which they are responsible for export performance.

1.This company is now known as AWD, having bought over GM's Bedford (UK) operations. Bedford has been in Bangladesh for nearly 40 years, and according to AWD, about 80% of the trucks on the road in Bangladesh are Bedfords. See AET September 1989, p.44.

PRICES AND DOMESTIC RESOURCE COSTS

Before we turn to export prices, we shall attempt to judge whether the production of CVs in India is inherently efficient. This can be done by looking at the Domestic Resource Cost (DRC) measure, which measures the cost of earning or saving a unit of foreign exchange, indicated, for example, in rupees per dollar.[1] If the DRC is lower than the prevailing exchange rate, it suggests that the product may be worth producing/exporting. The results of various studies are tabulated in A.4.3.

Studies mentioned under (1) - (3) of A.4.3 are too aggregative for our purpose, although their uniform conclusion is that DRCs are substantially higher than the exchange rate. Krueger (1975) finds that assemblers of different kinds of vehicles were generally more efficient than ancillary producers, but their DRCs are nevertheless somewhat higher than the prevailing exchange rate.[2]

Perhaps the most relevant study for our purposes is that by the World Bank (1973). This differentiates between import substituting and export activity, and finds DRCs in the former to be lower, since export incentives allow export prices to be lower than domestic. The lowest DRCs are, as expected, for the Telco and ALL heavy vehicles and these, alongwith M&M's Jeep and LCV, are efficient import-substitutes. In the case of HCVs, this efficiency is ascribed to produc-

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1. DRC = Nd/Yf-(Xf+Nf+Xi) x official exchange rate

Nd : Cost of indigenous non-tradeable inputs inclusive of interest, depreciation and wages.

Xi : Cost of indigenous tradeable inputs revalued at border prices (fob for exportables and cif for importables).

Xf : Cost of all imported tradeable inputs less tariffs.

Nf : Foreign exchange outgo on account of interest and depreciation on foreign currency debt and equipment respectively, and royalty.

Yf : f.o.b. earnings.

Source : ICICI (1985), p.85.

2.Krueger also finds that the DRCs of the different assemblers are not very sensitive to varying assumptions on shadow prices of capital and labour.

tion of only 2-3 standardized models and low labour cost. As for BTL, its DRC is considered reasonable in view of its then recent entry and low scale of production. Even the export DRCs for HCVs and Jeeps are economic if the opportunity cost of foreign exchange (RS 10-11) is seen as the benchmark.

More recent estimates from ICICI confirm the above findings. Judged by the opportunity cost of foreign exchange, all the DRCs under (5) - (9) would be considered efficient. Even otherwise, the 1980-81 DRC of 5 CV manufacturers (7.1) is lower than the official exchange rate, but that of 8 auto ancillaries is even lower (5.1). In 1974-75, 1 LCV manufacturer had an efficient DRC, but the 3 HCV firms had a DRC of 11.1 due to the "large expansion programme" undertaken by one of the manufacturers, the "full benefits of which will accrue only after some time" (ICICI 1977, p.15). The 1985 estimates are of the new Japanese collaborations in LCVs, and show the (ex-ante) DRC to be higher than the exchange rate.

DRC measures suffer from many drawbacks.[1] They are static in character and hence cannot take into account important learning effects. They should be used

> ...more as a way of deciding which are promising fields for fuller analysis than as a good substitute for such analysis (Little and Mirrlees 1974, p.365).

In other words, they are more useful as a rough tool for inter-industry comparisons rather than for intra-industry studies.

Unfortunately, it is difficult to compare DRCs or actual production costs internationally because of lack of data.[2] The only solution is to compare prices. Indeed, Kravis and Lipsey (1971) point to the "decisive advantage" of prices over costs in an empirical study on grounds of their greater objectivity, specificity and easier availability (p.43).

Given the quality and specifications of Indian CVs, it is to be expected that their prices would be at least lower than CVs from developed countries. Ceteris paribus, only a lower price would

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1.See Little and Mirrlees (1974), pp.363-65, and Bhagwati and Srinivasan (1975), p.194, for a critique.

2.Altshuler et al (1984), p.155.

confer a share of the market on them. There is some evidence for this phenomenon, as seen in A.4.4. Over 1969-72, at actual prices, Telco HCVs and M&M Jeep-trucks are cheaper than comparable imports, and ALL's vehicle is 1% more expensive. However, if we assume that inputs are available at international prices, both the HCVs as well as M&M's Jeep and LCV are substantially cheaper, and even BTL LCVs are only 4-6% more expensive. These figures are also consistent with the DRC results from the same source, shown in A.4.3. More recent data, also from the World Bank, shows a very substantial price advantage for Indian HCVs (See item 2 of A.4.4.) in 1985-86 as compared to European makes. Moreover, in 1987, landed costs of Telco and ALL 60-seater buses were not more than smaller buses from Korea, but higher than an even smaller bus from Ikarus of Hungary (item 3). But a 135 hp ALL truck is only slightly less expensive than a 180 hp Daewoo truck in 1988 (item 4). Detailed comparisons of vehicles (obtained from the corporate office of Telco's joint venture in Malaysia) used in the same applications shows that Tata buses and trucks were 12-16% cheaper in Malaysia (item 5) in 1987. The earlier mentioned news item on suitability of Indian vehicles for East Africa (Motor Transport, August 1989, p.19) also adds that Indian trucks were 30-45% cheaper than entrenched brands from Isuzu and Toyota and that the price factor was very important in explaining the success of Indian vehicles.

This price advantage is confirmed by our talks with Indian firms. However, there are occasions and instances when Indian prices have been higher. In the early 1980s, Japanese vehicles began to erode India's price edge in Malaysia. From 23% in 1978, Telco's share declined to 6% in 1982 and 3% in 1984. However, the yen increase thereafter restored India's price advantage, and Telco's share also rose beyond 12% in 1987.[1] In some African countries where it was an established brand, Telco vehicles were apparently able to command a higher price than Japanese vehicles in the late 1970s and early 1980s.[2] On the whole, however, it can be said Indian vehi-

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1.Data from Tatab Industries. 1987 data is for January to August.

2.Economic Times, June 9, 1987 and interviews.

cles have by and large been lower-priced than their competitors.

Several caveats in our use of prices as a measure of cost competitiveness should be noted: (a) the pricing decision is based partly on the balance between demand and supply, and this could result in price changes that have little to do with costs;[1] (b) many countries such as Korea, Japan, Germany, Sweden etc. are dependent to a very large extent on the external market. As such, they put a high premium on exports and practise "strategic pricing"; (c) as is well-known, prices in a market depend on market size and potential, as well as political factors. This was confirmed by Japanese and German companies; (d) the larger the range of products produced by a company, the greater is the potential for cross-subsdisation. In such a situation, the Indian CV companies are clearly at a disadvantage since their range is very limited. All this implies that the price-cost margin is rarely uniform for a company in different products, markets or over time. A prominent example of this is the well-known fact that Japanese vehicle prices have moved upwards far slower than the yen appreciation, implying that the firms are absorbing much of the increase. In other words, Indian CVs could be under-cut in certain markets at certain points of time, but we have enough evidence across time and space to prove that they have been generally cheaper.

In a discussion of export prices, it is relevant to consider (monetary) export incentives, since f.o.b. prices are net of these and therefore substantially less than domestic prices. Current incentives include:[2] (a) cash compensatory support (CCS) at 20% of fob value to neutralise for unrebated indirect taxes and assist in export promotion; (b) duty drawback (DD) of 4-8% of fob value to reimburse tariffs on imported raw materials and components and central excise duties; (c) import replenishment (REP) licences to provide importable inputs at international prices, and which can be sold in the market at a premium; (d) international price re-imbursement scheme (IPRS), introduced in 1981 to cover the difference between domestic and international prices of pig iron, alloy steel and aluminium. All these mean that the fob price can be 30-40% lower than

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1.See Kravis and Lipsey (1971), p.42.

2.For details, see Hussain Committee (1984), ch.III and ICICI (1985).

the domestic price, depending on the kind of vehicle and its level of indigenisation. Of course, it is not necessary that fob prices be reduced by the full amount of incentives -- that decision depends on the company's perception of the market. During 1978-79 to 1980-81, for example, gross profit on export sales (with incentives) was much higher than on domestic sales (20-24% as opposed to 9-11%) for 5 CV manufacturers.[1]

We do not intend to enter into a detailed discussion regarding the effectiveness of pecuniary export incentives. In view of the price competitiveness of Indian MHCVs as well as earlier generation LCVs, and given the limited evidence of higher export profitability, it seems that the incentives are adequate. A similar conclusion was reached by an earlier study by the World Bank (WB 1973, pp.20-22). The constraints to increasing exports appear to lie in factors such as quality of product (see concluding chapter). If the product lines are upgraded to developed country standards, the Indian product would conceivably be more expensive, at least initially. For these to be competitive, raising export incentives is not the answer since in theory any product can be made price competitive by increasing incentives. These issues will be discussed in the concluding chapter.

NON-PRICE FACTORS IN VEHICLE EXPORTS

Credit

If price was the major factor affecting trade, India's CV exports should have been much higher. However, if we discount for the lower specifications and poorer finish and ergonomics, the price advantage may be minimal, if at all. Given the low purchasing power (and foreign exchange) in many of India's major markets, credit appears to be a more important and often critical factor. One estimate suggests that about 50% of truck sales to the Third World are aid-

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1.ICICI (1985), pp.17-18.

related in one form or another.[1] India offers different types of export credit - Government to Government credit where the recipient can choose from an agreed list of products, Exim Bank buyer's credit (where the credit is offered to the importer directly) or Exim Bank supplier's credit (which is offered to the exporter and requires a bank guarantee and/or letter of credit from the importer).

Aid-dependent exports are sometimes referred to as "soft" exports, but this contention is not supported by facts. India's developed country competitors such as Japan, Germany and Britain are in a better position to finance purchases by poor countries. The Exim Bank, for instance, charges 8.5% interest rate for supplier's credit and there are additional costs of guarantees. Japan offers credit at 6-7% with no guarantees required. However, the real interest rate may often be lower for India because the rupee is stable or depreciating whereas the yen and mark are appreciating. But if a promising deal is in the offing, the Governments of developed countries may step in and offer mixed credits in the form of grants cum loans, which is effectively tied aid. India cannot match such offers.

Following the 1980s recession, even smaller markets/poorer countries were offered liberal credit facilities by the British, French, German and Japanese manufacturers. Although India offers Government credit to countries such as Sri Lanka, Mauritius, Ghana etc. on attractive terms (15-20 year repayment, 4% interest), developed countries can afford to be more generous, with 30-40 year repayments in some cases {See CEI (1988)}.

Thus, in the face of severe competition and with developed countries able to offer very attractive credits and mixed credits, Indian CV exports are by no means "soft". Of course, non-credit exports are preferable, but in a situation of cut-throat global competition, manufacturers cannot afford to neglect the developing country markets.

Are Indian credit terms competitive? For purely commercial credit, India does not lag far behind, particularly given the direction of currency movements. For bilateral Government credit,

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1.Financial Times Truck Supplement Nov. 16, 1989. See also Economic Times June 9, 1987 and CEI (1988).

India suffers from some handicap if it faces direct competition from a developed country. Nonetheless, such bilateral credits appear to be highly favoured by Indian CV manufacturers, and they felt that they could obtain large orders if the Government extended more such credits, because these are tied credits with far easier terms than normal commercial credit.[1]

Barter deals are one way of circumventing hard currency problems. Telco is to supply 1500 trucks to Uganda over 1989-93 in exchange for coffee. Here, European companies' flexible trade practices have helped them, whereas Indian companies appear to be handicapped by the involvement of state-trading bodies such as MMTC (Minerals and Metals Trading Corporation). In this context, ALL may be helped by the presence of Hindujas, its new owner, who have experience in commodity trade in Africa.

Service

The importance of after-sales service cannot be over-emphasised in a durable good such as automobiles. Both Telco and ALL realise this, and have posted their engineers abroad to ensure smooth operations. Telco, for example, has 38 people stationed abroad to service Telco fleets in various African and West Asian countries. This has apparently given them an edge against Japan in many of these markets, such as Tanzania and Uganda.[2]

The other important non-price factor is quality of product, which we have already discussed at length, showing that the rugged Indian vehicle does enjoy a certain niche.

On the whole, the levels and pattern of Indian CV exports can be explained by price, quality, credit and service factors. In the final chapter, we will assess the possibilities for an expansion in exports.

1.Some ALL and Telco executives said that they had over-exposed themselves in Africa (by using supplier's credits) owing to non-payment or delayed payment and were therefore unwilling to export any more except against bilateral credit or buyer's credit.

2.Field interviews and Motor Transport, August 1989, p.19.

The next section considers trends and changes in international trade in CVs, and highlights the differences between MHCVs and LCVs.

INTERNATIONAL MARKET : DEMAND PATTERN

Trends

Aggregate figures for world trade in CVs[1] exhibit the scars of the 1980s recession. Conventional trucks (of all sizes, including light pick-ups to heavy-duty multi-axle vehicles) is the largest segment, with total world exports exceeding $26 billion in 1987, up from $10.4 billion in 1975 and $ 20 billion in 1980. Other segments are buses, special purpose vehicles and tractors for tractor-trailers. Each of these markets hover around $ 2 billion only and, moreover, have not fully recovered from the recession of the early 1980s. In trucks, while growth has slowed down, the recovery has been faster owing to the domination of light vehicles. On the other hand, the other segments, particularly special purpose vehicles and tractors, consist almost entirely of heavy vehicles.

Major exporters of trucks are Japan (31.6% of world market economy exports in 1987), Canada (17.3%, but exports mainly to USA), Germany (13.8%) and USA (9.6%). Japan, which overtook Germany as the largest exporter in 1976, has never looked back. In buses, however, Germany remains the largest (24.6% in 1987) as opposed to Japan's 18.1%. Of developing countries, Brazil has the biggest share of 0.5% of the truck and bus market in 1987. Spain, sometimes treated as a developing country, had 1.6%.

Expectedly, developing countries were more important as markets, particularly after the oil boom of 1973. Saudi Arabia was amongst the three largest buyers of trucks from 1977 to 1984. Other important markets were Algeria, Nigeria, Kuwait, Venezuela, Indonesia, Egypt and Iraq, and many of these had imports in excess of $ 300 million in 1981. The softening of oil prices

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1.Drawn from various issues of the UN International Trade Statistics Year book.

after 1980 resulted in a steady decline in most of these markets. Overall, the largest market for trucks and buses together is the USA, and increasingly so in the 1980s, crossing 30% in 1984. Much of this is, of course, Canada-US trade. In 1986, for example, 26% of the number of CVs imported into USA were from Canada, and 60% of Canada's from the USA {MVMA (1988)}. Other important markets are France, Italy, UK and Germany.

Developed versus Developing Country Markets

There is an important difference between developed and developing countries across all classes of automobiles, and which affects the exportability of vehicles. This has to do with the very stringent regulations governing safety standards, exhaust emission, noise levels and also fuel efficiency. Japanese exhaust emission standards are reputed to be the most stringent, and Switzerland has the highest noise pollution standards. These standards also mean that many features and devices become compulsory requirement on the vehicles - for example, in the USA, there are standards for accelerator controls, brakes, crash protection, head restraints, mirrors, seats. warning devices and so on.[1] Moreover, manufacturers are responsible for defects in their product, and in countries such as USA product liability damages can be very high. Most developing countries, on the other hand, do not have very strict regulations, if any, regarding safety and environment.

Medium and Heavy Vehicles

Another relevant distinction is that between light and heavy vehicles. The degree of international trade in heavy vehicles (particularly of 15 ton GVW and over) is far lower than for lighter vehicles. This is because : (a) it is more difficult to transport HCVs across oceans; (b) HCVs tend

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1.There is a long list of safety standards relating to various items of equipment, classified under Crash Avoidance (100 series), Occupant Protection (200 series), Post-Crash Protection (300 series). See MVMA (1986), pp.75-92, and EIU (1982). For a comparison of noise, emission and fuel economy standards in different developed countries, see Toyota (1987), pp.40-41.

to be designed to cater to specificities of local demands, which also allows smaller home-based producers in touch with local needs to be competitive vis-a-vis imports from much larger manufacturers. One aspect of local demand is to do with road networks and distances - America's vast distances and excellent highways permit use of super heavy-duty vehicles which are not as extensively used elsewhere, and not at all in Japan's congested roads.Also purchasers with large freight volume have greater incentives to seek cost savings through trucks closely adapted to their specific needs[1] (c) there are onerous "Type Approval and Construction and Use Regulations" in North American and European markets, and these, according to Rhys (1984) act as a major non-tariff barrier to free trade in HCVs, the more so because the complicated nature of a CV allows for more detailed and wide-ranging regulations than in the case of cars.[2]

A few figures will bear testimony to these differences between light and heavy vehicles. As a share of production, exports of all CVs in 1988 were 37.1% in Japan, 8% in USA and 32.8% in Brazil. The same ratio for CVs of over 6 tons GVW was 27.1%, 1.5% and 24.2% respectively.[3] More telling are the disaggregated figures available from Isuzu Motors[4], which manufactures the whole range of vehicles, from cars to HCVs. In 1986, Isuzu exported 244888 CVs, of which 35605 were above 9 tons GVW. Relative to production, exports were 56.5% and 72.6% for vehicles greater and less than 9 tons. Within the heavy vehicle segment, those above 16 tons (including tractors) were even less export-oriented, the ratio being only 28.7%. Moreover, Europe and North America, which manufacture their own vehicles, bought less than 3% of Isuzu's more than 16 ton category exports, whereas they took up 37% of the 3.3-7 ton category, 57% of pick-ups, 79% of 4x4 "Troopers" and 83% of passenger car exports.

1.Kravis and Lipsey (1971), p.444.

2.In the USA, there is also a 25% import duty on truck imports, but this is applicable to both light and heavy trucks. Car imports, on the other hand, are subject to only a 4% duty alongwith quotas for Japanese cars.

3.Daimler-Benz Annual Report 1988, pp.96-99. For some countries such as Germany, UK and Italy, the two ratios are not very different, but in all cases the MHCV export ratio was lower than the all-CV ratio.

4.All figures taken from Isuzu (1987) "This is Isuzu".

All this implies that in the case of HCVs[1], direct export possibilities are limited, and companies may have to opt for local assembly/joint ventures, particularly if manufacturers already exist in that market. In the world's largest HCV market, for example, no non-American firm was able to gain significant market share without mergers or buy-outs of US firms. In the recession of the early 1980s, European firms rescued several ailing American companies - Daimler-Benz took over Freightliner, Renault has a 45% stake in Mack, and Volvo first bought over White Motors and then took over the heavy truck interests of General Motors, with a 76% share of the combined company called Volvo GM. In 1988, these three companies accounted for 42.2% of USA's class 8 (more than 15 tons) market. On the other hand, Japanese MHCV manufacturers, who attempted to either go it alone or have marketing arrangements with US firms, have not enjoyed great success in the class 6-8 markets (7 tons and above) since Hino first entered the market in 1984. In 1988, Japanese import penetration in the American MCV market (6-15 tons) was only 4% of total US sales.[2]

The other major markets viz. Europe and Japan, are also catered to by home-based manufacturers. The European market for 16 tons and over trucks is dominated by Daimler-Benz (19.1% in 1988), Volvo (13.7%), Iveco-Ford (13.1%), Renault (12.7%), Daf (11.6%), Scania (10.8%), and MAN (8.1%). Although each manufacturer is the market leader in its respective country (Benz in Germany, Iveco in Italy etc.), Europeans have looked upon Western Europe as a single market, and this outlook will be strengthened with the impending integration of 1992. That there is very little room in Europe was indicated in 1986 when Ford and General Motors quit the European heavy truck industry owing to recession, intense competition and over-capacity. Extra capacity was created following the boom conditions of the late 1970s, but world demand collapsed from about 520,000 HCVs (over 15 tons) in 1979 to 350,000 in 1983. However, demand

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1.Unless otherwise stated, all factual information that follows is drawn from the special Financial Times supplements on the World Truck Industry, 1986, 1987, 1988 and 1989.

2.MVMA (1989), p.19. The imports include only those sponsored by Japanese manufacturers or distributors in the USA.

has picked up since then, both in Europe and North America, and by 1988 companies such as Iveco and Daimler-Benz were constrained by a shortage of production capacity. Nonetheless, competition remains intense, and currently another phase of restructuring and a continuing search for fresh alliances in Europe is under way, prompted by, inter alia, Europe 1992 and the threat of a future slow-down in the economy. In 1987, non-European (Japanese) manufacturers accounted for only 2.2% of the European market share for vehicles above 5 tons GVW (Iveco estimate).

Similarly, the Japanese MHCV sector is marked by fierce competition amongst four domestic manufacturers, and there seems little likelihood of any foreign firm gaining a foothold.

Thus, MHCVs are characterised by : (a) intense competition within the developed country markets; (b) these markets are catered to by home-based production. Also, in developing countries the use of MHCVs to LCVs is relatively greater than in developed countries. All these factors make developing countries relatively more important as markets for MHCVs (either fully built up or c.k.d./s.k.d.) than LCVs or cars as compared to developed countries.

Light Vehicles[1]

The LCV market (upto 6 tons GVW) is much larger and the degree of trade far greater than in HCVs. As we have seen in chapter 2, all major LCV producers also manufacture cars, and this makes the number of potential competitors in the world market very large. Of course, product differentiation and styling variations are at least as important as for cars, particularly in the very light category, which includes car-derived vehicles, pick-ups, vans, "minivans" (US speciality) etc. Also, the very light segment has been growing at phenomenal rates in the 1980s, particularly in the USA where innovative products such as the minivan (which is also used as a car substitute) have captured the public imagination. Class 1 truck sales (upto 2.7 tons) soared from 0.985 m in 1980 to 2.93 m in 1988 (MVMA 1986, 1989), while all other CVs rose from 1.24 m to only 1.68 m. Similarly, in Western Europe, registrations of small vans (upto 2 tons) rose from 355,000

1.This section also uses Financial Times Supplements on Light Commercial Vehicles 1987, 1988 and 1989.

in 1980 to 667,000 in 1988.

Any firm contemplating LCV exports has to contend with the formidable Japanese, who are particularly strong in this sector. For example, in Europe about 68,000 one-ton pickups were sold in 1988, of which 80% were imported from Japan. Overall, the share of Japanese imports in Europe was 12.1% and 10% in the medium (2-3.5 tons) and small van sectors respectively in 1986. Moreover, if production of Japanese-owned and controlled plants in Europe is included, the share would exceed 20% in medium vans. The most ambitious of these ventures is Nissan's Motor Iberica in Spain. In the USA, too, Japan's import penetration ratio of 12.4% in 1988 in all trucks and much more in class 1 trucks[1] is supplemented by the direct presence of three truck-manufacturing joint ventures/subsidiaries of Mitsubishi, Nissan and Suzuki. In other continents such as Africa, 75% of CVs imported (most of them LCVs) were from Japan.[2] In South and East Asia, Japan is completely dominant being the source for 97% of CV imports, while it has 75% in West Asia.[3]

Thus, if we compare the LCV and MHCV sectors, they offer very different stories of Japanese import penetration. In the USA, Japanese import penetration in class 1, class 4-7 (MCVs), and class 8 (HCVs) is at least 17%, 4% and 0 respectively. Similarly, in Europe, it accounts for only 2.2% of the 5 ton and above market, but more than 10% of the below 3.5 ton class. In both regions, it has also been able to establish a substantial local presence in LCV (as well as car) manufacture, but not so in MHCVs. Direct CV trade between the USA and Europe is limited, and instead takes the form of local production via subsidiaries or joint ventures -- the most dominant presences being Europe in American HCVs (through purchase of American firms), and Ford and General Motors subsidiaries in several European countries, catering to the small and medium van segments.

1.Imports to total sales in the USA. Exact figures for class 1 imports from Japan are not available, but the figures is at least 17%. See MVMA (1989), pp.18-19.

2.MVMA (1989a), p.40.

3.ACMA (1988), pp.104-106. These figures are for all CVs, but LCVs are predominant.

ASSESSMENT

We have seen that Indian MHCVs have enjoyed a certain niche in developing country markets, owing to their rugged and uncomplicated character, a price advantage and competent field engineering. Moreover, the exports have generally taken place in small batches, where the major international manufacturers have not been too interested. The recession of the early 1980s, however, led to a period of rationalization of capacity and an intense battle for even smaller developing country markets. Technological developments such as electronic data-gathering methods are helping developed country manufacturers to design vehicles more suitable for Third World conditions, and are bound to put further pressure on Indian exports.[1] The exports of the industry as a whole have suffered in the 1980s even in nominal rupee terms (except in 1987-88 and 1988-89), owing to recession and lack of technological renewal by Indian companies. In terms of price competitiveness, Indian MHCVs have received a boost since 1985 owing to the steep yen increase, but this has arrested the decline in exports only in nominal and not in real terms, and that only in 1987-88 and 1988-89. On the whole, there appears to have been a decline in the export competitiveness of Indian MHCVs in the 1980s.

As between firms, Telco is relatively the most export competitive, followed by M&M and then ALL. BTL and SMPIL (and M&M LCVs) are uncompetitive internationally, producing LCVs that are obsolete by international standards. Of course, much of the reason for negligible LCV exports lies in factors external to BTL, SMPIL and M&M viz. the low demand for LCVs in India and the fact that in catering to similar demand patterns in India as for MHCVs, LCVs suffered more than MHCVs in terms of international norms. In the next few chapters, we shall isolate firm-specific factors responsible for differing domestic as well as international competitiveness.

1.See South, June 1989, pp.41-43. These techniques have been introduced around 1986, and according to the report the finished product will be far more suited to the Third World than earlier methods which used rough road test tracks.

CHAPTER 5

VERTICAL INTEGRATION AND SUB-CONTRACTING

INTRODUCTION

This is the first of three chapters that analyses the role of firm-level factors in determining the performance of firms as documented in chapters 3 and 4. To begin with, we shall consider the actual extent of VI in the chosen firms, bringing in sub-contracting information where available. Some primary data on inter-firm linkages that has been gathered will also be reviewed. Thereafter, the impact of these on the different facets of performance will be analysed. A synthesis of the arguments is presented towards the end, followed by a look at future prospects. Analytically, we will focus on ALL and Telco, because these are at the two extremes of integration (conveniently, also happen to compete for the same market), and as we discussed in the introduction, it is often very useful, methodologically, to study extreme instances. Moreover, VI was less of an issue in the other three firms, and our VI-related information on them is consequently also limited as compared to ALL and Telco. Even our econometric results in Appendix 2 are more sensitive to the extreme positions of ALL and Telco than to the more similar VI levels of BTL, SMPIL and M&M.

The chapter will show that the different levels of VI and inter-firm linkages as exist in the CV industry have had a more significant impact on relative technological capabilities than on relative overall costs and profits.This of course does not imply that it will not influence relative costs and profits in the future. We will also show that the degree of VI is best explained by a mix of production costs, transaction costs, and uncertainty considerations.

VERTICAL INTEGRATION AND RELATED ISSUES

Integration in the Indian CV Industry

It is evident from A.5.1 that Telco is the most integrated of the five firms, with its average degree of vertical integration over 1977-88 being nearly 40%. At the other extreme, ALL's average VI is just over 20%, which is even lower than the levels achieved by Japanese manufacturers (see ch.2). On the other hand, the three LCV firms display more similar tendencies, with average VI falling between 29-33%.[1]

The actual processes/products integrated are shown in Table A.5.2, on the basis of our field survey. All the firms have facilities for manufacture of engines, transmissions and for final assembly, as well as for some die repairing (important in India where dies have to be imported and are very expensive), and may be considered as the "technological core".[2] Unlike firms in Europe and North America, Indian firms have greater uniformity in their in-house activities. In Europe, for example, firms such as Daimler-Benz, Renault and Saab-Scania are highly integrated, but others such as Leyland-Daf and Enasa, and specialist manufacturers like ERF, Seddon, Foden etc. much less so. Moreover, assemblers also buy components they normally produce in-house if customers so demand -- e.g. engines from Cummins and Perkins, gearboxes from ZF and Eaton and axles from Rockwell and Eaton, some of which are often used even by large companies such as Iveco, Renault, Leyland-DAF and MAN. In India, such practices are still unusual, because the patterns of VI have been historically determined, and the component manufacturing sector is not as highly developed as in Europe.

There are also some important differences in the extent of integration across companies. Telco stands out as one of the most integrated automotive concerns, not just in India, but in the world.

1.The erratic behaviour of the VI ratio over the years can be ascribed in large measure to the balance sheet item "change in stocks". Ideally, the change in stocks should be allocated amongst the various components of expenses in the profit and loss statement.

2.Williamson (1985), pp.96-98, discusses the "efficient boundaries" problem.

Its in-house machine tool division alongwith production engineering is able to manufacture very complex CNC tools, machining centres and entire production systems. It also manufactures its complete requirement of tooling (including heavy press dies), jigs and fixtures. SMPIL also makes its own body dies, although these are mainly wooden rather than metallic. The other companies can make only very simple machine tools and tooling such as small jigs and fixtures. All companies except SMPIL have foundries (ALL has an associate company). Only Telco has a forge (at its Jamshedpur plant) and only ALL does not have a press shop and paint shop.

There is a historical dimension to Telco's decision to integrate in a major way. As compared to Tamil Nadu and Maharashtra, where the other companies first began operations, Bihar was a backward state.[1] This was inspite of the pioneering presence of Tata Iron and Steel company in Jamshedpur (also a Tata concern like Telco), the same city where Telco located. A foundry and forge were found to be integral to Telco's manufacturing in a situation where the ancillary industry was at an incipient stage of development. There may also have been a Daimler-Benz influence, itself a highly integrated company with a world-wide reputation for quality engineering.[2]

Like Telco, ALL may have also been influenced by its collaborator. British Leyland does not share a tradition of high internalisation with Daimler-Benz, and this is reflected in ALL's low VI.[3] But even if it does not have a high degree of integration, ALL does not practice as much arm's length purchasing as appears at first sight. It has followed a deliberate strategy of "quasi-integration", having promoted Ennore Foundries in 1960 in which it has a 19.7% stake, to supply it with automotive castings. It has also promoted a joint venture with the Tamil Nadu Industrial Development Corporation for the manufacture of bodies for ALL vehicles, as well as a "front end structure" (the face of the cab) for its premium haulage vehicles. In association with deal-

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1.In 1951, Bihar accounted for only 3.3% of all male workers in household and non-household manufacturing. Tamil Nadu and Maharashtra accounted for 9.3% and 12.9% respectively. (NCDB 1980, p.5).

2.In Brazil, too, Mercedes-Benz is the most highly integrated of all the automotive assemblers. This does not seem to be a coincidence. See EIU (1987a), p.29.

3.See Lall (1980), p.212.

ers, a foray has been made into forward integration through the promotion of Ashok Leyland Finance to finance vehicle purchase. Telco also gives some loans for hire-purchase. As of now, these forward integration operations are small and relatively unimportant for the "older" CV firms, but are being aggressively used by some of the newer generation LCV manufacturers to boost sales in a very demanding market.

Amongst the LCV manufactures, the house of Mahindras is a fairly diversified engineering group manufacturing alloy steel, elevators, plastics, bearings etc. In our context, it is relevant to note that in 1988 M&M acquired a controlling interest in International Instruments Ltd., a manufacturer of a wide-range of instrument panels for the automotive industry. It also took over Allwyn Nissan, one of the new generation LCV manufacturers. In 1989, it acquired the metal pressings unit of Guest Keen Williams, which has given it substantial additional strength in heavy pressing. Besides these, it has a wholly owned subsidiary producing industrial trailers and automotive components, but production of the latter is quantitatively insignificant.

BTL is also a part of an engineering group, the Firodias, whose interests, besides LCVs, centre on mopeds (Kinetic Engineering is the largest producer of mopeds in India) and scooters (Kinetic Honda began production in 1986). In 1983, a company to produce steering gears was promoted by the Firodias in collaboration with ZF Steering of Germany in which BTL also has equity participation. Jaya Hind Industries, which manufactures electronic control systems, pressure die cast items and other components for BTL and the two-wheeler companies, has an investment arm which controls the Firodia shares in BTL.

SMPIL, on the other hand, is a stand-alone company with no financial linkages with other concerns. But it would be fair to say that for all the LCV manufacturers, linkages with other companies have not been important so far in terms of their competitive strategies. This contrasts with ALL's very important quasi-integration strategy.

Sub-Contracting

We have only scattered information on sub-contracting to SSI firms. All the firms have a very

large number of SSI suppliers. Telco, for example, has over 3000 small scale suppliers located all over the country. Our field survey clearly brings out the very substantial technological linkages between SSI suppliers and CV manufacturers, confirming the findings of Lall (1980) and Narayana (1989). This is also true for SMPIL, the smallest of the CV firms. We also found many instances across firms of what Lall calls "establishment linkages" i.e. helping to set up and launch new suppliers. In many cases, these newly launched firms were former employees/distributors or existing shareholders, which helped to reduce search costs.

Our survey also reveals some major differences in this respect between Telco and other companies. By all accounts, Telco has been an exceptional case in the Indian automotive industry. The component industry in India started off mainly by supplying to the replacement market. Telco's arrival on the automotive scene in 1954 spurred the process of ancillary development. Initially, though, ancillarisation was very slow because Bihar was an industrial backwater and Telco (and Daimler-Benz, whose engineers were in Jamshedpur till the end of the collaboration agreement in 1969) had uncompromising quality standards. Gradually, the components industry developed, helped by an Ancillary Development Department manned by trained engineers. Telco provided continuous technical know-how, toolings, training and sometimes scarce raw material. According to the company, quality, delivery and price, in descending order of priority, were the main consideration in choosing a supplier.[1] During our field survey, Telco was widely acknowledged as having pioneered an engineering awareness right across the country. It was also the first to introduce a self-certification scheme for component manufacturers (CMs), while at the same time not compromising on any standards. Thus, inspite of its strategy of vertical integration or perhaps because of it (since it revealed a concern for high quality), Telco had a crusading zeal to develop supplier capabilities.

There is no doubt that the other firms also did many of the above to help develop small firms. None, however, has worked at it so hard and consistently as Telco. One small instance of this is

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1.Ghyara (1984).

provided by Lall's (1980) study, where all the 10 suppliers supplying exclusively to Telco had been developed by it, whereas only 6 of the 14 exclusive ALL suppliers had been developed by the company.

Telco's difficult progress in developing SSI suppliers can be gauged from UNCTC data for 1976-78. According to this, Telco had 500 suppliers, of which 69.6% were small-scale, accounting for 9% of total purchases. Corresponding figures for ALL were 339 suppliers, 83.8% SSI, 36.1% of purchases.[1]

However this figure of 500 suppliers for Telco is not comparable with other figures available, owing perhaps to differences in coverage/definitions. For example, the Annual Report for 1982-83 shows the total number of ancillary suppliers to Telco as over 2000 in 1976-77, and over 4500 in 1982-83. This represents a very substantial increase in the growth of ancillarisation, owing to the dramatic growth in sales and the greater ease of finding suppliers in the new plant in Pune, Maharashtra. According to Ghyara (1984), the proportion of SSI suppliers in Telco was more than 75% in 1983-84, which shows an increase from the 69.6% of 1976-77 (assuming that proportions in the UNCTC sample and the larger sample are the same).

Inter-firm Linkages

This section draws mainly on our field survey of 22 leading component manufacturers in the country, all of whom are original equipment (OE) suppliers to CV as well as other automotive manufacturers. These firms were usually large and established companies, often part of Business Houses such as TVS, Rane and Amalgamations, and usually the market leaders in their respective lines of business. The relationship between such companies and CV firms is therefore expected to be rather different from that documented in the preceding section.

The general nature of the relationship between these large CMs and vehicle manufacturers (VMs) has been closer to American than Japanese values (see ch.2). VMs have always tried to

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1.UNCTC (1981), p.18.

establish multiple sources of supply since they were afraid of labour strikes or output shortages in their suppliers' plants and the tendency of some CMs to indulge in opportunistic pricing.[1] There were no long-term contracts for purchase, but informal understandings did exist. Pricing was a sore point, where the relationship could even be termed as "combative", with the outcome being "considerably worse for small, dependent suppliers than larger, relatively independent ones".[2] There was rarely a perception of symbiotic growth, except between dependent SSI firms and the VM.

In terms of technical linkages, Lall (1980) found that for dissimilar technologies such as batteries and tyres, little interchange was required, but for other dissimilar technologies like electricals, the communication of specifications itself may require lengthy interaction. Where the technologies were complex but related to the firm's own activities, such as in the case of pistons and transmission components, there was substantial interchange and interaction. However, large CMs may have provided more know-how to VMs than the other way round. Our own finding on this is that in general there is little flow of technology from VMs to established CMs. In fact, the latter were able to draw on their overseas collaborators when some product changes/developments were demanded by VMs.

From our interviews with 22 CMs, we have been able to elicit some responses regarding inter-firm differences from 13 of them. A summary of their overall relationships with the CV firms is shown in Table A.5.3. This was an obviously sensitive subject, and the responses were no doubt guarded. Nevertheless, some inferences are possible, particularly for Telco and ALL.

Of the 12 responses received for Telco, 7 (58%) said that they enjoyed extremely cooperative relationships, 4 (33%) said cooperative and 1 (8%) said business-like. For ALL, 5 out of 11 (45%) found their relationships extremely cooperative, 3(27%) cooperative and 3 (27%) business-like. For the other companies, the responses were fewer. In BTL's case, 2 out of 7(29%)

1.Field survey, and Krueger (1975), pp.74-75.

2.Lall (1980), p.220. This is confirmed by Narayana (1989), p.61.

CMs said extremely cooperative, 3(43%) cooperative and 2(29%) business-like. Respective figures for M&M in 8 responses were 4(50%), 2(25%) and 2(25%). Most companies found SMPIL too small, and those that did respond said that SMPIL had no option but to cooperate, since it was too small to have much buying clout.

We also enquired into some other aspects of the interaction. The general opinion of the CMs was that Telco was more forthcoming than ALL regarding future plans, which delayed development of components for the latter. Part of the reason for this impression could be that Telco has more plans to discuss since it has been doing a lot of new product developments in the 1980s. Nevertheless, the impression does remain, and is also reinforced by the feedback that wherever possible and necessary, Telco provides CMs access to printed literature and use of its R&D facilities.

Technical interaction between Telco and CMs is also far more intense than for ALL. This is because Telco's in-house R&D and production capabilities are much larger and more wide-ranging, which means that its engineers can engage CMs in meaningful interchange across a variety of areas. For example, Telco has designed and developed some of its brake systems in-house, and then given it to Brakes India for manufacturing. Another firm, Lumax, developed a headlamp and tail-lamp for Telco's 407 LCV based on conceptual input from Telco. Similarly, the fuel injection equipment for the new 4 cylinder engine for the 407 was developed through a continuous, open and intensive interaction between Mico and Telco. The very high degree of interaction and mutual cooperation between Telco and its CMs is extensively documented in an article on the launch of its 206 pick-up in 1988 (Indian Auto Journal, July 1988). This is not to deny that ALL's engineers have technical interaction with their suppliers. For example, the "side-frame member" for the chassis was redesigned from a bent shape to a straight one and then given to the supplier to manufacture. Moreover, for highly complex products like fuel injection equipment, all CV manufacturers have to interact continuously with Mico. This interaction is, of course, greater at the time when a new or improved engine is being developed, and even more if the engine is an indigenous development, in which case the trial and error interactions are much

more than if it were simply a case of import-substitution.

These technical linkages are beneficial to both the VMs and CMs. In the previous section, we had mentioned the pioneering role played by Telco in developing SSI capabilities. In fact, Telco has played a similar role in the development of a large number and variety of proprietary CMs, particularly in the early stages when the industry was at a nascent stage. Part of this is simply accounted for by Telco's volume of production - the learning derived from supplying original equipment to a company of Telco's size was very valuable in terms of quality control, mass production techniques, process control etc. On the other hand, by the time ALL's volumes became significant (in 1961, Telco crossed 10,000 vehicles and by 1965 crossed 17,000; ALL did not reach these landmarks until 1978 and 1988 respectively), the CMs had already attained fair standards of competence and therefore did not need ALL's support to the extent provided by Telco, even if ALL had been willing.

All CMs (save one) were of the opinion that <u>distance</u> between CMs and VMs was not a constraint on the degree of technical interchange. However, they did mention that closeness would have resulted in other benefits such as lower transport costs and better inventory control. Most of them said that <u>informal</u> interaction between their employees and those of the VMs was more effective than <u>formal</u> exchange, although the latter was also necessary, particularly when decisions had to be taken. In a way, this response is partly contradictory of the view that distance did not affect the degree of technical interchange. If informal exchange of ideas and information is useful, closeness of facilities between CMs and VMs should certainly be beneficial since more informal interchange is then likely to occur. Perhaps the contradiction arises because technical interchange was rather limited, with few changes requiring continuous interaction having occurred in the vehicles manufactured by the VMs. If the technical dialogue had been intense and regular, distance may have played a part.

We also enquired into <u>steadiness</u> of demand. While no long-term contracts are signed, CV manufacturers do give some indication of their production plans. In all the 4 instances when CMs compared the relative steadiness of demand, Telco was stated to be a steadier customer, with

more realistic production schedules than ALL.

Between M&M and BTL, we have not been able to unearth substantial differences in their behaviour towards CMs as in the case of Telco and ALL. M&M's dealings with their suppliers were stated to be fair, and their public relations with them very good. Suppliers had access to multiple levels within M&M and in different departments. One CM classified M&M as a purchase-oriented company. BTL also had a good record in their dealings with CMs, and were not oppressive or dictatorial towards them. Suppliers appeared happy regarding receipt of payments from BTL. SMPIL, as we have noted, could in any case not afford to deal sternly with its suppliers, on account of insignificant buying clout. It used to even tailor its own production specifications to what was available in the market so that as far as possible CMs did not have to make any fresh investments on its account. CMs in fact were also very cooperative towards SMPIL (see Business India August 1-14, 1983).

IMPACT OF VERTICAL INTEGRATION ON COMPETITIVENESS

Market Share, Quality and Growth

In our econometric exercise in appendix 2, we found that VI is positively related to market share. Market share is itself affected, inter alia, by quality and variety of output, speed of response, availability of new products, price, etc. We will now elaborate.

Of all the CV manufacturers, Telco appears to have been a company in a hurry (see table A.3.3 for output figures). The only way it could achieve high growth and hence high market share in a location like Jamshedpur and in an environment of foreign exchange rationing was by integrating as far as possible. Foreign exchange rationing used to delay the import of components and machines.[1] This induced Telco to integrate not only into components but also into machine

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1.For example, Krueger (1975), on the basis of her survey of Indian automotive firms, found that rapidly expanding firms had more difficulty in obtaining their licenses and imports as needed, owing to delays when additional imports were required. On the other hand, firms with constant or slowly growing output probably had little difficulty in obtaining their requirements of licences and imports (pp.25-27).

building, an activity begun in Jamshedpur and later expanded on in Pune. In 1965, it also acquired a sick company called Investa Machine Tools which was amalgamated with the company in 1965. Availability of suitable machine tools was at that time perhaps a greater problem than the supply of components. Inspite of this, Telco, like the other firms, has often suffered from a shortage of bought-in components, particularly prior to the 1980s.

Insistence on quality of a high order was another reason for Telco's integration. Buying in from suppliers would have meant lesser control on quality of inputs, more so because engineering skills were not widely diffused. This also explains why, inspite of obvious cost advantages, SSI supply accounted for only 9% of total purchases in 1976-77, and increased only gradually thereafter. ALL's vendor rating data in fact showed that "small suppliers generally performed worse than large ones..." (Lall 1980, p.217). As we saw, ALL makes far more extensive use of small sub-contractors, accounting for 36.1% of purchases in 1976-78. This includes substantial job-work like welding, machining, small fittings etc. which tells on the product quality, particularly with respect to fit and finish vis-a-vis Telco vehicles.

Thus, objectives of growth and quality were factors that contributed to high integration in Telco, and also explain why it put so much effort into developing its suppliers. Its Annual Report for 1980-81 acknowledges the dependence of Telco on its suppliers, and points out that

> (Telco's) attention is ... focused on building strong ancillaries which will match (its) growth ...(so that) vagaries in the timeliness and quality of supplies (are kept to a minimum) (Chairman's speech).

Relative quality between the LCV manufacturers was affected, or perceived to be affected, by in-house body building. This facility, available in BTL and SMPIL, has given them strength in passenger applications. SMPIL, for example, claimed that the Standard-20 was the largest selling ambulance in the country before the company went into a decline in 1986. BTL offers a wide variety of factory-built LCVs. Since body-building is a highly labour-intensive operation, it requires very careful supervision, and customers do not want to go to the trouble of locating a suitable body-builder. Perhaps more importantly, the finish of these vehicles is better

since the body panels are pressed rather than hand-shaped. BTL is better off in this respect than SMPIL because its roof panel is a single large piece rather than two or three pieces welded together as in the case of SMPIL. M&M, on the other hand, have not made an investment in a body shop since their LCV is preferred in load-carrying operations; it can, however, arrange to give customers fully built-up ambulances, minibuses etc. by sub-contracting the work.

However, the example of the new generation LCVs like Eicher, Swaraj and DCM shows that very high quality finish can be obtained on buses, ambulances etc. if the right body-builder is found and if the VM takes interest and interacts with the body-builder. The question therefore is not only one of quality, but of quality at what cost. In the above situation, BTL and SMPIL enjoy a price edge vis-a-vis M&M in built-up vehicles like minibuses, particularly since they have amortised press tooling. For example, with the price of BTL's F 305 pick-up and F 305 minibus at 100 each, M&M's FJ 460D pick-up was only slightly higher, at 102.9, but its 16 seater minibus had an index of 110.3, as at October 1989. This same relative price structure has held throughout the 1980s.[1]

Costs, Prices and Profits

The most significant difference in VI in our study concerns machine tools and press tooling. According to an industry document, the machine tool industry in India, although fairly well developed, was not geared to producing machines that would allow high quality production, reduction in inventories and effective utilization of highly expensive machinery.[2] Our own survey reveals substantial dissatisfaction amongst automotive firms with the high costs and delayed deliveries of the domestic machine tool industry. Telco, on the other hand, has one of the most advanced machine tool manufacturing facilities in the country, as evidenced in its ability to manufacture highly complex equipment (see ch.6). This ability gives it a particular edge vis-a-vis

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1.Data relates to basic net domestic prices (without excise) of the vehicles, and has been supplied by M&M's marketing information services division.

2.Development Council for Automobiles and Allied Industries (1984), pp.38-39, 48-50.

the other firms in respect of SPMs, where the machine is virtually custom built and requires a high input of skilled labour. Thus, markups on SPMs produced in the market tend to be very high, analogous to top-of-the-line automobiles. Telco therefore produces all its SPMs in-house and saves substantially on capital costs, other firms having to either buy in the domestic market or import and pay duties in the range of 80%. According to company sources, the price quoted by market leaders such as Hindustan Machine Tools has always been higher than the notional cost of in-house manufacture. Moreover, the cost saving arises not only from direct cost differences but perhaps even more importantly from the fact that the in-house product is tailored to the exact requirement down to the last detail, and also allows instant response should the need arise to service or repair the equipment.[1] The specifications of the machinery required are themselves optimised and fine-tuned by the creative interaction between the in-house machinery manufacturer and user. On the other hand, standard GPMs are cost competitive in the market and Telco manufactures only 20-30% of its requirements.

Besides, Telco can also save by upgrading its existing equipment rather than go in for new machines. During slack periods, for example, Telco's engineers keep busy by converting their dedicated machines into more flexible ones, and by reconditioning machines, dies and jigs and fixtures.

Another distinct ability is Telco's design and manufacture of all its press dies. By definition, press dies are highly specific, and are extremely expensive. Moreover, these are not manufactured in India, and have to be imported at high cost, resulting from the large input of skilled and expensive manpower and high markups. According to Telco sources, they manufacture dies at 20-25% of what it would cost to import it from Japan. This is a major reason why Telco has been able to introduce its new LCVs with substantial sheet metal work inspite of the relatively low

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1.Krueger (1975) records that the domestically available machinery was often of the wrong capacity. In one of her case studies, the automotive firm was forced to accept a domestically produced machine with a capacity ten times more than that required, and in other cases firms were forced to accept several small machines in lieu of a single, larger imported machine. In both cases, the imported machine of appropriate capacity would have cost the firm less than 7% of the price paid for domestic machines. (pp.70-71).

volumes. For the same reason, Telco's goods vehicles come with a pressed cowl (a sort of half cabin) whereas ALL offers only the front face of the vehicle, which means that the Telco truck has a better finish. ALL obviously finds the cost of press dies an unnecessary price to pay for offering a good finish, particularly since it appears not to have affected its domestic market share. A large variety of press tooling in SMPIL and BTL, particularly the latter, has also given them a cost edge in fully built-up vehicles. In SMPIL's case, much of this tooling has been made in-house, although it is with a wooden base and hence inferior to the standard metallic tooling. In the case of BTL, the tools were bought from the market many years ago and have been fully written off in a financial sense.

If the benefits of having machine building and press tooling capability were so substantial, why did other companies not adopt similar routes? For one, these were unusual even in the world automotive industry, and required bold decision-making. Machine tool making was a complex technology requiring long years of learning and capital investments. Secondly, in years of recession, a more integrated firm suffers more, because its break-even point is higher. This point has not escaped Telco's management, who realise that

> ...growth is not only necessary and desirable for success in our industry; it becomes inescapable for a large leading company like (Telco) for which the break-even point increases every year (Chairman's speech, Telco Annual Report, 1986-87).

Of course, to the extent that slack capacity (both men and machines) can find alternative uses, the adverse impact of a recession is less, such as the upgrading and reconditioning of machine tools and tooling by Telco's engineers. Thirdly, the objectives of other firms were different from Telco's.

Faced with a predicament similar to Telco's, viz. supply of quality components, ALL chose, inter alia, to promote an independent foundry since it would not have enjoyed scale economies as an in-house unit. Today, Ennore Foundries is one of the most reputed in Asia. It imparts to ALL an edge vis-a-vis Telco, if not in terms of product quality, at least in terms of cost, since supplying to a large number of firms besides ALL (including SMPIL, M&M, BTL, Simpson & Co., and many others) gives it economies of scale and scope and also enforces market discipline.

For supply of forgings, Telco relies both on its Jamshedpur plant as well as independent

companies such as Bharat Forge. This "tapered integration" has potential benefits in that the firm can adjust its market demand after its in-house capacity has been fully used up. [1] The product purchased from the market can have a lower degree of asset specificity, thus reducing transaction costs, whereas the in-house supply could be more specific -- a direct implication of transaction cost reasoning.[2] Moreover, tapered integration would allow Telco greater bargaining power than ALL over its suppliers because of its own knowledge of the costs of production, the availability of a credible alternative supply source and at least as much economies of purchase as ALL (since it is a much larger firm). Again, there is no evidence that Telco actually uses its greater bargaining clout to extract more price concessions than ALL. In fact, insofar as price is an important element in a relationship, we have noted earlier that Telco has generated a somewhat greater sense of goodwill amongst its suppliers. However, this bargaining clout can be used to discipline the monopolistic/opportunistic price behaviour practised by some of the leading CMs (information gathered from VMs and CMs during our survey) without necessarily endangering goodwill. The same reasoning would apply to other products where Telco practises a policy of tapered integration - e.g. part of brake systems, steering gear and propellor shafts. BTL and M&M also follow this policy for supply of castings.

In fact, Telco gained from in-house production across a wide variety of components, owing partly to extraction of monopoly premia by suppliers, particularly before the 1980s. An instance of exercise of monopoly power is provided by Krueger (1975, p.56), who found that the largest cost differentials between in-house and ancillary supplier products were in those cases where the items were reserved for ancillaries by Government policy.[3]Another reason was that for a large

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1.Like quasi-integration, tapered integration is another alternative governance structure which tries to capture some of the benefits of full VI without incurring its costs.

2.Williamson (1985), pp.95-96. Although we do not have proof that Telco actually does this, it seems to us that it has nothing to lose and some gain to make by following this strategy. It must, therefore, be doing this, at least to some extent.

3.The assemblers were allowed to produce products reserved for ancillaries as per existing capacities but were not allowed to add fresh capacities after 1965. See also our footnote 2 on page 168.

number of components, Telco enjoyed greater economies of scale in-house than any CM, owing to its dominant size. This would have been true until the 70s but less so thereafter, as the components industry has grown in size and competence .

Sub-contracting Strategies

We have seen how, in the 1970s, ALL bought four times as much from SSI firms as compared to Telco. This was a key strategy in helping ALL to be cost competitive and face the challenge of the much larger Telco. For example, the average wage rates in Madras for different classes of auto component firms doing machining/assembly work in 1982-84 were Rs.4242 for category C, 6667 for B, 6542 for A (non-functional parts) and 7726 for A (functional parts) which establishes a clear link between wages and firm size.[1] Moreover, the study also found that productivity of firms doing machining or assembly did not vary across categories, thus establishing a clear cost advantage of sub-contracting to SSI firms.

Later, in the 1980s, we have seen that Telco was able to increase its purchases from SSI, thereby reducing ALL's cost advantage on this count.

Overall Effect on Cost and Prices

The overall impact on costs of the contradictory forces enumerated above can now be considered. It is difficult to ascribe a quantitative dimension to the different forces since detailed cost data is not available. Moreover, VI is only one of the factors affecting cost, which further complicates inter-firm comparisons. Finally, we do not have comparative cost data, and have to rely on prices.

As between ALL and Telco, Telco derives cost benefits from its machine tool and press tool divisions, as well as a wide variety of in-house components, and sometimes from its greater

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1.Narayana (1989), p.64. See ch.2 for an earlier reference to this study, where the categories A,B and C are explained.

bargaining clout over suppliers. Moreover, its transaction cost of buying from its suppliers is lower since it has nurtured the relationships more carefully. ALL's major cost advantage arises from its extensive reliance on SSI suppliers, and its part ownership of a high quality foundry to supply it with castings. Also, since it is much less integrated than Telco, it is relatively less affected than Telco during a recessionary phase i.e. its per unit costs do not increase as much as Telco's if there is underutilization of capacity.

We saw in chapter 3 that over the years, the Telco 1210 has almost always been priced cheaper than ALL's AL 3/1 176. To the extent that this reflects comparative costs, we might say that so far Telco's VI and sub-contracting strategy has been a lower cost solution than ALL's. But this statement is subject to many qualifications. Pricing is based only partly on cost considerations.[1] Secondly, ALL's vehicle is over-designed as compared to Telco's, with higher material content, which again reflects partly in higher cost and therefore higher price, and needs to be discounted if we are focusing purely on the cost effects of different VI strategies. Most importantly, as stated before, VI is only one factor in costs, and some of the others will be taken up in the next two chapters. At least for the moment, therefore, we cannot reach an overall conclusion on the impact of relative VI strategies on costs or even prices.

The other question is how SMPIL, a much smaller company than BTL or M&M, was able to remain price competitive inspite of being fairly integrated, having all the basic facilities that M&M and BTL have except for a foundry. The answer to this lies in the kind of production technology employed by SMPIL, and will be discussed in the next chapter.

Impact on Profits

More definitive conclusions can be reached with regard to impact on profits. To start with, we have to account for the lower variability in Telco's profits.

1.Prior to the early 80s, the market was a seller's one, and prices would have also depended on what the market would bear. After 1986, Telco has become a multi-product company, and certainly practised cross-product subsidising, making losses initially on its LCVs. All this distorts prices as a measure of costs.

With the MHCV market turning soft in the early 1980s, both ALL and Telco faced problems. But inspite of ALL's lower level of VI, variations in Telco's profitability were much lower. This is because it enjoyed substantial flexibility in its accounting policies, partly on account of an in-house machine building division (see ch.3). While these are accounting sleights of hand, lower variability not necessarily being a competitive strength, the company has also derived major tax benefits over the years by being able to adjust its taxable profits. The reasoning could go like this - given its high growth objective,Telco needed to integrate; in turn, its integration helped to maintain a more even cash flow and maximize investments from internally generated resources.

The results of Appendix 2 suggest that higher VI tends to influence profits negatively. As far as gross margins or markups are concerned (π_s), the negative impact is not pronounced, implying that labour expenses, material costs, selling and administration expenses, power, fuel and other variable expenses, all as a percentage of sales, are not very sensitive to the degree of VI.[1] We can therefore state with a little more certainty than in the earlier section, that costs per rupee of sales do not vary significantly with VI. If prices are not affected by the degree of VI, this also means that costs per vehicle are not significantly influenced by VI.[2] We have found little evidence in our study that vehicle prices are sensitive to VI,[3] particularly since there is no forward integration into distribution, which could have been one source of variation. If this is cor-

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1.Let R = Revenue, W = wage costs, M = raw material costs, W+M represent all costs other than interest and depreciation,

π = gross profit

$$\frac{\pi}{R} = \frac{R-W-M}{R} = 1 - \frac{W+M}{R}$$

In other words, when the gross margin is not sensitive to VI, it implies the same for the cost-sales ratio (W+M/R).

2.W+M/R =(W+M/P .Q)= (W+M/Q). 1/P where Q is output and P is price. Thus, if W+M/R does not vary with VI, W+M/Q (costs per vehicle) will also not vary provided vehicle prices are not sensitive to VI.

3.Here we are referring to the overall degree of VI rather than a part. For example, in-house bus body manufacture was found to be cheaper than sub-contracted bodies for LCVs, but this is not a relationship between price and the overall degree of VI.

rect, it implies that the different VI strategies as adopted by the firms in the CV industry have, on balance, not given any firm a significant cost advantage over another, at least for the period of the econometric study (1977-87). Then the higher average gross margins for Telco and BTL as compared to ALL, a far less integrated firm, owe to factors other than VI.

A more integrated company has to invest more capital in order to generate the same output as a less integrated firm, not merely when the initial investment is made but on a continuous basis so that the equipment does not get obsolete.[1] In our study, the correlation coefficient between VI and the capital-revenue ratio was 0.52 (see appendix 2). Thus, when VI was higher, the capital base was higher, and gross profits per unit of capital (π_c) were lower. This implies a lower productivity of capital (in terms of sales to capital ratio) but also lower costs per unit of capital.[2] The former arises because higher VI requires more capital but does not generate commensurate increase in sales, and therefore also not a commensurate increase in costs (particularly variable costs). Telco, with the highest VI, has the lowest average π_c, as well as the lowest average sales to capital ratio. ALL, on the other hand, enjoys much higher rates of return, although not as high as the more integrated BTL and M&M. VI strategies have on the whole affected rates of return on capital far more than they have influenced sales margins, owing primarily to their effect on capital formation.

Exports

We have seen that Indian buses are more popular abroad than trucks. Nonetheless, Telco's ratio of truck to bus export is far higher than for ALL. This is because ALL's cabin is hand-made and entirely sub-contracted, whereas Telco offers a factory-built (pressed) cowl which is then

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1.See Porter (1980), ch.14. More VI implies more capital for the same amount of revenue.

2. $\pi/C = (R-W-M)/C = R/C - (W+M)/C$ where C is gross capital. When VI is higher, R/C is lower, and W+M/C is also lower (since W+M/R does not change with VI, and W+M/C=W+M/R.R/C), but the absolute difference between these two ratios narrows, resulting in a decline in π/C.

handed over to sub-contractors.[1] This gives a more attractive finish to Telco trucks. In fact, it is not only the cabin, but, as documented earlier, the overall fit and finish of Telco vehicles is better, which is an asset at least in the overseas market, and is one reason for Telco's greater export intensity.

We could therefore postulate that in a market overwhelmingly concerned with functional characteristics of a product (such as the Indian CV market), domestic competitiveness will not be affected by inter-firm differences in aesthetic quality of output. However the firm with the better product finish will, ceteris paribus, be more export competitive.

Technological Change and Other Dynamic Considerations

TC is a process of trial and error, involving several stages of iteration. Moreover, many innovations involve strong and complex system interdependence not only at the production stage but even in the generation of concrete ideas. We had hypothesized (ch.2) that a more integrated firm may be better placed to undertake TC.

Again, let us contrast between ALL and Telco. In Telco, the iterations between concept generation, product planning, drawings, process design, prototype testing and tooling are facilitated by its integration. This is visibly demonstrated in the speed with which Telco has introduced its LCVs in the 1980s. The 407, for example, was developed from scratch to finish in only 18 months, a remarkable feat even by Japanese standards who take 3-4 years to introduce a new car model.[2] The biggest factor in this has been machine tools and tooling, which have created the entire production system as well as the very large number of press tools. Rosenberg's (1976) very perceptive analysis argues that "physical proximity between the producer and user of

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1.Substantiated by an article in Business India, August 15-28, 1983 and our survey.

2.Admittedly, the 407 borrows heavily from existing Mercedes Benz designs, but this does not detract from the achievement. See Nath and Misra (1988) for a stage-by-stage account of the development of the 407. The authors stress that this involved an integrated rather than linear system of functioning wherein all divisions, including production and machine tools provided inputs right from the beginning of the project. Analogously, Clark et al (1987) found that the Japanese advantage vis-a-vis European and American automobile producers in innovation lead time owed significantly to overlapping problem-solving cycles and continuous dialogue.

machinery seems to have been indispensable" (p.168) in the development of the capital goods industry in the UK and USA, since it allowed a creative interaction that was of mutual benefit.[1] In the case at hand, physical proximity is at its closest, in the shape of VI. Thus, in Telco, the production and R&D departments benefited by getting speedy, tailor-made responses; in the process of catering to these requirements, the machine tool division also gained expertise and proficiency. In-house casting has also helped to speed up prototype building, and test tracks and other test facilities to get quick feedback on performance. Also, greater sharing of information with suppliers has helped to get faster responses from them.

In contrast, ALL has found that it is sometimes difficult and time-consuming to get castings for R&D purposes from its own associate foundry. An example of the slow pace of productionising is the front end structure, a collaboration agreement for which was signed in 1984 but which went into production only in end-1987. Similarly, productionising of the ZF gearbox collaboration took more than three years between 1981-84.

It stands to reason that the greater the systemic interdependence of an innovation, the greater would be the benefits from VI.[2] In the example above of a completely new vehicle being designed, Telco had to call on the resources and capabilities of all sections on the company since almost everything in the vehicle was new. On the other hand, innovations which are more autonomous, i.e. those which can be introduced without major changes in other components or equipment, are less sensitive to the degree of VI. An example of this is the front end structure project of ALL, introduced only on premium duty vehicles. Analogously, a foreign collaboration may be less dependent than in-house R&D on the degree of VI, since the latter requires extensive iterations and prototype testing before it is ready to be productionised, whereas the former comes as a readymade package. Conversely, foreign technology will be less suited to the local enterprise's and its suppliers' production systems, as well as local demand patterns. In-house technology will

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1.See also Teece (1988), pp.262-63.

2.Teece (1988). The terminology of "systemic" and "autonomous" TC has also been borrowed from Teece.

have taken these factors into account in designing a technology package. At the stage of productionising, therefore, foreign technology may in fact be more sensitive to VI, mitigating the lack of sensitivity mentioned earlier to the extent that the package has to be modified.

On the whole, Telco's VI has given it a crucial edge in terms of innovation cycle time, which will stand it in good stead in an increasingly competitive market, particularly since Government policy is cumbersome with respect to foreign collaboration and the component and machinery supplying sectors are not geared to respond quickly.

However, a temporal dimension needs to be added to this analysis. At a time of technological ferment, a more integrated firm will be hard put to keep up with developments in diverse sectors and to make the requisite investments. External agencies (such as CMs) will be better placed to bring in new product developments, and an integrated firm may foreclose itself from such options. In the international automobile industry, where microelectronics has been the basis for most of the rapid TC that is occurring, there is a clear trend towards increasing reliance on specialised component suppliers to supply new products and to undertake design and development work. Not just components, suppliers are being asked for complete systems and sub-systems for vehicles.[1]

As of now, the Indian component manufacturing industry is a long way from attaining the technological stature of firms such as Lucas, Bosch, Magnetti Marelli, Eaton, Rockwell, Nippondenso, Bendix and so on. Nevertheless, thanks to upgradations in all vehicle sectors in India, the component industry is also undergoing a transformation. If not through their own R&D, Indian CMs are now able to supply near-contemporary products from reputed brands such as Eaton axles, Rockwell axles, ZF steering and gearboxes, Nippondenso electricals etc. through collaborations. In the 80s, the component industry has signed more than 300 foreign collaborations and modernized more than at any other time in its history.[2]

1.Altshuler et al (1984), ch.8, and Financial Times Supplement on World Automotive Components, June 8, 1989.

2.See Kathuria and Verma (1990) for an assessment of the competitiveness of the Indian component manufacturing industry.

So far, Telco has not suffered a decline in consumer appeal owing to foreclosure of options such as ZF gearboxes (it makes all its gearboxes in-house) or Rockwell or Eaton axles (it buys a small part of its requirements from them, but the bulk is in-house). As market competition increases in the 90s, such factors will become more important. But the most important differences in Telco's in-house facilities are forgings, castings, machine tools and tooling, all of which enjoy substantial economies of scope, and may be termed "generic assets" (Teece 1987). Investing and modernizing these facilities will have a beneficial impact on the entire firm, making it likely that the firm will remain abreast of contemporary technology in these areas.[1] Where the technologies are dissimilar or highly specialized, such as pistons, fuel injection equipment, electricals, lighting and instruments and so on, Telco, like all other firms, purchases from specialist suppliers. Technologically, therefore, Telco is unlikely to lag behind its competitors in the domestic market.

But cost and price considerations may mitigate against integration in the 90s. Owing to increasing competition, price is becoming an increasingly important instrument of strategy, as evidenced in the significance of the time dummy in the profitability equations in appendix 2 (implying that profitability has declined after 1985). This means that firms will need to pursue cost-cutting strategies more aggressively than in the past.

We have deduced that so far (upto 1987), VI strategies have not significantly influenced markups (π_s) (and also costs, not including interest and depreciation), although there is a consistent negative sign in the coefficient for VI. Econometrically, this result is sensitive to the fact that the two extremes of VI, ALL and Telco, do not have very different markups. This does not mean that VI in general does not influence relative costs or markups. As we have seen, both Telco and ALL enjoy cost advantages over each other through different facets of their VI strategies. On balance, these have resulted in no major net cost advantage to either firm.

In the 1990s, a change is likely. With the further development of and increasing competi-

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1.See chapters 6 and 7. Telco has recently modernized its foundry and forge in Jamshedpur, and also absorbed foreign technology in its machine tool division.

tion in the machine tool industry in India, the cost differential between Telco's in-house production and the market is likely to decrease.[1] Similarly, the component supplying sector is upgrading and expanding, which could conceivably lead to a cost differential between Telco and the market. SSI firms also gain more experience and become more reliable over time, which increases the advantage of firms such as ALL. That Telco is realising this is evident from the doubling of its suppliers between 1976-82, and further increases thereafter, and the lower level of integration in its second plant at Pune. But more action may be required particularly to reduce the very high break-even points that it is facing, which it could get away with in the earlier period when demand was less of a problem. One way to do this would be to convert some of the in-house divisions such as machine tools into arm's length suppliers.

SYNTHESIS AND INTERPRETATION

Background

The CV industry, like others in India, has functioned within an environment circumscribed by Government policy. This included restrictions on imports of components which continue to date (vehicle imports are in any case not allowed), owing initially to balance of payments and later also to infant industry considerations; and promotion of small-scale industries including reservation of several scores of auto components for exclusive SSI production; demarcation of products that could be made in-house and those to be bought in (1965); and monopoly regulations that prevented large (CV) firms from acquiring a stake in their supplying firms. Alongwith this, the industrial environment was characterised by lack of diffusion of skills, chronic power shortage and unbalanced regional growth. The upshot was an endemic shortage as well as uncertainty in

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1.See Mehta (1990) and World Bank (1986) for studies of the Indian machine tool industry. Although both are critical of the technological standards prevalent, they document the attempt to improve competitiveness by, inter alia, the signing of many new collaborations by leading firms. Also, capacity has increased substantially and the share of the top eight companies declined from 96% in 1978-79 to 76% in 1983-84 as a result of entry by many new firms. This increased competition holds particularly good for SPMs, where scale economies are less important than for GPMs, and where new firms have been able to make some inroads (World Bank, 1986).

the supply of inputs and machinery. At the same time, demand was much less of a problem, except during periods of recession.

Nevertheless, the CV industry appears to have attained substantial levels of putting-out in a relatively short span of time, owing partly to the externalities generated by the two pioneering firms - Premier Automobiles in the West (Bombay) and Hindustan Motors in the East (Calcutta) - which preceded most of the existing CV firms by about a decade, and began the process of skill diffusion in the engineering industry. The process of putting-out was hastened considerably by the 1965 demarcation (Krueger 1975, ch.3). Alongwith the mandatory indigenisation programmes, this resulted in an increase in the percentage bought from domestic CMs. The Tariff Commission (1968) records that between 1961-62 and 1965-66, components purchased from indigenous ancillary units as a share of total material costs rose for all firms - from 41.4% to 71.7% for the ALL Comet, 18% to 24.9% for the Telco L-312 (48 seater), 16.7% to 31.5% for the HML Ambassador car, and 21.9% to 41.7% for the PAL car. For SMPIL's 1 ton LCV, the ratio was 28.7% in 1965-66, and 47% for BTL's 3-wheeler [TC (1968), pp.140-42]. As compared to other Indian industries, the automotive industry appears to have witnessed faster and greater ancillarisation.[1] It also appears to have achieved greater ancillarisation than automotive industries such as the Philippines where car assembly began in 1951, as well as in other ASEAN nations.[2] More importantly, the levels of ancillarisation are comparable to those achieved by developed automotive industries in Japan and USA at comparable or later stages of

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1.According to the journal Laghu Udyog, 1981, quoted in Pandit (1984), the extent of ancillarisation in the transport equipment industry was 60 to 90%, communication industry was 50 to 75%, industrial machinery 20 to 40%, chemicals and pharmaceuticals 15 to 30%, and so on.

2.Domestic content in 1978 on assembled vehicles in the Philippines was only 34%, and 43% in 1983. (EIU 1985, p.37), as opposed to 90-95% for India. This obviously means that locally bought in parts would be far lower than in India.

development.[1]

The Indian CV industry has followed the general patterns of internal and external production established in the automotive world, with the difference that there is a much greater level of uniformity across firms in India. Most of the critical items were manufactured or at least finished in-house, including cylinder head and block, gearbox, axles, crankshafts, camshaft, press parts, and all sub-assemblies and final assembly. This is because at the time when the CV (automobile) industry was established , there was no independent supplier, either current or potential, of most of these items.Specialized parts such as electricals, pistons, fuel injection, lighting, as well as non-critical items reserved for SSI (such as rubber parts, mirrors, ornamental fittings, seats, etc.) are bought in. These components are on the whole manufactured at reasonably competitive prices, as pointed out by a World Bank study.[2] However, there are variations in the price at which components are available to CV firms owing to bargaining. In the case of proprietary components, most segments were dominated by 1 or 2 CMs, inspite of there being a multiplicity of producers.[3] These firms, who gave good quality and service, were able to earn some extra-normal rents in return, and sometimes even indulged in opportunistic pricing. With SSI firms, as may be expected, the relationship was unequal, and VMs took advantage not only of lower costs but also imposed lower average markups than they had to pay to large and dominant CMs.

1.In 1965, VI (defined the same way as we have) in Nissan, Toyota, GM, Ford and Chrysler was 32, 41, 50, 36 and 36 per cent respectively. As opposed to this, VI in ALL, BTL, M&M, SMPIL and Telco in 1977 was 20,37,39,34, and 39 per cent respectively. Moreover, this comparison is biased against the Indian firms, because they had not been in existence for as long a time in 1977 as their Japanese and American counterparts in 1965. By 1983, VI in Nissan, Toyota and Chrysler had declined to 26, 26 and 28 per cent (GM and Ford n.a.) respectively (Cusumano 1985, p.190).

2.The World Bank (1987) study found that Indian ex-factory prices of 15 ton GVW truck components were, on an average, 1.4 times that of corresponding U.S. prices. Some components such as engine valves, tie-rod ends, and brake linings were 50-70% of US prices.

3.See Kathuria (1990). On an average, there were 6-7 licensed manufacturers in each segment of the components industry in the 1970s.

Production Cost Differentials

It is against this background that the VI/sub-contracting behaviour of the CV industry needs to be looked at. The conscious choice of extreme strategies by ALL and Telco gives us a rich mosaic of facts. One of the first things that we notice is that the firm is not necessarily more expensive than the market in production cost terms, as Williamson (1985,p.94) assumes . Williamson implicitly assumes that the technology of production is equally familiar to all, which is certainly not true in a country which is beginning to industrialize.[1] Similarly, in a situation with a large dominant firm, internal demand may be greater than the rest of the market put together, enabling greater economies of scale in-house (however, as industrialization proceeds, other firms will also grow and economies of scope, if not scale, will ensure that eventually the market production cost becomes cheaper).

In the case of Telco, its production cost of many items such as SPMs, press tools, and initially even forgings and castings, was cheaper than the (domestic) market. In fact, in the 50s and 60s, and even the 70s, the production cost of a wide spectrum of components was probably cheaper in-house than market purchase.[2] The reasons for this were inadequate diffusion of technology, Telco's large size relative to the market, and the very high asset specificity (by definition) of SPMs and press tools. But production cost alone does not explain Telco's integration.

On the other hand, in ALL's case, market purchase was cheaper than in-house production, which is closer to Williamson's assumption. This was because of ALL's low scale of production. But just as for Telco, production cost considerations alone are insufficient to explain

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1.Often not true in developed countries also, e.g. at the time when a new technology is introduced. See Moss's (1989) review.

2.For example, in 1967, there were very large cost differentials between ancillary producers and in-house production by Hindustan Motors in the case of propellor shafts (Rs.203 and Rs.122 respectively), crankshafts (239 and 109) and shock absorbers (152 and 76), as reported in Krueger (1975, p.56). It is very likely that Telco would have also enjoyed production cost advantages across a wide variety of components.

its low VI.

To an extent, there is a linkage in our firms between scale and the degree of VI. ALL is much less integrated than Telco as it attempted to capture some scale economies denied to it by its size, by buying from the market. Similarly, SMPIL does not have a foundry, unlike BTL and M&M, but these are minor diferences compared to those between the MHCV firms. Different vintages of capital and production technology have allowed the LCV firms to maintain almost similar levels of VI (see ch.6).

Uncertainty

As we shall see, our explanation of VI will rely on a combination of transaction costs, production costs, uncertainty and life cycle hypotheses. Given its objective of high growth, Telco could assure itself of adequate inputs only by integrating as far as possible. This was because of uncertainty in the supply of inputs, resulting from foreign exchange rationing and a nascent supplying industry, the latter also leading to a problem of uncertainty in quality. This uncertainty is different from the strategic or behavioural uncertainty that is considered to be of "special" importance to an understanding of transaction cost economics issues (Williamson 1985, p.57). Our uncertainty is at least partly independent of transaction cost considerations, and affects both specific as well less specific assets, as evidenced in Telco's wide-ranging integration. Implicitly, this uncertainty also accounts for VI as a historical circumstance -- firms that have been set up in the 1980s, even a high growth one like Maruti (producing cars), have had no reason to integrate. On the other hand, HML, also a high growth firm in its earlier years, had an integration level next only to Telco's.[1]

As a generalisation, it could be said that given a high growth objective , uncertainty in supply could create a binding constraint, leading to high VI. If circumstances change, and

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1.From 2513 cars and CVs in 1950, HML's output rose to 16296 in 1960, which represented more four-wheelers than manufactured by any other company at that time. In 1961-62, self-manufactured components as a share of total raw material costs were 53.4% for HML's Ambassador, 66.2% for Telco's L-312 (48) and 2.2% for the ALL Comet (TC 1968, pp.140-41).

supply uncertainty becomes less binding, newer firms need not be as highly integrated. However, the older firms will find it difficult to disinvest, except very slowly, and would therefore continue to be highly integrated.

Another influence of uncertainty predicts movement away from integration. Since aggregate demand is more stable than demand specific to a firm, an upstream supplier will usually face greater demand variability when tied to one downstream firm than when it is an independent supplier.[1] This is a disincentive for integration, and more so for risk-averse than risk-neutral firms. Another disincentive is created by the risk averse firm's desire to share the burden of adjustment during a recession with its suppliers. These are demand uncertainties, as opposed to the earlier uncertainties in supply. A growth-oriented firm like Telco has covered itself against supply uncertainty, whereas the slower growing and more risk-averse ALL has allowed demand uncertainty to be a dominating consideration.

Life Cycle

Product life-cycle considerations could also be brought in. As Stigler (1951) argues, the market size in infant industries is too limited to support independent specialized firms. As demand for the final good grows, stages with increasing returns would be spun off, leading to vertical disintegration. Thus, non-existence of suppliers in the initial stages provides incentives for VI. However, if this was the case, all the CV firms (except Telco) should have integrated more than they did. The escape route for them was rationed imports and limited domestic supply. Stigler's prediction of high initial VI is most valid for products at the start of their life-cycle, rather than for infant industries who borrow the same technology at a later date (unless imports of inputs in the latter case are banned). Where escape routes are available for infant industries, firms may prefer not to integrate too much, especially if, as in Indian industry, it is difficult to shed labour (owing to labour laws) or scrap even old machines (owing to very high opportunity

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1.Blair and Kaserman (1983), pp.83-88.

cost of capital). Other CV firms besides Telco preferred the escape route, at the cost of lower growth.[1]

Overall, the life cycle hypothesis does not, by itself, add very much to the explanation of VI in our study. Inasmuch as the growth of the CV industry has spawned more suppliers at different stages and increased competition, Stigler's predictions are valid. Very slowly, firms are offloading some of their in-house tasks on to the market. But while the life cycle hypothesis offers a (partial) explanation of industry-level VI, it is inadequate in explaining VI differences between firms. However, it could play a greater role if interlinked with other theories such as transaction costs.

Transaction Costs

> Transaction cost issues are widespread, since potentially
> ...any problem that can be posed directly or indirectly as a contracting problem is usefully investigated in transaction cost economizing terms (Williamson 1985, p.41).

Initially, Telco's integration would have given it a production cost advantage in many items. But if costs of bargaining with potential monopoly suppliers are taken into account, the ambit of VI would increase. Hypothetically, even if cost of an item is cheaper in the market, the cost plus markup may be cheaper with internalized production owing to opportunism arising from lack of competition amongst suppliers. Internalization of markups would therefore be another motive for VI. Other transaction costs would arise from the need to constantly monitor quality and to ensure timely deliveries, given Telco's quality and growth objectives. In Williamsonian terms, there was a high degree of opportunism and behavioural uncertainty (arising from lack of competition), parametric uncertainty (state-contingent, higher in the infant industry stage), bounded rationality, and a high frequency of transactions (in Telco's case, since it was fast growing). According to

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1.This is supported at an industry level by Levy (1984) who, using US census data, found that demand growth in 38 industries was significantly and positively related to the degree of integration. Levy's finding is consistent with Stigler's hypothesis that young industries (also those that are growing faster) are more integrated (see Perry 1989, pp.230-34).

Williamson (1985, pp.30-32), a combination of opportunism and bounded rationality would, in the absence of asset specificity, warrant market supply with effective competition amongst suppliers. However, since there was no competition amongst suppliers in our case, and given the high frequency of transactions, a more transaction - specific governance structure is called for, Telco having chosen unified governance. Transaction cost reasoning was partially respected to the extent that specific assets like SPMs and press tooling were fully internalised, whereas GPMs (and later forged items) were only partially internalised.

We have seen that in its second plant in Pune, Telco was less integrated. This is because by then suppliers were more reliable and competition amongst them was greater. This reduced Telco's transaction costs of market purchase. In general, it has been able to practice a policy of tapered integration in several product groups owing to lowering of market transaction costs.

Telco's SSI strategy is also consistent with transaction cost considerations. It would have suffered very high transaction costs in monitoring uneven quality and delivery from SSI firms, given high frequency and its insistence on quality. These costs would not necessarily have meant reduced profits (in fact, quite the reverse), but would have interfered with Telco's objectives. In order to lower these costs, moreover, it assiduously built up and nurtured its supplier base. Over time, therefore, it was able to rely to a greater extent on SSI suppliers.

Moreover, Telco has been, at least relative to the other firms, a strongly technologically oriented company, with a focus on in-house R&D. In transaction cost terminology, the extensive R&D iterations pose a problem of adaptive, sequential decision-making: it is not possible to foresee ex-ante the different situations that may arise or the responses that may be required from suppliers, which also increases cost of correcting ex-post misalignments. Moreover, development-related expenses specific to the innovation have to be incurred. With high ex-ante and ex-post costs, VI is a favoured option, and Telco's VI strategy has been particularly suitable towards reducing these high R&D-related transaction costs.

ALL's quasi-integration, particularly into castings, and its overall very low level of integration can be explained in the following way. ALL's extensive reliance on SSI showed that cost-

minimization was a very important objective, wherein it was able to exploit not just low costs but also the low markups of SSI suppliers. Since its growth was slow, the frequency of transactions was lower than Telco's. Also, it was not as worried about fit and finish of the vehicle. Both these factors reduced its transaction costs of monitoring SSI suppliers, and also explain why it did not stretch itself as much as Telco to develop its suppliers. Production cost considerations also militated in favour of extensive purchase from SSI.

At the same time, on a very crucial input as castings, which can prove to be very costly if rejections are high (i.e. very high ex-post transaction costs), ALL chose to itself promote a foundry, so that it could monitor quality more effectively. Unlike Telco, however, the foundry was not internalised owing to the lower scale of ALL's operation, it being felt that arm's-length purchasing would allow sufficient scale economies to be reaped. For other inputs, too, ALL could not internalise to the extent Telco did inspite of opportunistic pricing by suppliers, owing to its low scale, preferring to exercise strict quality checks over bought in components.

As in production, ALL bought in a lot of R&D. This, as we explained earlier, also suited its disintegrated production structure. If it had undertaken own R&D to the extent Telco did (even assuming that it was as capable), it would have incurred very high transactions cost at various stages of innovation. Assuming that whenever it imported technology ALL did so at a price lower than in-house supply, ALL economised on generation costs of technology, as well as on transaction costs (substituting one transaction with the collaborator for dozens of transactions with suppliers, at least upto the pre-productionising stage). Given its strategy of relying more on technology imports, a more disintegrated production structure was more suitable (see also next section).

Technological Change and Organization

Based on our foregoing discussions, we can also suggest a possible generalization of the link between TC strategies and the form of organization:

Exhibit 5.1. TC Strategies and Implied Contracting Modes

	AUTONOMOUS INNOVATION	SYSTEMIC INNOVATION
IMPORTED/BOUGHT-IN TECHNOLOGY	VERY LOW INTEGRATION (A)	INTERMEDIATE DEGREES OF INTEGRATION (B)
OWN R&D	INTERMEDIATE DEGREES OF INTEGRATION (D)	HIGHLY INTEGRATED (C)

The exhibit shows that ceteris paribus, an autonomous, imported innovation can be productionised easily even in a firm that has a very low level of integration (quadrant A). On the other hand, when own R&D substitutes for imported technology, the efficiency of the concept, prototype, testing and other stages (i.e. generation or pre-productionising stages) is also called into question, which favours integration for transaction cost reasons. When this is combined with systemic innovation, demands of pre-productionising as well as productionising require a very high level of integration (quadrant C). In quadrant B, there are opposing tendencies. Since technology is imported, transaction costs at the pre-productionising stage are very low. At the productionising stage, the transaction costs will be higher if there is more vertical disintegration since a systemic, imported technology requires substantial modifications. However, productionis-

ing costs of the technology may be higher with greater integration, and capital costs will certainly be higher (when own R&D produces systemic innovations, the productionising costs need not be higher with greater integration). The net effect will determine the degree of integration. In quadrant D, pre-productionising transaction costs are high, but are low thereafter. Conversely, productionising costs are not very high even with integration, since the innovation is autonomous.

Synthesis

While acknowledging that VI depends on a trade-off between scale and scope economies, on the one hand, and transaction cost economies, on the other, Williamson accords far more importance to the latter. He implicitly assumes that technology is available costlessly, whereas in a developing country engineering and entrepreneurial skills are not widely diffused. In many situations, production cost considerations also create incentives for VI, unlike in Williamson's analysis. Together with life-cycle and uncertainty considerations, this leads us to predict a much higher level of VI than implied by transaction costs alone.

In our analysis, the most complete explanation for VI is offered by a mix of transaction and production cost considerations. It should be noted that if a firm integrates to economize on transaction costs, it does not necessarily mean that it would be more profitable, since many transaction costs do not have an immediate pecuniary impact.[1] Telco suffered potentially high transaction costs since it had targeted for high growth and quality as well as own R&D (relying less on imported technology). This incentive for VI was reinforced by production cost considerations, particularly in the initial period of the Indian life cycle when skills were scarce. Even when a product was available on the market, Telco's dominance and scale ensured that it did not suffer sizeable cost penalties, or even enjoyed actual cost advantages. Moreover, at the beginning of the

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1.See Williamson (1985), p.32. In a world where transaction costs are pervasive, the "organizational imperative" should be to "organise transactions so as to economize on bounded rationality while simultaneously safeguarding them against the hazards of opportunism", rather than simple profit maximization.

life-cycle, transaction costs were also higher, as was uncertainty in supply of inputs, creating further incentives for VI. Moreover, once the firm had integrated, it was locked into the situation owing to the virtual imposibility of shedding labour and the high opportunity cost of capital. It is likely that there was also a reverse influence of VI on Telco's behaviour and strategies, once it realised that it was locked in to a high level of integration. For example, to grow, Telco had to integrate. Once integrated, it had to keep growing to keep down its break-even level of operations. Another influence was that it could utilise its elaborate infrastructure to undertake own R&D of a relatively ambitious nature.

For ALL, production cost considerations favoured the market to a much greater extent, owing to its lower scale, and the fact that technology and skills were less scarce in Madras than in Jamshedpur. Its transaction costs were also relatively low, given its objectives, but were higher for castings owing to the critical nature of this input -- leading to quasi-integration in castings. Low transaction costs also explain its extensive reliance on SSI suppliers. Telco, who faced higher transaction costs in dealing with SSI suppliers, relied far less on them, and also devoted much effort to developing them and thereby reducing these costs. Again, for a relatively risk-averse firm such as ALL, uncertainty in demand is a stronger motivation than uncertainty in supply, creating further incentive for vertical disintegration. Finally, ALL's reliance on imported technology favoured low to moderate degrees of integration (quadrants A and B in exhibit 5.1) for productionising and transaction cost reasons. As in Telco's case, ALL's low VI may have had some reverse influence, reinforcing the strategy to rely more on technology imports.

A major point of difference between Williamson's theory and our application of transaction cost analysis is the relative importance of asset specificity.

> ...Asset specificity is the big locomotive to which transaction cost economics owes much of its predictive content. Absent this condition, the world of contract is vastly simplified... (Williamson 1985, p.56).

In his book, Williamson develops at length the impact of asset specificity on organization, with internal organization being favoured as specificity increases for reasons of both transaction and production costs. However, ALL chose to quasi-integrate into castings, by no means a highly specific investment as compared with many others like SPMs, press tools, etc. Its potentially

high transaction costs in castings arose not from the specificity of the investment as from the critical nature of the item and the consequent need to set up very elaborate monitoring systems. Similarly, Telco's integration did not stop at SPMs and press tools, it included less specific investments such as castings, forgings and 30 percent of its GPM requirements. In all these cases, transaction cost of buying from suppliers would have been high because of opportunism, lack of competition, and consequent high monitoring costs. Also, for Williamson, production cost differentials arise only on account of scale economies, with internalization resulting in lower penalties as asset specificity goes up. But we have found that lack of diffusion of technology often gives VI a production cost advantage even when the assets are not specific. In our analysis, asset specificity sometimes enhances the explanation of VI, but it is not the big Williamsonian locomotive. Generalizing this, we could say that when competition is low or absent, as in most developing countries, transaction costs of market purchase are high across a wide variety of high-technology/critical components, whether or not these are specific to the buying firm.

PROSPECTS

In the international automotive industry, as we have seen, the Japanese have established norms of efficient organization that have left other countries scrambling to follow suit. Integration economies have been achieved without sacrificing on advantages of scale and specialization. Reliance on CMs is increasing, not just for production but also for R&D.

Our CV firms have quite a long way to go before they can compare with Japanese firms. For one, although Government policy forced a fast pace of ancillarisation in the sixties and seventies, the level of integration has not declined since 1977 (although there are a few specific instances such as the buying in of forgings in Telco's second plant).[1] Secondly, the relationship between CMs and VMs has not flowed from a perception of symbiotic growth. Thirdly, the CMs were not able to act as catalysts for technological change. All this has to change if the industry is to

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1.This is inspite of the Modified Value-added Tax introduced in 1986 to reduce the cascading impact of indirect taxes, which had created an incentive for integration.

achieve international competitiveness.

Recent events indicate that the beginnings of these changes are now possible. The components industry has upgraded substantially in the 80s, and signed hundreds of new collaborations. Some sub-assemblies like rear axles can now be bought in directly from CMs. Many modern technologies bearing the world's most reputed names are now available to VMs. Competition between CMs is also increasing. The SSI sector has also developed and gained in expertise and experience, as has the machinery supplying industry. In terms of our theoretical structure, the transaction cost of buying from component and machinery suppliers is declining. At the same time, the production cost advantage of specialised suppliers is increasing. The situation is therefore ripe for a general decline in integration levels (at least full integration) in the CV industry, as also predicted by our theories, and may in fact be an important element of competitive strategy in a changing domestic market. The increasingly competitive domestic market is also demanding a greater variety of components on their vehicles, including brand names, which also favours greater buying in.

Relationships are a particularly difficult issue, and can change only slowly. However, the entry of Maruti in collaboration with Suzuki in 1982 is providing an example for others to follow. Already the largest producer by far of cars (1989 output 110,000), Maruti has articulated a Japanese-style policy of buying from just two suppliers per component. It has also invested in six joint ventures (alongwith Indian and Japanese promoters) to supply it with various components. It also enjoys good relationships with its suppliers, and in many cases has even signed long-term contracts with them. This demonstration effect, alongwith the increased competitive checks on opportunism, makes a change in established traditions towards an era of symbiotic growth more likely.

The lesson to reduce full integration levels is particularly valid for Telco, and to a lesser extent for M&M, BTL and SMPIL. The options would be to shift to some form of mixed governance, such as quasi or tapered integration, or even complete externalisation for the input concerned. Telco's integration was not driven by profitability considerations, but by its desire for

high growth. It achieved a high level of technological synergy in its various integration decisions, and also enjoyed cost advantages on many of its in-house components, particularly during the expansionary phase of development of the CV industry. However, with market conditions becoming more competitive and uncertain, reduction in overall costs as well as fixed costs become important. It may be necessary for some of Telco's divisions such as machine tools and press tools to become independent subsidiaries, or at least to sell to other firms while remaining in-house divisions, which would reduce break-even levels of operation. In fact, there are few auto firms, if any, with a machine tool division catering only to in-house requirements. In 1937, Toyota founded an in-house machine tool shop to substitute for bought in machinery. By 1941, it had built a new factory which it detached from Toyota, called the Toyoda Machine Works. Toyota had a 25% stake in this company.[1] Similarly, Mazda produces "Toyo" machine tools both for in-house use as well as for external sale. Honda Engineering, a subsidiary of Honda, supplies machine tools both to Honda and other companies. These firms, moreover, are much larger than Telco, and so could have supported an in-house machine tools division with greater ease. Besides this, Telco may also find that there are a growing (even if only slowly) number of products where it is more advantageous for it to buy from the market.

ALL is the only one of our five firms to have achieved buying-in levels comparable to the Japanese. But it has not been able to forge close relationships with its suppliers, an aspect on which it has to work harder than Telco. This is also true for the LCV manufacturers.

Thus, while different VI and buying in strategies have succeeded in the domestic market, Indian CV firms have to learn from international experience if they are to make a significant dent in the export market. Some policy recommendations on this theme will be found in chapter 8.

1.Cusumano (1985), pp.248-49.

CHAPTER 6

MANUFACTURING TECHNOLOGY AND ECONOMIES OF SCALE

INTRODUCTION

In this chapter, we shall ask whether firm size has any effect on its performance. This brings in the issues raised in chapter 2 viz. economies of scale and scope, nature of manufacturing technology employed and change in this over time. In metal-working industries, a variety of technological and organizational arrangements can be used to accomplish the same task. The Indian CV industry illustrates this scenario vividly.

We shall begin by reviewing the different aspects of manufacturing technology and firm scale, including scales of production and investment, machinery and manufacturing processes employed in the different firms, capital intensity of production, inventory management, and quality control practices. We shall find that even though all firms have enjoyed some scale economies over time, differences in scale and related factors have not had a significant impact so far on relative costs between firms. Scale economies in marketing have however played an important role. Also, those firms who had not modernized their facilities suffered a sizeable erosion in their profits per unit of capital since the mid 80s as they sought to close the gap by heavy doses of investment.

MACHINERY AND MANUFACTURING PROCESSES AND RELATIVE SCALES

Scales of Production and Investment

Table A.3.3 shows the output levels of the different firms. The smallest firm, SMPIL, had a peak output of 5810 LCVs in 1984; BTL produced 16045 LCVs including 2940 three wheelers

in 1987; and M&M made 11577 LCVs (including jeep-type LCVs) in 1984. Internationally, these scales are extremely small, as table A.2.1 shows, and particularly if synergies with car production are also considered (see ch.2). In particular, Japanese production of LCVs of 3-4 ton loading capacity (the nearest approximation to Indian LCVs) was nearly 1.5 million in 1988, giving to many leading manufacturers volumes in excess of 250,000. However, M&M's production of about 30,000 Jeeps does give it some respectability in an international sense (its utility vehicle output is 10-20% of the largest producers such as Toyota, Chrysler, Ford and Suzuki, and is comparable to smaller producers such as Rover, Subaru and General Motors).

In stark contrast, MHCV demand in India is very large, allowing both Telco and ALL to achieve international scales of production. Telco's production of about 50,000 MHCVs (mainly 15-16 tons GVW) makes it the largest producer in the world in the 10-16 ton size class, ahead of Navistar, Ford, General Motors and Daimler-Benz, which produced 36-41,000 units in 1988. ALL, which has achieved an output level of 20,000, would come in at no.6.[1] If we consider all MHCVs (above 6 tons GVW), Telco's world standing (including buses) would be between nos.7-9.

The relative size of firms as indicated by their fixed assets is shown in table A.6.1. Gross fixed assets (GFA) were in the region of Rs.700 crores for Telco, and 183 crores for ALL. M&M, although producing a much larger number of vehicles, had a GFA figure slightly lower than ALL at Rs.176 crores. BTL's investments totalled Rs.83 crores, while SMPIL's were 27 crores. Of course, owing to capital valuation biases, these figures (or, for that matter, those for net fixed assets) are not accurate indicators of the relative current worth of the machines. A correction has been attempted as described in chapter 3 to take account of increases in the price of capital goods since 1977. These figures are shown in the columns for deflated fixed assets

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1.Financial Times Supplement on World Trucks, November 16, 1989 (for Indian firms, the figures include trucks and buses, since the chassis is the same for both). By the same token, Telco and ALL cannot be considered amongst the world's largest producer of buses, since their buses are essentially trucks. The world's leading bus producer is Ikarus of Hungary, which makes around 11,000 buses (down from 14,000 two-three years ago, see Financial Times Supplement on World CVs, November 6, 1990). Telco and ALL respectively have manufactured "buses" at a peak level of around 12,000 and 10,000 annually.

(DFA) in A.6.1 . We have also attempted to correct for the period prior to 1977, which is shown as adjusted DFA in A.6.1.[1] Firms with more recent (bunched) investments viz. BTL, M&M and SMPIL, are affected more than Telco and ALL. However, the broad orders of relative magnitude of the assets are not affected, except to increase the divergence between ALL and M&M.

Machinery and Manufacturing Processes

The technologies employed by the different firms present a mixed bag. At the bottom end of the rung is, expectedly, SMPIL. Considering its size, SMPIL is, as we have seen, a fairly integrated firm. This means that its limited investments have been spread thinly. By and large, its facilities are extremely old and dated, although there has been an injection of fresh technology in the 1980s, particularly after 1984, much of it specific to its new car collaboration. Most of its machining is done on traditional GPMs. The assembly line for LCVs employs hand-pushing methods, and the body-building and pressing facilities are also primitive. Between 1967 and 1977, for example, its GFA, even in nominal terms, increased from Rs.3.9 crores to only 5.1 crores, and in 1971 and 1973 the GFA even declined owing to zero addition to capital (along-with scrapping of some equipment). In other words, the company stopped investing after it completed its indigenisation programme in the late 1960s. It was not until it embarked on an expansion programme in 1981 that its investment increased more than marginally, with GFA in 1983 being Rs.13.8 crores and 27 crores in 1986 (table A.6.2 shows the percentage annual increase in GFA). In this phase, some newer machines such as a numerically controlled jig borer and a relatively modern assembly line for its new car, were introduced, but on the whole the facilities remain old and well-worn, with many processes dating to the pre-1950s era of batch

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1.This is done on the simple assumption that before 1977, the real fixed assets of the firm grew linearly.Suppose we take X to be the middle year between the inception of the firm and 1977. We then divide half the value of the DFA of the firm in the year 1977 by the Wholesale Price Index of non-electrical machinery in year X. This value is considered as the adjusted value of DFA in 1977. Conceptually, this has to be greater than the corresponding DFA, since we are adjusting for asset formation prior to 1977 in terms of 1976-77 prices.The difference between adjusted DFA and DFA in 1977 is added to the value of DFA for every subsequent year to arrive at the adjusted DFA for those years.

production. SMPIL also manufactures body dies with a wooden rather than metallic base, which suits its low-volume orientation.

BTL's facilities are of more recent vintage, with a mix of pre-1950s, post 1950s, and 1980s technologies. Of our five firms, it was the last to enter the industry (1958) so that in 1968 its GFA, at Rs.2.2 crores, was lower than SMPIL's. BTL's investments were, however, more regular, and by 1977 its GFA was Rs.8.1 crores. Thereafter, the rate of investment stepped up considerably : A.6.2 shows that the rate of modernization (i.e. percentage change in DFA, GFA) between 1977-87 was on the whole higher in BTL than the other firms. By 1987, the GFA was Rs.83 crores. Recent technologies have been introduced in different areas, including a transferline (imported from its collaborator, Daimler-Benz) for machining the engine cylinder block in 1982-83. Upto 1988, the company had brought in 6 CNC machines, mainly used to manufacture tools which require high accuracy. Besides these, BTL made selective use of CNC machining centres and CNC turning centres in production operations by substituting these for a few GPM and SPM operations. At the same time, none of the earlier machines are made redundant, because they are more intensively used in roughing operations. A major investment has also been made in a fully conveyorised assembly plant in Pithampur to assemble the new Traveller LCV (also a Daimler-Benz product). The Pithampur plant also has electrophoretic dip painting and automated welding equipment (used to weld the floor and chassis). On the whole, BTL has maintained a fairly regular investment schedule and kept many of its facilities abreast of contemporary technology. Moreover, since it has acquired some of its plant at throwaway prices (the 1971 engine plant was in fact a gift, and the transferline was acquired, second hand, at very cheap rates), the value of fixed assets is biased downward as compared to most of the other firms.

In terms of the overall state of its manufacturing facilities, M&M lies in-between SMPIL and BTL. Between 1967 and 1977, its GFA rose from Rs.7.3 crores to 22.5 crores, and Rs.176 crores by 1987. However, its investments have been bunched and irregular, as can be seen from A.6.2, its modernization (of DFA) varying from 52% in 1978 to 3% in 1987. Moreover, both these and

earlier investments have been spread across the many divisions of the company, including manufacture of jeeps, LCVs, tractors, components, as well as trading activities. As in the case of SMPIL, M&M's investments also suffer from a thin spread. In the vehicles division, its most modern facilities are at Igatpuri where the Peugeot XDP 4.90 engine is assembled. Here, there is a small foundry for the aluminium cylinder head, and a large number of SPMs for machining head, block, connecting rod, camshaft and crankshaft. Till 1988, two NC and one CNC machine had been installed, used mainly as standby or for development jobs. Movement of parts is done through hand-pushing on rollers, without mechanical aids. The same is true for engine assembly. The recently taken over press facilities of GKW are also closer to contemporary technologies, but other plants at Nasik, Kandivili and Ghatkopar by and large employ the old GPM technologies.

Telco has invested regularly in order to keep its highly integrated plant uptodate and has, on the whole, the most modern manufacturing facilities. In fact, high investment and continuous upgradation of equipment appear to be articles of faith for Telco, as successive Annual Reports show (of course, they also reduce tax liability, as ch.3 showed). GFA increased from Rs. 80 crores in 1968 to Rs.207 crores in 1977. Although the rate of "modernization" between 1977-87 was not as high as BTL, it was done on a much higher base. Another point to note is that Telco's capital base is under-valued relative to all other companies (ch.3). In other words, the ratio of current market worth of equipment to the value of DFA is highest for Telco, probably followed by BTL. According to the Chairman's speeches in the relevant annual reports, 50% of Telco's GFA in 1977-78 was less than six years old, and was almost the same in 1984-85. In 1984-85, the average age of plant and machinery was eight years, "much of it... the latest in technology".[1] Even the other assets, though "older in terms of balance sheet definitions, are really young and efficient, thanks to continuous..... maintenance, reconditioning and modernization".[2] Some

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1.Chairman's speech, annual Report 1984-85.

2.Chairman's speech, Annual Report 1977-78.

examples of recent process developments are a modern forge shop, a high output foundry line and a new paint shop. In 1985, a collaboration was signed with Nachi Fujikoshi of Japan to manufacture NC/CNC machining lines and machining centres, which are now in extensive use throughout the company. In 1978-79, the company designed and manufactured transfer lines for machining cylinder head castings, and did the same in 1986-87 for the engine of its lighter vehicle. Overall, there is little doubt that Telco was far ahead of the other companies in terms of the vintage as well as condition of its production facilities.

ALL's production facilities are to Telco what SMPIL's are to BTL. Between 1967-1977, its GFA rose from Rs.11 crores to 25 crores, reflecting a relatively slow rate of investment, partly because of ALL's high vertical disintegration. Thereafter, the rate of investment was much higher, GFA increasing to Rs.183 crores in 1987. But, as A.6.2 shows, the "modernization" has been concentrated in the period 1978-83, and resembles M&M in its irregularity. Although not as thinly spread as M&M, much of this investment took place in greenfield sites at Hosur, Bhandara and Alwar. The centrepiece of ALL's plants, however, remains the mother plant at Ennore. Here, most of the technology is of the GPM-oriented, batch-production kind. Incremental changes are being introduced through selective introduction of NC and CNC machines in finishing operations, as in the production of gearboxes. The engine parts like head and block are pushed manually from point to point on rollers, but the final assembly line moves on a mechanical conveyor. ALL's associate, Ennore Foundries, is considered to be one of the finest in Asia. In 1983-84, it opted for a major change in technology, installing a high pressure hydraulic moulding machine. Thus, Ennore Foundries uses more contemporary technology as compared to ALL's Ennore plant.

Capital Intensity of Production

One quantitative indicator of the physical assets provided to employees is given in A.6.3, which shows the adjusted value of DFA per employee. Between ALL and Telco, the latter had a much higher ratio on the average between 1977-87. However, over 1980-84, the ratio was higher

for ALL, owing to a spurt in new investments in greenfield sites, which was not matched by commensurate increase in employment, once ALL realised that the late 70s boom was over. Therefore, in terms of actual physical assets available for each employee to work with, Telco was always ahead of ALL, particularly when the undervaluation in Telco's asset base is considered.

As between the three LCV manufacturers, BTL has, somewhat surprisingly, the lowest ratio of fixed assets per employee over 1977-79. However, much of this could be ascribed to the downward bias in the value of its assets. Also, given its cost consciousness, it is possible that wherever possible, it would have substituted labour (often temporary and hence low-paid) for capital. Its regular investments also meant that its ratio had crossed SMPIL's by 1980 and M&M's by 1985. Relative to SMPIL, M&M has always had more fixed assets per worker and probably more than BTL upto the beginning of the 1980s.

Over time, there is a distinct upward trend in the assets per worker ratios, which represents a real increase since the figures are at constant prices. As A.6.3 shows, the percentage change was highest at BTL, where the ratio quadrupled over 1977-87. In ALL, the ratio more than doubled. Telco's increase is steady, if less dramatic, since it has invested and upgraded very regularly.

It is interesting to note that these figures go against the normal tendency of lighter vehicle production to be more capital-intensive. For example, as the accompanying table shows, investment per employee was much higher for light vehicle manufacturers than for MHCV manufacturers like Nissan Diesel and Hino. Hino's ratio, in turn, is higher than Nissan Diesel's because it manufactures a large number of LCVs for Toyota. In Telco's case, its volumes are larger than any LCV manufacturer, and it could therefore afford to invest large amounts of capital. But the high ratios for ALL, as compared even to a high volume firm like M&M (high volume in Jeeps), shows that the LCV firms may need to step up their investment further.

Table 6.1
Gross Fixed Assets per employee in Japan, 1987 (mn. yen)

Toyota	32.88
Suzuki	32.04
Daihatsu	16.66
Honda	22.43
Isuzu	35.48
Nissan Diesel	11.42
Hino	21.53

Source : Calculated from EIU (1988).

World Bank Evidence

In 1973, a World Bank study rated the different CV manufacturers on different criteria (table 6.2) These performance ratings were based on a point system, with weightage being given under a large number of parameters. For example, under manufacturing, there were 23 parameters, including age of facilities, layout, material handling, tooling, conveyors, suitability of machines, inspection systems, working conditions, training programmes etc. Product engineering included vehicle design, engine design, styling and product planning.

Table 6.2 : Summary Performance Ratings of CV Manufacturers

	BTL	Telco	ALL	M&M
Product engineering	88	77	38	32
Manufacturing	89	87	51	35
Materials management	90	88	58	23
Marketing	78	75	39	25
Parts and service	79	100	57	43
Financial controls and reports	86	54	26	29
Organization	89	90	56	34
Overall	85	82	46	33

Source : World Bank (1973), p.10.

Under manufacturing, M&M had a rating of 35%, ALL 51%, Telco 87%, and BTL 89%. Maintenance and housekeeping were cited as poor in M&M, but good to excellent in other firms. Quality of trucks of BTL and Telco were rated good. Personnel relations were rated poorly,

except for BTL and Telco. Material handling was a general weakness.

Similarly, under product engineering, only Telco and BTL were commended. BTL's truck lines were "...well engineered, suitably styled and economical to manufacture...". Telco's products are "...quite good both as to functional design and economy of manufacturing in the context of the Indian market...". For other manufacturers, basic vehicle designs were said to be substantially out of date.

Inventory Management

Effective management of inventory in India is constrained by a fear of shortages/strikes in supplier plants, as well as by the need to import most of the requirements of steel which, owing to delays and cumbersome procedures, necessitates holding large inventories.[1] Table A.6.4 shows the ratio of inventories to sales over 1977-87. M&M generally has the lowest inventory holdings upto 1983/84. This needs to be discounted to the extent that M&M does not offer fully built up LCVs, unlike BTL and SMPIL. This is one reason for a lower share of imports to total bought in items in M&M vis-a-vis BTL, and hence requires lower inventories.[2] However, SMPIL has managed with a much lower import ratio than other firms, so its generally high inventory ratio (in excess of 30% 6 out of 10 years) is an indictment of its organization and inventory management. After 1983, owing to conscious control efforts, BTL's inventory ratio declined to under 25%, and was as low as 20.6% in 1987. On the other hand, M&M's inventory performance deteriorated after 1983, without any increase in its import ratio.

Telco's inventory ratio was at or above 35% over 1977-82, higher than any other, partly

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1.AIAM (1985a) estimated that more than 75% of the demand for steel by the automotive industry in 1985-86 was required to be imported.

2.In 1981 and 1987, this ratio was 14.9% and 20.5% in BTL, but 13% and 10.7% in M&M. SMPIL's ratio of imports was generally lower, being 3.7% in 1981 and 5.6% in 1985. However, in 1986, its import ratio shot up to 33.9% owing to high initial imports under its new car collaboration, and resulted in its inventory ratio also shooting up to 45%.

because of its high import ratio.[1] Thereafter, inventory control was much better, generally below 30%, reaching a low of 21.9% in 1988. In ALL's case, inventories were generally lower than Telco, but import ratios were also lower. After 1982, its inventory control also improved, owing partly to a substantial fall in its import ratio. Another reason for ALL's lower inventories was its greater reliance on SSI suppliers than Telco. SSI suppliers are mainly located around the parent plant (the buyer), and can therefore supply to it "just-in-time". They are, in any case, more amenable to arm-twisting than the large-scale, independent suppliers, and can be coerced to supply according to the buyer's requirements.

Alongwith the evidence presented in ch. 5, this means that there is a trade-off between inventory and cost control, on the one hand, and quality on the other (recall that SSI suppliers offer both lower cost and lower quality). Moreover, higher inventories could be a conscious strategy in order to maximise production, given constant shortages of inputs. Faced with these options, Telco has opted for quality and production maximization at the expense of higher inventories and costs. Since 1983/84, as fears of input shortages eased (the market in any case became demand-constrained, which meant that capacities were not being fully utilised), and as the market became more competitive (meaning that costs became more important), Telco's inventories have declined substantially. This is also true for the other firms.

Although imports are a problem, they do not go beyond 10-20% of total materials consumed. Therefore, much of the blame for poor inventory management must be ascribed to firm organization and practices. In 1983, inventory ratios were 9% or less in GM, Ford and Chrysler, 5% in Nissan and less than 3% in Toyota (see ch.2). Even in the 1950s, these ratios were 11% in Ford and Chrysler, 14% in Nissan and GM, and 9% in Toyota (Cusumano 1985, p.302). These comparisons show that Indian CV firms will need to work very hard to even attain the world standards of the 1950s. A beginning was made since 1983/84 when most firms showed a decline in their inventory ratios. Further declines will require more coordinated action with suppliers, and is

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1.Import ratio in 1979, 1981 and 1987 was 16.2%, 17% and 16.6% and was down to 12.8% in 1988. Corresponding ratios for ALL were 11.4%, 11.7% and 4.3%. After 1983, in fact, ALL's import ratio was always below 5%.

linked with the relationship between vehicle and component manufacturers (discussed in ch.5).

Quality Control

A vital part of the manufacturing process is the system of quality control and inspection. To a large extent, output quality is determined by the age, condition and vintage of the manufacturing facilities themselves. Beyond that, the strength of quality control (QC) staff, and the systems and procedures for QC determine ultimate quality. In the case of the pre-1950s GPM technologies, reliance on human skills was high, since setting of tools was done manually. Checking was also manual, with the aid of mechanical devices. All this demanded continuous attentitiveness on the part of workers, and required large QC staffs to constantly check quality. Nevertheless, towards the fag end of the day/shift, attention tends to flag and quality suffers.

As automation increases, quality of output becomes less dependent on the engineering skills of workmen. In a transferline, for example, a cylinder block is fed in at one end and a finished product taken out at the other, with minimal human intervention. A few workers may be oversee-ing the process. Here, quality control would be in the form of periodic dimensional checking of the tools and fixtures. Requirements for QC staff will obviously be much lower than for GPMs.

Similarly, with more flexible automation, such as NC and CNC machines, human intervention comes in at the start of the operation, when the machine programs have to be set. Moreover, over time, these machines are getting more sophisticated, capable of automatic material transfer as well as in-process quality checking. The Japanese, in fact, have pioneered the concept of defect prevention rather than cure, with the focus of quality control shifting from inspection to process control.

Thus, with more automated systems, there is less reliance on temperemental human engineering skills, and hence a greater likelihood of achieving better quality and more consistent output. Schmitz and Carvalho (1989) demonstrate this in the case of the Brazilian car industry where only the more strategic operations vital for quality improvements were automated.

Table A.6.5 presents some fragmented data on QC that we have been able to gather. In

1967/68, all the firms employed basically similar (GPM) technologies. At that time, Telco was the only firm that had adopted the method of Statistical Quality Control (SQC). ALL was about to introduce SQC in its Auto Bar Shop (where mass production machines were in use). Telco even had automatic testing equipment for dimensional checking of items produced in large volumes.[1] Its high ratio of QC staff to total production workers (14%) is adequate reflection of its commitment to quality. ALL also had a relatively high ratio of 9%, whereas BTL and M&M had only 5%. But the other LCV firm, SMPIL, had a higher ratio of 9.6% (since the other car firms, PAL and HML, also had similarly high ratios, it may mean that car production required proportionately more QC staff than LCVs/jeeps. In 1966, SMPIL made 1098 cars and 979 LCVs).

By the late 1980s, these ratios had changed, though not for all the firms (as compared to the 1967 figures, the later ratios are downward biased since the denominator is total employment and not just production workers). In Telco, the ratio declined substantially, even taking the bias into account, to 6.6% in 1988. In ALL, on the other hand, there was no significant change, QC/total employment being 8% in 1987. M&M's QC ratio was the only one to increase, from 5% to 5.8% in 1988. In BTL and SMPIL, the ratios declined, particularly for the latter.

Telco's lower QC ratio in the 1980s reflects its much greater degree of automation as compared to the 1960s, as well as the beginnings of an organizational awareness of process control. In ALL, where the reliance on human skills is still very high, the pursuance of high quality has not allowed the company to reduce its QC ratio.

In contrast, the LCV firms appear to have inadequate QC staff, all of them having QC ratios lower than Telco, a far more automated firm. Even though some organizational differences could lead to reduced requirement for QC staff, the disparity between the MHCV and LCV firms is too great. For example, SMPIL, which relies more than ALL on human skills, had a QC ratio of only 4.2% in 1988 compared to 8% for ALL. Similarly, BTL's 3.2% compares poorly with Telco's

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1.See Tariff Commission (1968), chapter 5, for details on QC methods adopted at that time.

6.6%, and so does M&M's 5.8%, since it is a less automated firm than BTL (and obviously Telco).

Therefore, based on our knowledge of production technologies and QC ratios, we have come to the conclusion that the LCV firms paid relatively less attention to QC than MHCV firms, which would have ultimately reflected in product quality.

Capacity and Investment

Another bit of evidence on the commitment of firms to modernization is to see to what extent investment decisions are independent of capacity expansion decisions. Although firms can have a strategy of tying their major investment decisions to capacity expansion, this will not necessarily result in modernization of older capital equipment. The hypothesis is that ceteris paribus, the greater the influence of capacity expansion on investment, the lower is the commitment of firms to regular modernization.

To test this, we ran a simple regression between percentage change in deflated fixed assets (1976-77 prices) as the dependent variable and percentage change in installed capacity as the independent variable. A priori, we would expect Telco to have the lowest correlation.

The results in table A.6.6 show that for Telco investment is indeed unrelated to capacity creation, so much that the relationship appears negative (although statistically insignificant). In ALL and M&M, and to a lesser extent BTL, investment is closely tied to expansion of capacity in the period 1977-87. This does not, of course, mean that investments did not occur independent of capacity expansion (for example, the engine upgradation projects in all the three companies). For SMPIL, the lack of a statistical relationship is counter-intuitive, given earlier evidence. This is mainly because it was implementing its new car project with an unchanged overall capacity of 7500 cars and LCVs. Some of highest increases in investment occur in this period between 1983 and 1986. Thus, this period with very low correlation between investment and capacity expansion dominates the earlier period in a statistical sense.

This exercise confirms the earlier evidence about Telco's regular investment profile. All the

other firms are well behind (SMPIL's results are discounted given other evidence), of whom BTL has invested more regularly than others.

Synthesis

We have seen that Telco stands out on virtually all counts in the context of manufacturing processes in Indian CV firms. It has always re-invested a high proportion of profits, and has the most capital-intensive production methods. Its plants are in very good condition, not least because it is capable of doing all repairing and reconditioning on its own. Moreover, in-house manufacturing of machines leads to lower wastage and more economical operation since they are designed to the firm's specific requirements. In the 80s, Telco has been reconditioning its dedicated machines towards more flexible capabilities. Its quality standards are exemplified by high QC to total employment ratios as well as by evidence in chapter 5. Inventory control was one weak area, owing to a corporate objective to maximise production (and therefore keep a "safe" stock of inventories) and emphasise quality and growth. However, inventories have reduced substantially since 1983.

ALL presents a mixed picture. Large sections of its plants still rely on GPM technologies, inspite of its having invested huge amounts of capital in recent times. This has enabled it to close the gap between itself and Telco in terms of the capital-labour ratio. Organization of production in terms of layout, materials management etc. leaves much to be desired. Inventory management was generally better than Telco. Given its extensive reliance on outside suppliers as well on GPM technologies, it has to employ a large QC staff to maintain high quality, which gives it the highest QC ratio amongst all firms in the 80s.

BTL, the LCV leader, is different from ALL in many ways. It has a lower capital-labour ratio than ALL, inspite of a very regular rate of investment over 1977-87 (the gap has however closed). Technology choice has been selective and careful, so that some important sections of its plant have been modernized. As early as 1973, BTL had received high marks from a World Bank team in respect of manufacturing and materials management. Inventory control, somewhat lax

earlier, tightened up considerably after 1983. Owing to efficient organization, and a lower reliance on human engineering skills than all firms except Telco, its requirement for QC staff is low. Nevertheless, the QC ratio appears too low and may reflect a relatively casual attitude towards QC as compared to MHCV firms.

SMPIL is a small company with generally dated and well-worn facilities. Assets per employee were very low, and increased at a very slow pace in the 80s relative to BTL. Thus, although its capital-labour ratio was higher than BTL in the late 70s, it was almost half by 1986. Inventory control was not very good, but improved substantially over 1982-84, deteriorating again thereafter owing to the initial phase of its car project. Its QC ratio, which was even higher than ALL's in 1967, declined significantly by the 80s. Since it relies extensively on human skills in production, its low QC ratio is more of an indictment than in the case of BTL.

In terms of total number of four-wheelers produced, M&M is next only to Telco. However, its capital-intensity of production is not only lower than Telco, but also ALL, and, after the early 80s, BTL. The technology is still oriented towards batch-production, much in the manner of ALL. The company was given very low ratings by the World Bank team in 1973 with respect to manufacturing, maintenance and materials management. But the situation has improved substantially since then, as evidenced in a decline in its inventory ratio from 33% in the mid 70s to less than 25% a decade later, and an increase in its QC ratio between the 60s and 80s. Although its QC ratio is higher than SMPIL, its QC staff, as in the case of BTL and SMPIL, appears inadequate as compared to the MHCV firms.

IMPACT ON COSTS, PRICES AND PROFITS

Scale Curves : Temporal Effects

Econometrically, we observed in our pooled sample that the size of the firm (as measured by value of production) does not have a significant impact on the profitability of firms. However, we cannot infer from this any relationship between size and costs i.e. on economies of scale,

since lower costs do not necessarily mean higher profits, as we shall see. Moreover, the relationship could differ across firms, which is not possible to observe in a pooled sample with limited data. Finally, value of production is not a very good measure of scale, but was a necessary limitation since heterogeneous physical units cannot be used in a pooled sample.

In this section, we are attempting an analysis of "scale curves" for each firm for the period 1977-87. The cost figures used include all operating costs such as wages, materials, change in stock, other expenses such as power and fuel, selling costs, R&D and depreciation.[1] Our task of calculating physical outputs is made considerably more accurate by the essentially single-product nature of all firms except M&M. Nevertheless, we have adopted an aggregation procedure to take account of the most important secondary products of each company. The aggregation was done on the basis of relative prices of the different outputs (which can be calculated from the balance sheets) in each year, and the final output was denominated in MHCV equivalents (Telco and ALL), LCV equivalents (SMPIL and BTL) and jeep equivalents (M&M), which are the respective major products of each company. For ALL and BTL, we aggregated CVs and engines; for Telco, CVs and excavators; for SMPIL, CVs and cars; and for M&M, LCVs, jeeps, tractors and c.k.d. jeeps and trucks.

To start with, table A.6.7 shows the price indices (1977=100) of vehicles and parts and semi-finished steel, and the indices of unit cost, realisation or price (revenue/production) and profits per unit of output for each firm.[2] In general, the cost indices were lower than the wholesale price indices (WPI) for vehicles as well as steel except for ALL, where this was the case only after 1981. This implies that real unit costs of vehicles have declined over the years. Moreover,

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1.Thus, costs are not just production costs but also include costs of marketing and administration.

2.Profits in Tables A.6.7 and A.6.9 are defined as Sales less operating costs. Since costs do not include "purchase of trading goods for sale" (goods bought for re-sale without production value-added), we have excluded trading goods from sales as well. Sales also exclude "other income" (income from interest, financial services etc.), and since the cost counterpart of "other income" is very small, we have made no corresponding debit entry on costs. Thus the profits before interest and tax (PBIT) figure in chapter 3 differ from this definition of "profits" to the extent that the latter does not include other income and also does not take into account expenditure capitalised. For calculating markups or profits per vehicle, this is the more relevant definition since other income does not arise from sale of vehicles.

the unit price indices for each firm were, more often than not, lower than the corresponding cost indices, particularly in the later '80s, implying that the full burden of cost increases would not have been passed on to the customer.

More telling evidence is provided by the scale curves, exhibits 6.1-6.5 in the appendix graphs, which show the real unit costs and unit revenues (deflated by the WPI for semi-finished steel)over time. The graphs demonstrate (it should be noted that they are drawn to different scales) that there is some decline in real costs over time, although this would be less obvious if we were to deflate by WPI of vehicles (after 1981, WPI of vehicles is much lower than that of steel). In any case, our view is that steel price is a better deflator of costs since it is an input into production, whereas the vehicle price index would subsume all effects of input costs, scale economies and even profit margins. The narrowing of real profit margins per vehicle is also evident from the declining gap between the price and cost curves, particularly since 1984 for Telco and ALL, and since 1982 for M&M and BTL.

ALL's real costs declined from Rs. 0.85 lakhs to 0.70 lakhs over 1977-87, after increasing initially to Rs. 1.02 lakhs in 1981, and do not appear to have any relationship with capacity. Over 1977-81, capacity rose from 9500 to 19500, but costs increased. In 1982, capacity increased by another 1000 vehicles, and cost plummeted to 0.74 lakhs, and even nominal costs declined. In part, this decline may have been a one year lagged response to the large capacity increase in 1981, but also to considerable belt-tightening after its expansion plans went awry in the early 1980s. Again, capacity increased to 23,000 in 1983, and stayed at that level, but costs first went down and then up again. Moreover, these costs also do not appear to be related to capacity utilization in any systematic way. All this reflects the lack of any substantial automation effort i.e. a change in technique of production (which may conceivably have reduced unit costs), the low share of "fixed" costs[1] in total operating costs (12-17%), and the influence of other factors (including scale and scope economies of supplier firms, bargaining with suppliers,

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1.Fixed costs include wages and salaries, depreciation, and other expenses such as rent, repairs and insurance.

wages to employees etc.) on costs.

On the other hand, Telco's costs appear to be more responsive to scale as well as to capacity utilization. In 1978, there was a major increase in capacity, from 29160 to 38160 units which coincided with a cost increase but was followed by a cost decline in 1979. Given the sizeable increase in capacity as well as output, Telco introduced transferlines for machining cylinder head castings in 1978-79. This would have helped to reduce unit costs. Similarly, a smaller capacity increase in 1981 followed the same cycle of increase and decline, and also occurred in 1983, 1985 and 1987. In all these years, there was also a decline in capacity utilization as compared to the previous year, usually followed by an increase. This means that organizationally Telco took about a year to respond to capacity increases or, in other words, its actual capacity (on a two shift basis) was somewhat lower than that indicated in the years of capacity increase. Fixed costs over the period were, not surprisingly, much higher than ALL, falling between 17-24%. The general degree of automation was higher than any other firm, including dedicated assets such as SPMs and transfer lines (which are very scale-sensitive).

In the case of the LCV firms, the unit costs of the relatively more automated firm, BTL, declined from Rs. 0.35 lakhs in 1977 to 0.24 in 1986 but went up to 0.30 in 1987 (on account of large capital expenditures for its new vehicle). There are similar orders of decline in M&M and SMPIL - 0.41 to 0.29, then up to 0.34 in M&M in 1977, 1985 and 1987, and 0.42 to 0.30 over 1977-86 in SMPIL. In BTL, the level of fixed costs is 15-20%, as compared to 20-28% in SMPIL and M&M. This means that there are greater potential economies of spreading fixed costs in the latter firms. These high fixed costs arise mainly from the large wages and salaries bill, owing in turn to high average salaries in M&M, and a large labour force in SMPIL (which to a large extent is used as a substitute for capital). Between M&M and SMPIL, the latter shows relatively more sensitivity to scale because this is greater at the margin at the very low levels of production of SMPIL. Also, M&M's production and capacity figures include tractors, which does not impart much production economies for jeep/LCV production, implying that M&M's total capacity is an overestimate of its scale for present purposes.

Some very simple, univariate regressions will substantiate the above discussion. Table A.6.8 shows that the influence of scale (as given by overall weighted production) on unit deflated costs is negative and significant for all firms except ALL, where it is negative but not significant (equation 1). Similarly capacity utilization has a negative and significant influence on unit deflated costs for M&M, SMPIL, and Telco, where fixed costs are high, but positive and significant for ALL and BTL, where fixed costs are low (which effectively implies that capacity utilization is not important) (equation2). Finally, if we regress "capacity" unit costs, i.e. unit fixed costs scaled up or down on the assumption of 100% capacity utilization and then added to unit variable costs, on weighted production, the results are the same as in the first equation (equation 3).

In other words, we are distinguishing explicitly between the fixed cost or indivisibility effect, and the other effects of scale such as change in technique. In ALL, fixed costs are low and the technique is mainly GPM oriented. Also, the low level of VI means that the benefits of scale may go to the supplying firms which may not pass the same on to ALL. All these factors would account for the results in A.6.8. On the other hand, SMPIL uses even more low-volume technology, but its fixed costs are high, making it scale-sensitive. Telco has both high fixed costs and scale-intensive equipment. BTL has low fixed costs, but more scale-intensive machinery than all firms except Telco. M&M has high fixed costs, and the techniques are not very scale-sensitive.

Thus, all firms except ALL have shown themselves to be scale-sensitive. Even so, real costs have declined in all firms, irrespective of the techniques of production or the degree of fixed costs. On the basis of the available evidence, it is not possible to state that the firms with low volume technology showed a lower percentage decline in unit costs as compared to the higher volume technology firms, as predicted in Figure 2.1. However, at higher scales of output (0_1 or 0_2 in Figure 2.1). Telco and BTL may enjoy proportionally greater cost declines because the required additional investments will be relatively lower. For example, we learnt that BTL needs to operate its transferline for machining cylinder blocks for its Mercedes-Benz engine only twice a month, implying tremendous excess capacity. Here, higher output would reduce unit fixed

costs as well as marginal costs. Thus, there is structural underutilization in capacity owing to mismatch in capacities between different machines, and this applies to Telco as well.

Over time, deflated unit revenues (real price) tend to follow a very similar path to unit costs. However, the gap between these two curves (profits per unit) has declined, particularly after 1983 for ALL and Telco, and 1982 for BTL, M&M and SMPIL. In addition, in SMPIL, unit profits were very low over 1977-79 as well. Thus, real prices have declined more than real costs over time for all firms.

Inter-firm Comparisons

We now turn to the subject of inter-firm comparisons, where a great deal of circumspection is required. For the MHCV firms, the overwhelming part of the production over the period under consideration was of one basic model in each case - the 1210 for Telco and the Comet for ALL - which also happen to be comparable and competing products. However, Gold's other condition (ch. 2) - similar levels of VI - is not met. In this context, it may not be inappropriate to assume, on balance, no cost advantage to either firm arising from differences in levels and patterns of VI (see ch.5). Moreover, many important scale economies arise from overall firm size rather than any particular process/unit. As we shall see, these latter economies (such as marketing) predominate in the current situation.

Except in 1977 and 1978, ALL's real unit costs exceed Telco's, as table A.6.9 shows, but real unit prices exceed Telco's for the entire period, which accords with the evidence (ch. 3) that actual ALL prices were almost always greater than Telco. As in chapter 5, however, we need to remember that ALL's over-designed vehicle is a little more expensive to produce. Moreover, ALL's product mix has a greater proportion of heavier vehicles, as well a greater diversity of vehicles. Both these factors imply that actual cost differences between ALL and Telco, if any, may not amount to very much, particularly since 1986, when Telco began producing LCVs and which bias Telco's cost downwards (as compared to ALL). In any case, even if these factors are not taken into account, the cost gap between ALL and Telco has narrowed since 1983.

The other point concerns profits. As A.6.9 shows, ALL has consistently enjoyed much higher profits per unit of output than Telco, often twice that of the latter. This is a very important finding, for it shows up the difference between the two firms in a classic sense - ALL has a low-volume - high margin strategy , whereas Telco has a high-volume-low-margin strategy. Since profits per unit of sales are on an average the same for both companies (see PBIT/Sales in A.3.7), high profits per vehicle in ALL imply higher prices, which can also be seen from A.6.9.[1] In part, this is because ALL produces a proportionately much larger number of premium vehicles (such as double deckers, multi-axles, special application etc.) than Telco, the profit margins on which are much higher than the ordinary MHCVs.[2] Quantitatively, however, such vehicles account for no more than 5-10% of total ALL output; therefore the other explanation for higher unit profits must rest on an exercise of some oligopoly power in a duopolistic environment characterised by excess demand until 1983. Even after 1983, though margins have declined, they were still much higher than Telco's (which also declined). This has been possible because neither of the two companies pursued an aggressive marketing or pricing strategy (except in more recent times), both having their respective geographic and product strengths, and which allowed ALL to charge somewhat higher prices. Telco, on the other hand, pursued a high growth objective, and was content with relatively lower unit profits. However, even in Telco's case, the unit profits declined substantially after 1983, which implies that it was also making some oligopolistic or "excess" profits prior to 1984. In fact, its profits per vehicle declined so much that it had to rely heavily on "other income" to bolster its overall profits.

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1. $\pi/R = \pi/Q.1/P$. If π/R is the same, and π/Q is higher, 1/P must be lower, or P must be higher. Although π in A.3.7 is not the same as π as used in our scale curves, but the profit-price relationship mentioned has been empirically verified. However, if the difference was only higher prices, ALL's PBIT/Sales ratio would have been higher than Telco's. Telco's PBIT/Sales ratio increases because of its much greater proportion of "other income" as a percentage of sales (2% in Telco, 0.2% in ALL in 1987). In other words, ALL makes much greater profit per rupee of product sales as compared to Telco.

2.ALL sells about 50% of its output as bus chassis, whereas for Telco the ratio is about 25%. There is no evidence that percentage profit on a bus chassis (the same as for the truck essentially) is higher, unless the buyers demand fully built up buses, which they occasionally do. This may contribute in a small way to ALL's higher margins per vehicle.

Amongst the LCV firms, the product mix is more heterogenous, although the degrees of integration are more comparable. We have weighted the M&M output in jeep equivalents (whose price is quite close to but usually slightly lower than its LCV price), and SMPIL and BTL in LCV equivalents, and tried to make some broad comparisons. BTL has the lowest unit costs, and usually but not always lowest unit prices (its actual market prices of comparable vehicles were usually the lowest), SMPIL being lower in 1981, 1982 and 1985. SMPIL's unit prices as well as actual market prices were lower than M&M. This brings out rather forcefully, since SMPIL is a very small firm, the unimportance of relative scale in explaining relative unit costs in the situation being analysed, where SMPIL has used technology suitable to its scale of production, and where "time economies" were realised by all firms since models were changed very infrequently.

Another possible reason for lack of scale economies may be the impact of size on wages. In India, large work forces tend to be highly unionized and involved in political activity, resulting in higher wages and benefits for them. Of course, the relationship between firm size and wages is not monotonic, especially once a minimum size is reached. Table A.3.9 shows that SMPIL and BTL, whose work forces did not exceed 5000 throughout the period, had the lowest average wages. This in turn would have created a greater incentive for them to substitute cheap labour for capital, and to delay capital investments, an incentive that SMPIL and BTL (to a lesser extent) made use of. ALL, situated in the same area as SMPIL (so that locational factors do not play a part), but with a work force three times as large, paid its workers an average of 40% more than SMPIL over the period. Of the two largest firms, M&M and Telco, M&M has higher wages although its work force is less than half of Telco's 36250 (1988), owing primarily to its location in Bombay.[1] Overall,ceteris paribus, size of work force and wages tend to be positively related.

In terms of profits, SMPIL's extremely low margins per vehicle (even negative on two occasions) reflect a survival strategy i.e. low-volume-low-margin, since it was trying hard to maintain

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1.Besides size and location, another influence on wages is the average level of employee skills. Moreover, growth-oriented companies like Telco may be willing to pay higher wages /wage increases in order to retain employees.

and improve upon its output. Nevertheless, a very low asset base, alongwith some receipts under "other income" enabled it to earn a respectable rate of return on capital. BTL, on the other hand, being in a position of strength, enjoyed very high unit profits which, as a percentage of unit prices, usually varied between 11-17% which is even higher than 11-13% in the case of ALL. This was possible inspite of BTL's having the lowest market prices, which is a reflection of its relative efficiency; but it also used its position to extract high profits since it could have chosen to price much lower and still earn handsome profits. Its strategy may be termed as (relatively) high-volume-high-margins.

M&M, which had a virtual monopoly in its main product (jeeps) until 1985, opted for much lower markups than BTL, unit profits/prices varying between 7-9% and around 4% since 1985. Much more than Telco, M&M can be questioned about the monopolistic element in its profits prior to 1985.

Thus, BTL, ALL and M&M, in that order, had the highest percentage markups on their vehicles, but in BTL's case this was partially mitigated by the fact that its prices were the lowest in its class. Telco's markups were much lower; moreover, it was priced cheaper than its competitor. For all these firms, but to a far lesser extent in the case of Telco, profit margins per vehicle embodied an element of oligopolistic price setting. In the second half of the 80s, increasing competitive pressure forced the firms to spend more on modernisation and product development, and price increases were also relatively muted, all of which contributed to lower profit margins.

Profitability

We saw that scale considerations have not played an important role in determining costs. However, at least in the case of one firm, SMPIL, profits may have been affected. Its small size and high fixed costs meant that it was under constant pressure to improve capacity utilization, which it sought to do by keeping its markups per vehicle very low. Its low scale prevented it from promoting its sales beyond a regional level. This is turn made it difficult to increase output beyond a point. Its modernisation was also constrained since it would have meant amortizing its

investments over a low scale of output. However, this low level of modernization and investment was sufficient for SMPIL to maintain a certain level of domestic sales upto the mid 80s, thus making it domestically competitive in its geographic niche at that point of time. This also meant that its low profits per vehicle and per unit of sales translated into a much more respectable rate of return on capital. None of the other firms had to function under such severe constraints as SMPIL. Not surprisingly, SMPIL was the hardest hit by the wave of new competition from the Japanese LCVs since 1985.

Caveats

There are, of course, many non-scale related factors that influence unit costs. However, unless these systematically influence costs in a particular direction, our ten-year time span of comparison is sufficient so as not to allow unsystematic influences to bias the conclusions. One systematic influence is product variety, which biases costs upwards as compared to firms with less variety (ALL has greater variety than Telco). The other is the degree of sub-contracting to SSI, which should reduce cost (ALL has more of this than Telco, but Telco's increased substantially in the 80s). On the whole, assuming that different degrees of VI do not give either firm a production cost advantage (they would still influence overall size of firm and hence non-production economies), ALL's costs are upward-biased as compared to Telco. Such problems do not arise in the inter-firm LCV comparisons, because the results are very clear-cut viz. SMPIL's costs are lower than the much larger M&M (even though the unit costs are in jeep equivalents, which is slightly lower priced than M&M's LCVs), and BTL, with greater product variety than the others, is still the lowest cost producer.

Lastly, it needs to be remembered that we are comparing firms, most of which are multi-plant. However, while Telco's and M&M's plants are established and working at capacity, ALL's and BTL's newer locations are not yet fully operationalised or working to capacity. This, beyond the usual notion of "capacity", could bias ALL's and BTL's costs upwards, since much of the land is lying idle.

Productivity

Vehicle Per Employee

We saw that productivity in terms of vehicles per man was lower in MHCV firms as compared to LCVs (ch.3). This is because a heavier and larger vehicle requires more people for assembly, material handling, machining etc (ch.2), notwithstanding the fact that Indian MHCV firms have higher capital assets per employee. At the same time, labour expenditure as a share of vehicle cost is higher in M&M and SMPIL as compared even to an integrated firm like Telco because material costs are much higher in MHCV firms, which reduces the share of other factors like labour and capital. In other words, in terms of costs, the capital-labour ratio is higher and labour-output ratio lower in MHCVs, but the labour-output ratio in physical units is higher than in LCVs.

Between the LCV firms, M&M's productivity in terms of vehicles per man is the highest upto 1984, since its tractors (which are included in the overall figure) require a lesser number of workers per unit than LCVs; and because BTL was providing a much larger share of its vehicles as fully built up, which also requires more labour. Finally, M&M employed more capital (in a financial sense) per unit of labour, again upto 1984 (but this did not mean that it was more automated). After 1984, some of the important process changes initiated in BTL, particularly the transferline and CNC operations (also coinciding with a sharp increase in the ratio of assets per employee) began to make an impact, leading to a doubling of adjusted weighted productivity from 2.8 in 1983 to 5.6 in 1987. SMPIL, expectedly, has a very low productivity, since it has consciously adopted a policy of using human skills to the maximum extent possible, and its adjusted productivity is often even lower than Telco's; moreover, it also supplied a number of its vehicles in fully built up form.

Between ALL and Telco, the latter's productivity (adjusted for VI) is always higher, and the gap has widened over time, owing to Telco's greater automation and more regular and judicious investments over time, as well as ALL's expansion programme beginning 1980 which increased

employment but anticipated demand did not materialise. Also, given the technology that it employs, as well as its high degree of buying in, ALL requires a lot of quality control staff, which do not add directly to production, but instead reduce productivity per man. Moreover, productivity is reduced by the production of a larger percentage of super heavy-duty vehicles. But Telco's productivity is also biased downwards since it employs a large number of people at its machine tool division, which does not get corrected in our standardisation for VI because that takes care of only current and not capital inputs. Also, Telco has substantial number of employees in its training division as well as in social welfare activities, much more than in other companies.

Within Telco, there are major differences between its Pune and Jamshedpur works, each of which have a higher turnover than the other companies. In 1989, both plants produced around 30,000 vehicles but per worker productivity was 2.47 in Pune and 1.37 in Jamshedpur (2.07 and 1.06 in 1987). Notwithstanding some bias because Pune produces a relatively lighter mix of vehicles, and is also less integrated, the difference in productivity highlights an important problem in India - the difficulty of shedding labour. This problem is usually more severe the older a firm is, and the more integrated its plant. Jamshedpur is not only the most integrated, but is one of the oldest automotive plants in India.

Over-Manning

In our study, both Telco and ALL were found to be over-manned firms, given the existing levels of technology in the two firms. In ALL, weighted output rose from 15107 in 1984 to 17279 in 1987 (19038 in 1988), while employment declined from 10900 to 10668 (10728 in 1988). Excess employment was created by the capacity upsurge over 1980-83. Similarly, in Telco, weighted production rose from 46306 in 1983 to 59033 in 1988, while employment declined from a peak of 40382 to 36250. Here, the level of employment is partly a historical legacy which, in the context of the levels of technology adopted by Telco in the 80s, was rendered surplus.

On the other hand, the LCV firms were clearly not over-manned on their own terms, since employment increased regularly in M&M and SMPIL, and rose in BTL as well albeit in a fluctuating manner. THis results in exaggeration of the differences in vehicle productivity between MHCV and LCV firms in the 80s.

A related problem in inter-firm as well as inter-temporal comparisons of productivity arises from capacity utilization. If we adjust for capacity utilization, we would get a measure of output per unit of labour time spent rather than of output per worker. However, capacity is defined primarily with respect to machinery, and even that is highly subjective. The labour complement is usually added with a lag, and may not be added at all if demand slackens. For example, in BTL, installed capacity was constant at 15000 vehicles over 1981-84, but employment varied every year, between 3995 and 4742. Similarly, in Telco after 1983, employment was declining every year owing to natural attrition at the same time as capacity was rising. In other words, it is difficult to relate capacity under-utilization to labour under-utilization in an accurate way, and therefore does not permit of an adjustment of productivity figures to get an estimate of output per labour time. But the problem does make us aware that, for example, output per labour time in ALL is somewhat higher than indicated in unadjusted figures, since after 1982 ALL's capacity utilization was very low. Moreover, in the comparison between BTL and M&M, M&M's very high utilization rate (108-136% over 1979-85, implying that the third shift would have been used often) also contributed to its higher productivity upto 1984. BTL's utilization rate over 1980-87 was only 68-85%.

Finally, in the 70s, ALL's productivity vis-a-vis Telco may have been affected by its greater product complexity, including a greater variety of models and a much larger proportion of super heavy-duty vehicles (which require more manpower per vehicle). The former factor viz. product diversity would be operative only if capacity was fully stretched, which was certainly not the case when capacity utilization was very low and employment was declining since 1983.

IMPACT ON QUALITY, EXPORTS AND TECHNOLOGICAL CHANGE

The process technology influences and is influenced by product technology. More flexible processes allow greater changes in products (see ch. 8). This meant that ALL could introduce a greater variety of products (including super heavy-duty vehicles) than Telco at least upto the mid 80s, and was one reason for its higher unit profits per vehicle. Even a very small firm like SMPIL was able to introduce some product variations on account of its very flexible (GPM) processes, enabling it to retain its market share (upto 1984).

In terms of market perceptions, functional quality of competing ALL and Telco products is comparable. ALL achieves this through a very strict QC process implemented by a very large QC staff, and it is reputed to have one of the finest QC departments in the Indian engineering industry. Telco's emphasis on quality needs no repetition, coming as it does from relatively high automation and sophisticated testing equipment, high VI and, notwithstanding these, a large QC staff. In terms of fit and finish, Telco scores over ALL, one reason being its larger output which enables it to mass produce many external components, most notable being the pressed sheet metal cowl.

In comparison, LCVs manufactured by BTL, SMPIL and M&M do not enjoy the same reputation for durability and quality. Part of the reason for this is the relative lack of attention by LCV firms to QC . This is also evidenced in the negligible exports of these LCVs, as compared to the relatively high exports of MHCVs. Of course, there are many, more important reasons for Indian MHCV being more exportable (ch. 4), relating primarily to product technology.

Besides better vehicle finish, Telco's greater export-intensity vis-a-vis ALL can also be ascribed to scale economies in marketing. Being a much larger firm, Telco can afford the fixed costs of a wider overseas presence, both for promotional purposes as well as for after-sales services. It has 30-40 personnel located abroad, and more than 10 go on regular assignments. In addition, being part of the Tata group, it gets the benefit of market promotion through Tata Exports, which has six overseas offices and to which Telco executives are also deputed. Such facilities are not available to ALL.

DISECONOMIES OF SCALE

Other than the evidence that wages tend to be higher in larger firms, we have not found any systematic diseconomies phenomenon prevailing in the CV industry. In order to keep wages down, but perhaps more importantly to check the strength of labour unions, companies may opt for multi-plant operations, even when their existing plants may not be large enough to allow sufficient scale economies. The decisions of M&M, ALL and BTL to opt for multi-plant operations may have been influenced by these factors and the hope of beginning a new "work culture"; but partly also by the advantage of "backward area" operations, wherein capital, power, etc. are available at concessional rates, labour is any case cheaper, and sales tax rates are lower. An added advantage is of not putting all the "eggs in one basket", a big plus in an environment where all firms have suffered from long strikes. On balance, therefore, multi-plant operations are unlikely to have handicapped firms, even if their primary motive was to avoid high wages and labour militancy.

If it is reasonable to say that only a growth-oriented firm can have grown to a reasonably large size, as is clearly the case for Telco, then diseconomies of growth can also be brought in here. In the Indian context, a faster growing firm had more difficulty in obtaining licenses and imports when needed (see Krueger 1975,pp. 25-27, and our ch.5). As we have seen, it required to keep a buffer stock of inventories, which was the price it had to pay for its objective of high growth. After 1983, this particular diseconomy has become less important.

Going by the notion that none of the CV firms has reached the upward sloping part of their cost curves, we might say that on balance, scale economies predominate over any possible diseconomies. In fact, most of them are very far from the threshold level of production, beyond which the curve may flatten out. Only Telco alone may have reached a size and stage where its functional or U-form structure may impose too great a burden on its functional heads.[1] Accord-

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1.See Williamson (1985), pp 279-81 for a discussion on U-form and M-form modes.

ing to its new chief executive, Telco may have to adapt itself to more of a multi-divisional structure, since its product profile has changed since 1986. This may also mean that the Pune Factory would concentrate on LCVs and cars, and Jamshedpur on MHCVs.[1] Somewhat different is the case of BTL. Although a relatively small firm, it has a very top-heavy decision-making structure. This will need to change as the company grows, and more systems-oriented management practices may need to be introduced.

INTERNATIONAL COMPARISONS

We have seen that in the protected domestic environment, all the firms, including SMPIL, managed to produce at competitive cost. But only the MHCV firms (and M&M in Jeeps) were export competitive, in a limited way. We shall make an international comparison of scale-related factors in order to understand the extent to which they are responsible.

Economies of Scale and Scope, and Prices

We have observed that while MHCV production conforms to world scales, LCVs are produced at very low levels. In addition, all major international LCV manufacturers also produce passenger cars, the lack of which handicaps further the Indian LCV procedures. On the other hand, there is no single pattern in the world of MHCVs, since there exist internationally competitive firms which are highly specialized and make only MHCVs, those that make the full range of four-wheeled automotive products, and those whose MHCV production forms only a part of its diversified but synergestic product range. At the same time, it is true that the larger MHCV manufacturers, who are also more diversified (both in auto and non-auto), are putting increasing pressure on the specialized manufacturers through their lower unit cost and increasing product range.

Indian firms have enjoyed economies of scope to a limited extent. All the three LCV firms

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1.See interview of Ratan Tata, who took over as Chairman in 1989, in Business World, January 3-16, 1990.

produce either jeeps or cars. SMPIL, in fact, started off as a car producer, but had faded out in that segment by the mid 70s. In 1983-84, a new collaboration was signed for manufacture of the Austin Rover Saloon, 1520 of which were produced in 1985-86 (18 months). SMPIL's GPM-oriented technology has made it possible to use the existing facilities for machining the engine and other parts of the car. The choice of the up-market car was in keeping with SMPIL's capability in low-volume production, also enabling it to charge higher markups than if it were competing in the standard car market. BTL, which produced three and four wheeled LCVs, has started making the "Traveller" (new LCV) and the "Trax" (jeep-type vehicle), both of which use the existing Daimler-Benz engine. In the Trax, 60-70% of the parts are the same as the Matador, including the frame and the power train. Hand fabricated rather than pressed sheet metal is used in order to make up for lack of scale in Trax production.

M&M, like SMPIL, did not begin with LCVs. Its major output is Jeeps, with which the LCV has enjoyed some synergy. The FC-150, an LCV launched in 1965, was basically a forward control jeep, and the 1981-launched NC series was a jeep with an extended wheelbase. M&M's Peugeot diesel engine is used on a wide range of its vehicles, including jeeps, extended jeeps, and LCVs. Some synergies are also enjoyed with tractor production, as in 1973 when the tractor (diesel) engine was converted into a high speed engine for use in LCVs. However, these substantial potential synergies for M&M LCVs do not get reflected in their costs which are higher than both SMPIL and BTL, proving again that economies of scale in production have not been important thus far. The most important synergy is in the realm of marketing where M&M uses common dealers for LCVs and jeeps , reducing distribution costs for the former and giving it a very large market spread. This marketing synergy has in fact helped M&M to maintain a market presence in LCVs inspite of sustained pressure from newer generation LCVs.

In ALL, economies of scope arise from within the MHCV range rather than from non-MHCV production. It uses flexible, mainly GPM technology to manufacture a range of 6-cylinder engines, of which it produces greater variety than Telco. The recent collaboration with Hino also seeks to produce a range of 4-and 6-cylinder engines sharing common bore and stroke and capa-

ble of manufacture in the same production facility.

Until 1986, Telco's scope economies also arose from within MHCVs. Economies of scope have become an important issue for this highly integrated company since the mid 80s, when demand has become a constraint. Its machine tool division, of course, is always in use to make new machines and recondition and change existing ones. Casting and forging facilities also enjoy general usage with changes in dies and moulds. But for the other operations, the company has to make special efforts to utilise all its facilities and dies. Thus, it has sought to commonalise parts as far as possible, as in the 807 (8 tons) and 1210, and the 407 and 608 LCVs (where the cabs are identical). Overall, Telco has five basic engine types, which are offered in vehicles ranging from 2 tons GVW to tractor-trailers. The venture into LCVs in 1986 was part of a longer-run programme to derive greater economies of scope, since growth in MHCVs was perceived to be limited. However, production commonalities between LCVs and MHCVs are limited. Telco also has plans to enter the passenger car market.

As compared to international CV manufacturers, Indian firms are generally less diversified, whether it is in auto or non-auto fields. Moreover, the production of the secondary product is not large enough (except in M&M's case) to allow significant potential economies. None of this has prevented Indian MHCVs, whose scales are large, from being price competitive and exporting to developing countries. Even the LCVs were price competitive, although less so), but their specifications and quality are not acceptable abroad. The lack of economies of scope may be felt more keenly in areas such as R&D and marketing, where large firm size is an asset, and this is also true for Indian MHCV firms.

Productivity and Wages

Table A.6.10 shows the productivity, in terms of vehicles per employee, of some leading international firms. The figures for MAN, Daimler-Benz, Hino and Nissan Diesel are underestimates because they produce a larger proportion of over 16 ton vehicles as compared to Indian firms. This is particularly true for MAN, 72% of whose output was over 16 ton trucks or articu-

lated units, and explains its low productivity of 1.03. Another reason for bias is that product variety in Indian firms is much lower, and batch size (production of one lot) is much larger. These biases may be somewhat mitigated because of over-manning in Indian MHCV firms. Overall, Indian firms' productivity is not more than 20-30% that of the efficient Japanese companies in the MHCV sector, and only 6-14% in the case of LCV firms. The gap is much wider for LCVs because of the use of highly automated techniques in production of LCVs and cars (LCV firms also make cars), and wipes out completely the wage cost advantage to Indian firms (assuming Indian wages to be 8-10% of Japanese levels). On the other hand, automation is less widespread in MHCVs, and Indian firms do enjoy a net advantage of lower wages after allowing for lower productivity. This would imply that cheap labour has been a source of international price competitiveness for Indian MHCV firms, but not so for LCVs, where automation has reduced substantially the number of workers in the production process. In LCVs, the observed price competitiveness of Indian firms is due to the lack of investment in new products and processes, which reduces the capital element in cost very substantially. Unlike MHCVs, however, this price competitiveness does not translate into export competitiveness.

SYNTHESIS AND PROSPECTS

Until the mid 80s, the different strategies relating to modernization, scale, production processes etc. did not significantly affect the domestic market shares of different firms. To an extent, all the firms relied on "over-engineering", which implies a delay in introduction of new and more efficient technologies owing to the availability of low-cost engineering skills (Teitel 1984). However, Telco, inspite of being overmanned, was the quickest and most regular investor in new technology, and had a relatively dedicated production set-up. SMPIL, the smallest firm, delayed investment and modernization as long as possible, banking on very cheap but skilled labour to produce output of acceptable quality. BTL, a very cost conscious firm, modernized selectively the more important processes at low cost, partly via imports of plants that were redundant (but still useful) in their countries of origin. At the same time, it also made use of very cheap labour,

most of which was "temporary" (69% of total employees in 1987), and was the only firm to be able to keep such a high proportion of daily wage workers. Thus, it minimized capital cost but was still relatively more automated than other firms (except Telco) where it mattered. ALL, competing with a high-volume and quality conscious competitor, chose the alternative path of flexible production with high reliance on human engineering skills, coupled with a very strict quality control process. M&M, though a relatively large-volume producer of jeeps, opted, in the main, a cautious attitude of batch-production, GPM-oriented technology, inspite of being faced with the most expensive labour force amongst the five firms. This of course enabled it to maximise possible synergies between its different product lines viz., jeeps, LCVs and tractors, although this did not result in lower costs of LCVs as compared to competitors.

> Thus, there may have existed a kind of notional 'evolutionary equilibria' in the sense that a variety of firms and plants coexist at roughly similar levels of economic performance, by exploiting more economies of scale with less flexibility, more economies of scope and lesser economies of scale, and so on (Dosi 1988, p. 155).

This is particularly true for the MHCV segment. On the whole, relative scales of production have not been very important in explaining inter-firm unit cost differences, particularly in the LCV sector. In the MHCV segment, Telco may have enjoyed some unit cost advantage over ALL because of its scale, but this may not be very much after ALL's heavier product mix and more material-intensive product is taken into account.

Over time, as production and capacity increased, all firms have realised scale economies (i.e. real unit costs have declined) even where, as in SMPIL, capacity expansion essentially meant a duplication in existing facilities. This implies that scale economies arose not so much from change in techniques of production, as from spreading of fixed costs such as labour and the network of dealers and from increases in specialization.[1]

One of the most important scale economies so far has been that of marketing and dealership.

1.The limitations of the "learning curve" concept, which attributes improvements in performance to accumulated experience, have been pointed out by Gold (1981) (see ch.2). We have therefore not attributed any scale economies to "learning", although it may have had some impact.

These costs are included in our "scale curves", and although data on them is not separately available, we know that their incidence per unit of output declines significantly as output increases.[1] Even more importantly, marketing synergies explain the widespread dealer network for Telco and M&M LCVs, for both of whom LCVs are secondary products. In the absence of their respective main product lines, Telco and M&M could certainly not have afforded such an extensive network for LCVs alone. Moreover, economies of scope also arise, in the case of multi-product firms, from cross-product subsidising (as Telco did initially for its LCVs), enabling them to gain a foothold in the market. These cross-subsidies can in general be made by any firm introducing new products, even in the same market segment. Large scale is an asset here, since per unit losses in the subsidised product can be spread over larger volumes - an instance is BTL's Traveller, subsidised by its mainstay, the Matador.

Although relative production scales did not have a major impact on relative unit costs for different firms, they did affect unit profits per vehicle in the case of SMPIL, whose sales were limited by the localized nature of its dealer network. Its very low scale prevented any sizeable increase in its dealership, and forced it to accept very low margins in the face of (limited) competition from BTL's Matador, a cheaper vehicle with a better finish. In a relative sense, ALL also could not afford as wide a dealer network as Telco. But unlike SMPIL, it was strongly entrenched in certain markets (buses and premium vehicles), a position which enabled it to carry out its strategy of extracting high margins. In the case of ALL, as well as for all other firms (save SMPIL), there was an element of oligopolistic pricing, which was however much more muted in the case of Telco, who pursued a high-volume-low-margin strategy. Moreover, in this environment of limited competition, greater investment appeared to reduce profitability per unit of capital - e.g., Telco (usually) had a higher π_s but lower π_c than ALL; SMPIL whose π_s was lowest of all firms, had higher π_c than ALL and Telco from 1980/81 - 1984/85 (this is also consistent with the negative sign of the "modernization" and "capital-revenue ratio" variables in the π_c

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1.For example, none of the firms has increased its dealer network in proportion to the increase in the number of vehicles sold.

equations in appendix 2).

Change in Behaviour and Strategies: the Eighties

By 1981, it was clear that the boom in MHCV demand was over. In LCVs, the entry of many new firms with latest technology was on the cards. By 1984/85, the entire CV market had altered from a sellers' to a buyers' market. To meet this new situation, all firms embarked on major investment programmes. In all cases, except possibly Telco, this reduced profits per unit of capital (A.3.8). The lack of erosion in Telco's π_c indicates that its investment programme had followed a "correct" path, since its investment strategy (that of a regular and steady rate of investment) was competitive in the changed situation as well. In the case of all other firms, there was a spurt in investment at different points in the 1980s.

It was not only the denominator (capital) that was affected in the new scenario. The profit margin itself (i.e. unit profit per vehicle) came under pressure owing to the more competitive conditions, after 1982/83. In other words, price increases were less than cost increases for all firms. Gradually, pricing of output has begun to emerge as a tool of competitive strategy. Even the market and price leader in LCVs, BTL, has felt that "the input cost has increased substantially and yet the selling prices could not be increased to meet the competition and maintain the optimum production.[1] Similarly, the MHCV leader, Telco, increased its prices in December 1986 by only 5% inspite of much larger increases in overall costs.[2] At the same time, its rival ALL became much more aggressive in its pricing and narrowed the gap between the prices of their respective main product - over 1980-85, its AL 3/1 176" was 3-19% more expensive than Telco's 1210 SE/42; w.e.f. 1986, the gap was usually less than 1% and since January 1989 the ALL price has been consistently lower. Telco has allowed this to happen since it was keen on recouping the development costs of its LCV line of products. For ALL, this price restraint was

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1.BTL Annual Report, 1986-87.

2.Telco Annual Report, 1986-87.

accompanied by a boom in its output in the second half of the 1980s, implying that increasing growth and scale may have been taken on board as a corporate objective. This is also indicated by the growing number of Highway Service Centres, particularly in areas where ALL is under-represented, and the stated objective of enlarging the dealer network throughout the country.[1]

In this situation, a firm such as SMPIL would be under severe pressure, since it was already operating on survival margins. However, much more than its profitability, its market share was under threat from new vehicles such as Telco's 407 and Mahindra Nissan's Cabstar. Having a very localized market, it was very vulnerable to efforts by existing as well as new firms to encroach into its territory. M&M's LCV product line was similarly under threat, but its much stronger sales and service network enabled it is better withstand the pressure. In 1984, market shares in the 3-5 ton class were around 25% for both firms; but in 1988, M&M had 16.3%, while SMPIL was down to 5.8% (see A.3.6). Even BTL suffered, but to a much lesser extent (market share down from 49.7% to 41.2%), because its product was cheap and was placed at the lighter end of the 3-5 ton market. In the MHCV market, by contrast, the only completely new product, the Isuzu FVR, has not been a success, leaving Telco and ALL to compete for market shares, albeit in a more competitive and demanding market than before.

The new environment is also more demanding, and increasingly so, in terms of quality and finish of output. This requires investments in modern manufacturing methods, at least in processes where high tolerances are required, as well as in quality testing equipment. New products also require some fresh plant and equipment. All this places a greater burden on small firms such as SMPIL where, moreover, there was a major backlog of modernization. SMPIL's burden could have been reduced if it was less integrated than its competitors, but it was not. It did enjoy one potential advantage, however, in that it began producing an up-market car, where the margins are higher and which would have offset to some extent the burden. However, the car was not a success, and therefore could not play this role. The backlog factor also applies to all other

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1.AET, July 1990, pp 21-22.

LCV firms and ALL. Amongst LCVs, SMPIL, M&M and BTL, in that order, require an upgradation in processes and process control. In the case of M&M, its increasing volumes may even require a transition to at least semi-automatic methods of production in some processes, so that continuous flow could be maintained. Similarly, ALL is also moving towards higher volumes, and needs to add this dimension to its known capabilities for flexibility, possibly by adding a large number of NC and CNC machines. With increasing volumes, GPM-oriented technology becomes a burden, not only in terms of costs but also in terms of its ability to maintain consistency in quality.

Prospects

Until the early 1980s, the firms were pursuing essentially "equivalent" strategies in the sense that irrespective of their chosen strategies, they enjoyed relative stability in market shares, and were earning reasonable to high profits. If the post-1983 period is any guide, firms were making excessive profits prior to that, and most were also under-investing in modernization, relying instead on "over-engineering". Firms that were closer to the "right" strategies earlier will have a lesser backlog of work (such as Telco, and BTL relative to M&M, and SMPIL) and will be better able to prevent an erosion in their competitiveness. Some, like SMPIL, have found it difficult to survive, as evident from its lockout since February 1989. Moreover, as scales increase further, Telco and BTL, who have made investments in volume-sensitive technology, may enjoy proportionately greater cost reductions than their competitors.

International competitiveness, however, demands much more than has happened in the domestic market so far. It is not enough that the CVs are price competitive, since the product specifications (particularly for LCVs) are generally not acceptable overseas. If the products are upgraded then their price will certainly not be competitive in the short run. But there are a number of areas where, if action is taken, both price and quality competitiveness could improve.

High inventories were found to be a general weakness of Indian firms, and, besides macro problems (including a fear of shortage of inputs, which meant that high inventories were some-

times helpful in maintaining or gaining market share), reflect inefficiency in organization and also require more coordinated action with suppliers. Another reflection of inefficiency is the very low levels of labour productivity, owing, inter alia, to over-manning (in turn reflecting poor manning practices, as well as actual excess labour), low investments in physical capital, high inventories and the large number of quality control staff as well as "defect correction" staff.

The question for Indian firms, as for all other industrializing countries seeking to become global players, is not whether to automate or not, but at what pace and under what conditions. It is clear that the new microelectronic technologies offer real and tangible benefits of quality, increasing flexibility, reduction of labour and working capital inputs, and reduction in waste (material inputs).[1] On the quality question, the new technologies do not permit any delay in adoption or allow any factor substitution. Indeed, Schmitz and Carvalho (1989) show that the new technologies are being used in an incremental way in the two largest car firms in Brazil, with the only short term result being an improvement in quality. Clearly, Indian firms will need to adopt these quality enhancing processes in a much bigger way, which will also help to improve productivity. However, in processes where the same quality can be achieved by a more labour intensive process, the decision to automate or not has to be judged in terms of its impact on costs.

But there is also an issue which goes beyond the impact on immediate costs. Given its demonstrated advantages, there is a need for firms to initiate a learning process with the new technology, so that it can be applied to increasing advantage. In this respect, Telco is way ahead of the other CV firms, and its learning and assimilation have been even faster because of its in-house machine tool division.[2]

We have seen that in the arena of exports, scale has been an important impetus - both for

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1.Schmitz and Carvalho (1989).

2.Schmitz and Carvalho (1989) found that in two of the largest automobile plants in Europe in 1985, the one with in-house supply of (automated) machinery had managed to keep its plant running smoothly. The other plant, which bought in machinery, mainly from abroad, suffered frequent breakdowns, which led it to question the viability of its automated lines.

MHCVs as well as for M&M jeeps. On the other hand, in LCVs, Indian scales are very low which would make marketing very difficult, even if the product was acceptable. Even in MHCVs, the larger firms abroad are expanding their product range and cutting costs. This may also put pressure on Telco and ALL , particularly the smaller ALL which, unlike its small European counterparts, does not have aggregate suppliers on the scale of Bosch, Cummins, Rockwell etc. to buy from.

CHAPTER 7

TECHNOLOGICAL CAPABILITIES, TECHNOLOGICAL STRATEGIES AND TECHNOLOGICAL CHANGE

INTRODUCTION

We shall begin with a quantification of technological change (TC) efforts in terms of inputs such as R&D expenditure, royalty, R&D manpower etc. This will be followed by a description of the nature and extent of TC outputs over the years, and the impact of these on the competitiveness of the firms, particularly on market shares. We shall also analyse the different technological strategies followed, and look at the linkage between in-house and imported technology. We shall find that all the firms have developed R&D capabilities that are not insignificant, particularly in the process of catering to domestic market demand. But in creating vehicles for this market, Indian firms have been ruled out of major overseas markets. Relative to product TC, process TC has been neglected in most firms. The organic linkage between the three issues of technology, vertical integration and manufacturing technology and scale economies will also become apparent during the course of this and the next chapter.

TECHNOLOGICAL EFFORTS

In-house R&D

In terms of R&D expenditure as reported by the companies, Table A.7.1 shows that Telco and BTL are relatively more R&D-oriented. The R&D intensity (R&D/Sales) of Telco exceeds 1% for most of the period 1977-87, peaking at 1.33% in 1986. BTL, whose data is available only w.e.f. 1981, peaked at 1.87% in 1984, but declined continuously to 0.95% by 1987. ALL and

M&M (for the three year data available) have a much lower R&D intensity, 0.21-0.31% for M&M, and 0.15-0.77% for ALL. In SMPIL, 1982-86 data shows considerable variation, between 0.15 and 1.05%.

Absolute levels of R&D expenditure obviously vary widely. Since 1986, Telco has been spending more than Rs.10 crores annually, between five to ten times the expenditure by ALL. In 1988, it employed 753 people including 214 engineers in R&D, most of them in the Engineering Research Centre (ERC) in Pune, one of the most famous in India's industrial establishment. ALL had 242 R&D personnel including 79 engineers. The much greater level of R&D expenditure per R&D employee in Telco reflects greater complementary investments in capital equipment as well as a higher level of R&D activity.

Since 1984, R&D expenditure in BTL shot up substantially and even exceeded that for ALL, varying between Rs. 1.2-1.8 crores. About 140 people were in R&D, of which 45 were engineers. In contrast, R&D expenditure at M&M, a much larger company, appears to be around Rs. 1 crore.[1] R&D employees numbered 66, including 23 engineers. However, according to M&M, this excludes product and process engineering personnel whereas the BTL figures include them, which, however, the latter denies.[2] Including product and process engineering personnel, M&M's R&D employees go up to 201, of which 102 are engineers. Even so, its R&D employees/total employees ratio was only 1.2% on its own terms, whereas for BTL it was 2.9% (1987 figures). In SMPIL, given the small size of the company, absolute R&D expenditure was between Rs.0.06-0.31 crores in the 80s. R&D manpower was 59 strong, including only 6 engineers.

It should be noted that given the low levels of R&D expenditure (in an international sense), absolute outlay becomes more important than R&D propensity when making inter-firm comparisons. We shall return to this point later.

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1. In 1987, Rs.80 lakhs were spent on R&D in the Nasik R&D centre, alongwith capital expenditure of Rs.20-30 lakhs.

2. According to BTL, the figure of 140 R&D personnel excludes process engineering staff.

Technology Imports

Another input into TC is technology import. The balance sheets of the firms give us data on embodied (imports of capital goods) as well as disembodied (royalty and fees for knowhow) imports of technology. In absolute terms, both these are usually higher for Telco as compared to ALL, but when computed as a percentage of sales,[1] the reverse is often true (table A.7.2). We must also keep in mind that much of the technology import for Telco is for its capital goods division, which biases its TECSAL ratio upwards compared to ALL. As we shall see, ALL has used foreign technology to bolster its in-house R&D efforts in order to match Telco's greater R&D capabilities.

BTL's TECSAL ratio is very high, being 7% in 1987, and always exceeds 1%, on account of both royalty payments (when they existed) and capital goods imports. Of the five firms, BTL and SMPIL were the only ones to manufacture entirely new vehicles via collaboration, necessitating large foreign payments. M&M's TECSAL ratio was at its highest (1.4-2.1%) over 1981-84. In absolute terms, its imports of capital goods were on the average greater than BTL's. SMPIL managed with minimal or even zero technology imports until 1980, when it introduced a new engine. Later, when the car project began, its TECSAL ratio rose further, and was as high as 8.1% in 1986. On the whole, BTL's regularly high TECSAL ratio adds to its substantial R&D intensity. M&M has both lower R&D intensity as well as TECSAL ratios. SMPIL's TECSAL ratio was very high in some years in the 1980s, which supplemented its erratic R&D intensity.

International Comparison

High as Telco's and BTL's R&D intensities are in the Indian context, they pale into insignificance when compared to leading international firms (table 2.4), where R&D intensities of 3-4% are the norm. Moreover, even these high intensities are complemented by selective "imports" of

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1. In India, where there is a restriction on the amount of royalty payable, the collaborator may resort to higher pricing on capital goods (Desai 1988). We have therefore lumped together the two forms of technology imports when calculating the technology imports to sales ratio.

technology, either via collaboration with other firms or through licensing agreements.

The higher R&D intensities of foreign firms translate into even higher absolute levels of R&D expenditure. For example, Daimler Benz's automotive R&D expenditure in 1988 was 2 billion DMs ($1.1 billion), including 700 mn DMs in CVs. Total R&D employees were 12665. Other firms such as Volvo, Saab-Scania, Honda and Isuzu spent 955, 493, 1564 and 291 mn dollars respectively, in 1989.[1] This compares with Telco's figures of less than $10 mn alongwith 753 R&D personnel. Since there are substantial economies of scope in R&D, the large foreign firms are in a position to undertake a variety of synergestic R&D projects. Thus, although Telco is a large scale firm in terms of MHCV production, its R&D outlay is insignificant by international standards owing to low unit value realization of CVs, and lack of economies of scope. All the other firms are even further behind. The implications of this for international competitiveness will be spelt out later in the chapter.

TECHNOLOGICAL OUTPUT

There are strong reasons, more so in an IC (industrializing country) firm, why measures of R&D inputs are incomplete and even misleading indicators of TC activity (ch.2). We have pieced together information on major changes in product technology (process technology having been dealt with earlier) in each firm since its inception. The account shows that all the firms have been technologically active, far more than their meagre R&D outlays would lead us to expect. We will begin with the MHCV firms.

Telco began by assembling CVs in 1954 under a 15 year licensing arrangement with Daimler-Benz. Initial concerns with operationalizing the technology and indigenisation gave way to the process of upgrading the vehicle. The company began R&D in 1959 but the R&D Division was formally established in 1966. In 1964, Telco introduced the 1210, increasing the payload from 5 to 7.5 tons, which involved redesigning, in consultation with Daimler-Benz, of all the major

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1. Business Week, April 9, 1990, pp.46-47.

aggregates such as axles and gearbox. This product was a runaway success, and was regularly improved upon over time. In December 1967, the prestigious ERC was established at Pune, which played a very important role in subsequent developments. In 1969, the collaboration with Daimler-Benz ceased, but it continues to hold foreign equity in Telco (of a non-voting variety). The Mercedes-Benz logo was replaced by the "T" of the TATA trademark.

The next logical step for Telco was the improvement of its engine. Perhaps the most significant development in the 70s, it converted the D-B OM 312 pre-combustion chamber engine into the 692 direct injection engine. Introduced in June 1971, this gave a 15% improvement in horsepower alongwith a 15% decline in fuel consumption. This was followed in 1975 by the 1210S, a semi-forward version of the conventional long-nose truck, and resulted in an increase in loading space. In 1977, the 1210E version was produced with a large number of improvements, resulting in an increase in the warranty offered, to 64000 km - the highest in the country at that time. In 1979, it produced a chassis for Tatab, its affiliate company in Malaysia, adapted to timber-carrying needs. The next year the 1516, a new and heavier vehicle (10 ton payload) was put on the market, and which conformed to EEC standards. The greater power required for the 1516 was produced by the OM 352, an engine obtained under a fresh licence from D-B, and came to be known as the 697. Other MHCVs that were developed included the 1312 (a de-rated version of the 1516) and 807 (8.4 ton GVW) in 1982. The latter's engine was a 4 cylinder version of the OM 352. For the heavier vehicles, with a front axle load greater than 5 tons (e.g. the 1516), power-assisted steering becomes necessary, and this was developed in-house by Telco. Turbo-charging technology (which enhances engine power) was purchased from KKK of W.Germany in 1977. All these developments required commensurate changes in aggregates such as gearbox, axle, springs, shackles etc. The gearboxes have been changing continuously over the years, and currently Telco offers a range of synchromesh gearboxes on all its vehicles (some are optional).

None of the vehicles introduced between 1980-85 enjoyed anywhere near the phenomenal success of the 1210. Besides the above-mentioned, these included a foray into developing a rear-engine bus, and other variations such as the 909, 1510, 1612, 707, and 1313. These chasses are

offered in different operations - truck, bus, tipper and tractor-trailer versions. There are also the 610, 713 and 1210 cross-country vehicles with four-wheel drive, intended mainly for the army.

More recent innovations have proved to be more successful. The outstanding example was the 407, a 4.5 ton GVW LCV, which had already occupied 30% of the 3-5 ton market by 1988 (A.3.6). The vehicle, introduced in 1986, was an entirely Telco effort, albeit borrowing freely from existing Daimler-Benz vehicles and concepts. The engine, the 497 SP, was a 4-cylinder version of Telco's 697 engine, and was the only direct injection engine its class, which enabled the 407 to pass the Government's fuel-efficiency tests. The 608 (6 tons) and 206 (2 ton pickup), introduced in 1987 and 1988 respectively were, however, less successful, the former because of competition with more efficient Japanese vehicles, and the latter owing to marketing problems. The 206 has also passed the fuel-efficiency tests, and a left hand drive version been developed for the export market. Other product variants developed in the MHCV class include the 2416 (a multi-axle 24 ton vehicle), the 1616 (an articulated 25 ton GTW), the 1613 (16 ton truck) and the LPO 60 (11.2 metre, 60-seater bus).

Ashok Leyland was a FERA company until 1986, with British Leyland holding over 50% of the equity till 1983, and 46% till 1985. ALL's progress in indigenisation was slower than Telco's, owing to reorganisation of its capital structure,[1] and to the need to adapt the BL technology to low-volume operations. For example, it had to go in for rolled rather than pressed metal frames.

Right from the beginning, ALL adopted a strategy of offering a wide range of MHCVs. The first vehicle to be asembled was the BL Comet, in 1954. By the early 60s, the company had introduced concepts such as articulated trucks, 4x4 trucks, tippers, and heavy duty vehicles, much before Telco did. Subsequently, ALL introduced 203" and 210" wheelbases on the Comet (initial wheelbase was 176") to cater to higher capacity needs of passenger applications. Another first was the introduction of air brakes, in 1966, and currently ALL offers full air brakes on all its

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1. In 1959-60, the indigenous content of the Leyland Comet was 38.5% compared to 64% for the Tata truck. However, by 1966-67, the respective levels were 89% and 93% (TC 1968, pp.132-37).

models. In 1967, the 16 ton Hippo Dumper was offered for off-highway applications.

The product range was widened further in the 70s, with special focus on developing a comprehensive range of passenger models. In 1975, the Viking passenger chassis, incorporating cold-rolled straight frames, was put on the market. A double-decker chassis, the Titan, based on BL designs, was also introduced. In 1981, in collaboration with BL, the company constructed and test-marketed integral buses with air suspensions, which had a niche in applications such as tourist and airport coaches. Similarly, a vestibuled/articulated bus with total capacity of 150 passengers was tested in 1982, and introduced in 1984.

Perhaps ALL's most significant technological achievement to date has been the Taurus, an 18 ton truck which pioneered the concept of multi-axles in India, and which allow higher payload with lower loads per axle . Moreover, unlike other developments, this was an in-house effort. The Taurus, introduced in 1980, was later up to 24 and then 25 tons GVW. Another multi-axle vehicle was the Tusker Super 2214, a 6x2 vehicle whose rear axle can be retracted when the vehicle is unladen.

Alongwith these product developments, ALL also undertook to upgrade its aggregates. Over time, successive series of BL engines were introduced, beginning with the AL 350 and followed by the AL 600 (150 hp), the AL 680 (180 hp) and the more efficient AL-370 (110 hp). In 1978, the company opted for a fresh collaboration with Leyland for its 400 series engines, as well as an improved rear axle and a new gearbox. It also collaborated with ARAI to improve fuel efficiency, resulting in the development of the AL 6.65 engine, a modification of the AL-402 developed earlier for marine applications. In 1986, it signed an agreement with Hino, one of the world leaders in MHCVs, to manufacture the new generation "W" series of engines, going from 70 to 175 hp. In 1989, ALL also signed a collaboration with Iveco of Italy for manufacture of their 9.5 litre engines for powering heavy duty vehicles.

Other aggregate developments include the ZF synchromesh gearbox project, begun in 1981 in collaboration with ZF of Germany and Leyland Vehicles. Regular production began in 1984. Another collaboration was with Self-Changing Gears in 1984 for semi-automatic gearboxes for

passenger applications, and with Leyland Vehicles for the design and manufacture of a modern, ergonomic front-end structure, eventually intended to lead to the development of a complete cab system.

The Hino collaboration has allowed ALL to extend its range to lighter applications. The "Chital", with a capacity of 26 seats, is targeted at an "intermediate" market, and its counterpart in the goods segment is the Comet Junior (7.5 tons GVW). In 1990, ALL even introduced a bonnetted truck (like Telco's semi-forward ones) for the first time, in deference to psychological fears of Indian drivers.

Currently, ALL's range of products extends from the 7.5 tons Comet Junior to the 100 tons GTW Rhino Tractor (295 hp), numbering 29 basic models which are offered with diverse options. Its range includes different types of buses, tippers, tractor-trailers, 4x4 and 6x6 vehicles for the army, oil field trucks, fire tenders, dumpers and industrial engines.

Amongst the light vehicle manufacturers, Mahindra & Mahindra began vehicle production in 1956 with the phased manufacture of the Willys Jeep. Foreign equity participation has always been a minority one, with the major shareholders being Chrysler (8%) and International Harvester (6.4%). In 1990, Peugeot and the International Finance Corporation also acquired minor stakes in the company.

Besides indigenization, M&M's initial preoccupation was to establish its various product lines - petrol trucks in 1965, tractors in 1966 (by an M&M subsidiary, The International Tractor Company of India), and a number of associate companies. The original design of the Jeep truck was from the Kaiser Corporation (earlier Willys). Introduced in 1965, the FC-150 was a 0.75 ton payload, normal control petrol truck. In 1968, this was changed from left to right hand drive.

Following the oil shock in 1973, M&M found it necessary to introduce diesel engine options on its jeeps and trucks, since diesel was always cheaper than petrol, and diesel engines are also more fuel-efficient. This was done by converting the low speed tractor diesel engine into a higher speed one (38 bhp at 2300 rpm), in 1975. Another option was the higher torque Perkins P4 engine, bought in from Simpson & Co.

A separate R&D Department was set up in 1971, soon after which, in 1974, the 20 year collaboration agreement with Jeep Corporation (subsidiary of American Motor Corporation) ended. In 1977, the rear axle on the LCV was changed from semi-floating to full-floating type in order to cater to heavier loads. Other measures to strengthen the vehicle included a heavy duty straight chassis instead of a lighter bent chassis; loading space was increased by lengthening the wheelbase from 82" to 104.5". With all these changes, the payload has been increased overtime from 0.75 to 2.25 tons.

The tractor diesel engine could have been at best a temporary option for the LCV. In 1979, M&M signed a collaboration agreement with Automobiles Peugeot of France for the manufacture of the XDP 4.90 pre-combustion chamber diesel engine. This was one of the world's renowned and efficient engines in the late 70s. By the early 80s, the XDP was being offered on jeeps and LCVs. In 1983, the drive train was modernised with the introduction of a 4-speed gearbox (replacing a 3-speed one), designed by Kia Machine Tools of S.Korea.

There were also some exclusive developments on the jeep front. In 1980, an extended version of the jeep was introduced as a mini-truck (somewhat like a pickup), with a payload of 1 ton. In 1985, for the first time in 30 years, M&M changed the exterior body of its jeep, with styling and body dies provided by Korean and Japanese firms. The MM 540 also offered some new features geared towards providing more comfort.

Of the five manufacturers, M&M is the only one to have exported vehicles (jeeps) regularly to developed countries. This required a substantial amount of effort from the R&D and product engineering divisions, since the vehicles have had to satisfy strict noise, safety and pollution standards in countries like Germany, Italy and Australia. This involved, for example, reoptimisation of exhaust/ intake systems, redesigning of brakes, substituting Mitsubishi petrol engine for the diesel engine (Iran export order), special tests such as seat-belt anchorage tests etc.

More recently, M&M has gone in for further upgradation in its engine. In 1987, it signed a fresh collaboration with Peugeot for its 1984-vintage XD-3 engine, which develops 75 hp compared to the XDP's 62 hp. Both engines are part of the same series, so fresh investment by

M&M will be minimal. The indigenization process of the XD-3 would begin in 1990-91. Another agreement was signed in 1989 for manufacture of the Peugeot 504 pickup with a 5 speed gearbox, a vehicle that would compete directly with Telco's 206. Besides all these TC efforts in the auto division, M&M has also been busy in introducing new tractors as well as upgraded engines on its existing range of tractors.

Like M&M, Standard Motors did not begin with CV manufacture. In collaboration with Standard Motor Co. of England, SMPIL began progressive manufacture of the Standard car in 1955. Its initial model, the Vanguard, was discontinued in 1957 on the advice of the Government. A succession of models were introduced thereafter - the Standard-8, Standard-10 (1959), Standard Herald (1960, two-door), Standard Companion (1961) and the four-door Standard Herald (1968). In order to help it to utilise the Vanguard petrol engine, SMPIL was allowed to manufacture a one-ton payload truck. This was introduced in 1965.

The Herald was a failure on the market, a problem compounded by a prolonged strike during 1970-71. After the company reopened, the Herald was re-engineered and introduced as the Gazel in 1972-73. Although it was a more popular car than the Herald, SMPIL had lost ground in cars to rivals PAL and HML, and could not regain a significant market share.

In 1971, SMPIL began making bodies for its Standard-20 CVs. Moreover, the engine, rear axle and gearbox developed for the Vanguard could be used in the LCV, which helped in its indigenization. However, the real push into LCVs began with the oil shock of 1973, when SMPIL's petrol-driven vehicles (both cars and LCVs) were found to be virtually without buyers. Dieselisation was obviously the first priority. With the help of British Leyland, who provided designs and other help, the Standard-20 was dieselised as early as June 1975, using Austin Rover's 2.12 litre diesel engine.

Once dieselisation was achieved, efforts were made to improve the versatility of the LCV. A 16-seater minibus was introduced in 1977-78. In 1979-80, SMPIL purchased technology in the form of designs, drawings and other knowhow for a 2.52 litre pre-combustion chamber diesel engine and D series 4-speed gearbox from BL. The production facilities for the engine were also

bought from BL. Within a year, these improved aggregates had been fitted on to the Micro series of vehicles, and introduced in the market in 1981-82. By 1982-83, the body styling of the old Standard-20 was altered to the new "Vista-Vue" series, the design, development and tooling for which were done in-house. This enabled SMPIL to increase its geographical penetration.

SMPIL was the first to introduce LCVs into the Indian market as a mini-lorry concept, test marketed in 1982-83. Again, this was an indigenous development. A heavier duty fully floating rear-axle was developed with Axles India (producing under licence from Eaton Axles). The front axle was also changed to I-beam type, a feature normally reserved for much heavier vehicles. This helped to increase tyre life by 45,000 kms. In 1984-85, a micro-lorry with a 3 ton payload was offered on the market, as opposed to the 2.2 ton payload of the Standard-20, the differences being the heavier duty engine and the rear axle, with additional changes such as a new crown wheel and pinion, and dual circuit brakes. The chassis was also newly developed in order to cater to the heavier payload.

The company has also produced a 21 seater luxury bus with an extended wheelbase, lower floor and posh interior. This was the first vehicle of its kind with a monocoque construction, but had limited success.

In 1985, SMPIL re-entered the car market after signing a collaboration with Austin Rover for manufacture of the Rover Saloon, in 1983-84. The petrol engine of the car, the Standard 2000, was indigenised right from the start. This was done with the help of Austin Rover, utilising the existing cylinder block of the 2.12 litre LCV engine with a new bore and stroke, and importing pistons and twin carburettor systems from Austin. A new paint shop was commissioned, the technology being obtained from United and General Engineering, U.K. No further developments took place since SMPIL went steadily downhill since 1985, culminating in a lockout in 1989.

Bajaj Tempo was the last of the CV manufacturers to begin progressive manufacture, which began with Tempo 3-wheelers in 1959 following a 10 year collaboration with Vidal & Sohn Tempo-Werk of Germany. Another 5 year agreement was signed in 1965 for the manufacture of Viking 4-wheelers. Vidal had a 26% share in the equity of BTL. In October 1965, Vidal was

taken over by Rheinstahl Hanomag of Germany who became BTL's collaborators. Viking sales began in 1966. The Viking used a ZF gearbox, for which a separate collaboration was signed with ZF of Germany for the period 1965-74.

As early as 1967, BTL was thinking in terms of dieselisation of the Viking, for which an agreement was concluded with Hanomag. Production of this dieselised vehicle, known as the Matador, began in 1969. The entire plant for the Hanomag engine was gifted to BTL by Hanomag in 1970-71 after the latter discontinued production of the D-301-E2 engine. By 1974, the Viking range had been discontinued since petrol engines were much less economical.

After achieving rapid indigenisation, R&D in BTL focussed on functional improvements. Over 1975-77, for example, the fuel efficiency of the Hanomag was improved.

In 1977, BTL introduced the F305, a Matador with a new front face and a number of improved features such as strengthened front suspension, constant velocity drive shafts etc. During the same year, the company completed dieselisation of its 3-wheeler vehicles, and also developed a smaller wheelbase of the F-305 with an open body for rugged road conditions. Both models were put into production in 1977-78 after field trials.

BTL sought further functional improvements in its vehicles, and decided to collaborate with Daimler-Benz (who had taken over Hanomag and was therefore also the major foreign shareholder) to upgrade its engine technology. The agreement for the pre-combustion chamber OM 616 engine was signed in September 1978. By 1983, when the transfer line for the cylinder block of the engine was commissioned, substantial indigenisation had been achieved. The Matador with the D-B engine was called the F-307 series, and had a much better power to weight ratio than the F-305 (since the payload was around the same i.e. 2 tons, but the OM 616 had 65 hp as compared to 48 hp of the D-301).

With its own body-building and press facilities, BTL was able to offer a large number of variants of its vehicles. The Matador's front-wheel drive also helped, because this makes it technically easier to execute variants (the FJ and the mini and micro lorries were rear-wheel drive). This included ambulances, tippers, station wagons, minibuses etc. This was done not only

on the F-305 and F-307 series, but even earlier on the Viking and 3-wheeler range of vehicles. As early as 1970-71, BTL developed a high lift platform truck on its Matador chassis for airport use. All these activities helped BTL to broad-base its market demand.

Like M&M and SMPIL, BTL also attempted to introduce a higher payload vehicle. Based on the more powerful D-B engine, the company developed the 2.25 ton payload F-407, fitted with dual wheels on the rear axle (i.e. a 6x2 vehicle). However, unlike the micro lorry and the FJ vehicles, the F-407 was a front wheel drive, and developed traction problems in the face of the overloading that is chronic in Indian conditions. It was not a success.

During the phase of liberalisation in the early 80s, BTL was the only one amongst the existing LCV manufacturers to opt for and implement progressive manufacture of a completely new LCV, the "T-1 Transporter" of Daimler-Benz. Approval for the collaboration was received in 1983-84. The plant for the Traveller, as the Transporter is called, was commissioned at a new site in Pithampur in November 1987 with modern manufacturing facilities. Powered by a 72 hp (at 4400 rpm) version of the OM 616, the Traveller was the first rear-wheel drive vehicle for BTL.

Using the experience gained while getting ready to produce the Traveller, BTL was able to develop its own rear-while-drive vehicle. This was the Tempo Trax, a rough-road, jeep-type vehicle. Fully designed and developed by BTL in-house, production of the Trax commenced in July 1987. However, the vehicle has not been a great success, with only a 0.18% share (587 vehicles) of the utility vehicle market in 1989.

In 1988, the company introduced the Matador Max, involving a re-designed and strengthened chassis, stronger suspension, and improvements in steering, brakes, ergonomics etc. The older D-301 engine was re-engineered and was able to pass the fuel efficiency norms for LCVs. More recently, BTL is attempting to develop rear-while-drive vehicles in the Matador range.

Technology Exports

Technology transfer can be effected both within and outside the country. Depending on the nature of the transfer, one or more of product engineering, process engineering and industrial

engineering departments could be involved in the transfer process.

Three of the five CV firms have undertaken technology exports so far - Telco, ALL and M&M. Of these, the most complete package was offered by Telco[1] to a joint venture in Malaysia that was approved in 1975 and began manufacture in 1977. This was Tatab Industries, in which Telco took 29% of the equity and provided 80% of the equipment from its own factories. It also provided its trademark, training, project execution and even marketing and management. Tatab assembled 15 ton Tata trucks and buses. Another joint venture was undertaken earlier, in 1972, to Tata Precision Industries in Singapore for the design and production of miniature tools for the electronics industry, for which most of the knowhow was supplied by specialized European firms. This venture also includes a very successful centre for training of local workers in industrial skills.

ALL and the Sri Lankan Government launched a joint venture in Sri Lanka in 1983 for the progressive manufacture of ALL trucks. ALL's equity stake in this venture, called Lanka Ashok Leyland, is 28%.

M&M established a subsidiary in Greece with 55% equity share under the name Mahindra Hellenic Auto Industries. The objective was to use Greece as a base for exports to non-traditional markets, particularly the EEC (Greece being a member of the Common Market). Assembly of CKD and SKD jeeps began in 1986.

IMPACT OF TC ON MARKET SHARES

Product TC is expected to have a direct impact on market shares, whereas process TC impacts more directly on costs (and thereby on market shares). It is evident that not all the above-mentioned TC efforts were equally successful in the marketplace. The degree of success is a function, inter alia, of the technological capability of the firm, the degree of effort it puts into TC, its choice of technology, and market size.

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1. The information on Telco's technology exports borrows from Lall (1987), pp.181-82.

To get back to Telco, we saw that within a decade of its starting CV production, it had a major success in the 1210, followed by the 1210S in 1975. This helped it to increase its share of the truck market, from 54.1% over 1961-65 to 66% over 1966-70. If we consider only trucks (where weight carrying capacity and overloading are more important than for buses), Telco's share rose from 67.6% over 1966-70 to 73.5% over 1976-80. Since the truck market has always been twice the size of the bus market, this guaranteed for Telco the lion's share of the MHCV market as well as a large volume of absolute sales. Moreover, until 1982-83 growth of its output has been usually supply-constrained owing to shortages of power and components, as evident in the large volume of unsatisfied demand.[1] Its only serious competition, after the gradual demise of PAL and HML in MHCVs, was from ALL.

The 1210 was Telco's mainstay, and its success enabled Telco to absorb the many failures (in terms of market acceptance) of its R&D efforts. As much as 30-40% of its R&D time was spent in dealing with the feedback from customers and from its extensive sales and service network i.e. on improving its existing vehicles. Thus, successive models of the 1210 were the 1210 with the 692 DI engine, the 1210S and the 1210E. The failures of Telco's R&D efforts included the 1516, 1312, 807, 909 and other vehicles developed over 1980-85. The 1516 and 1312 represented efforts to upgrade carrying capacity while also improving aesthetics, fuel efficiency, cab etc., i.e. bringing the vehicles closer to developed country standards. However, while priced much higher than the 1210, these vehicles were not sufficiently distinct (in the customer's eyes) from a 1210 which by then was capable of massive overloading, carrying payloads upto 10-12 tons. Similarly, resistance to higher prices did not allow the rear-engine bus and buses with power steering to succeed.

On the other hand, competitive pricing, a sound product (and an extensive dealer network) enabled Telco's 407 to notch up a very impressive market share. Its other LCVs have, however,

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1. Unsatisfied demand or order backlog for Telco was 44340 CVs in 1964 (1950 for ALL), and 12951 in August 1971. The decline of PAL and HML in the mid 70s meant that order backlogs existed for both ALL and Telco upto the early 80s (sources for figures: TC.1968, p.110, and MRTP Report 1971, p.261). In 1982, the backlog was 140841 for all CVs, which reduced rapidly thereafter (Lok Sabha starred question No.806, 21st April 1982).

not had the same success.

Being a much smaller company, none of ALL's innovations has had the kind of impact (in terms of market presence) of the 1210 or the 407. Since its strength was in passenger rather than load carriers, this limited the market available to it. Because it was up against a volume-oriented competitor, it had to be willing to experiment with a lot more product variations. It was able to achieve this through a regular inflow of technology from BL.

ALL's most successful innovation was the multi-axle vehicle, but its initial sales were very low. Similarly, the total market for vestibuled, integral and double-decker buses is only 200-300 vehicles per year. However, in bringing in a range of diverse products, ALL has managed to corner the specialised market segments which has boosted its overall profit margins. Moreover, ALL will have a first-mover advantage as these products, particularly multi-axle vehicles, become more important.

A significant development in ALL, not matched by Telco so far, is the collaboration for modern and fuel efficient diesel engines. These Hino engines are an optional fitment so far on ALL vehicles, but their introduction is a source of long-run competitive strength for ALL.

LCVs had a later start than MHCVs and till date, MHCV demand is far greater than that for LCVs, a very unusual phenomenon when compared with other countries. The first to enter LCVs (not including the heavier models of PAL and HML) was BTL's 3-wheeler, but its Viking 4-wheeler was launched in the same year as SMPIL's and M&M's LCVs. While all the manufacturers switched from petrol to diesel vehicles, BTL had a head start, having converted as early as 1969. Even before the oil shock, this was a major advantage for BTL - its output doubled between 1968 and 1970, while that of M&M and SMPIL declined (A.3.3). BTL has not relinquished this advantage till today, and remains the market leader.

The Matador was a major success for BTL, and resulted in excess demand (order backlogs) for the vehicle through much of the 70s and early 80s. Thus, as in the case of the 1210, BTL focussed its efforts on improving the Matador and offering a large number of variants of the same chassis. Besides its price advantage, it is this large number of factory-built variants that

helped to make BTL the most successful LCV manufacturer. However, products like the F407, Traveller and Trax have not been a success - the F407 because of traction problem, Traveller because it is expensive and has a limited target market and the Trax because of design bugs and competition from established vehicles such as the Jeep and Maruti Gypsy. The Matador therefore continues to be the "cash cow" and BTL is making constant efforts to improve upon it.

M&M has for long enjoyed a monopoly in its dominant product line. It is therefore difficult to assess the impact of any TC effort in jeeps in a relative sense (i.e. in terms of market share). What is true is that the jeep established itself in both the civilian and military markets in the country - acceptance in the latter is not easy. Moreover, at least in the military sector, the Jeep did face competition from the Nissan Patrol "Jonga", produced in the defence factory. Also, the TC effort undertaken to modify the jeeps for different export markets shows that product engineering skills were of a high order.

In LCVs, of course, M&M faced competition. Unlike SMPIL and BTL, its initial dieselisation was an in-house effort. But the more successful LCV was the one with the higher torque Perkins engine, borne out by the fact that it is still in demand even today. The Peugeot engine dieselisation increased its market share only temporarily, from 22%% in 1980 to 29% in 1983, down to 24.9% in 1984 (A.3.5), since SMPIL and BTL also followed suit. Similarly, other developments towards strengthening the vehicle were replicated in the competing companies. The mini-truck (NC 665), which was quite popular between 1982-86, succeeded mainly because of LCV-related fiscal concessions rather than because it catered to any specific product need.

SMPIL was conceived on a much smaller scale than any other CV or car manufacturer. Nevertheless, its LCV volumes were comparable to those of M&M's (not including the NC series). SMPIL did all the basic functional improvements and in fact went a step beyond M&M by changing the face of the vehicle, whereas M&M's frontal look has been unchanged since its introduction. The mini-lorry and micro-lorry enjoyed some success, particularly since SMPIL was the first to introduce the concept. Also, SMPIL was able to execute a number of factory-built variants (though not as many as BTL), which gave it a relatively higher share in passenger

applications.

SMPIL's biggest failure was the Standard 2000 car, whose engine and gearbox have given cause for complaint. This shows that SMPIL's product engineering, which had successfully developed a number of LCVs, may not have been quite ready to tackle a luxury car with more demanding performance characteristics.

On the whole, the three LCV manufacturers did not offer vehicles that differed substantially in terms of functional efficiencies, although BTL's D-B engine may have given it some advantage of "image". Of course, to the extent that product improvements were introduced at different points of time, the first mover may have enjoyed some temporary advantage. BTL's lasting edge over SMPIL and M&M owes to its price, large number of product variants (resulting from product and process engineering) and a better styling and finish. On the other hand, both M&M and SMPIL enjoyed their respective niches, which they continued to do until 1984. But BTL's strengths were more visible after the entry of new firms, due at least partly to better management of both product as well as process TC.

MANAGEMENT OF TC : TECHNOLOGY IMPORTS AND R&D

TC, R&D and Imports: some Propositions

In most of the cases of TC analysed above, technology imports (TI) played the dominant role, backed by complementary inputs from the firms' product, process and industrial engineering departments. But Telco has consciously adopted a very different route - once it had absorbed and adapted the D-B technology to its own requirements, it developed know-why capabilities and was able to initiate new developments on its own. Greater in-house R&D (R&D for short) capability is, however, not necessarily a good thing. The question is what the different technological strategies imply for domestic as well as international competitiveness.

Both types of strategies - a predominantly TIA (technology import and adapt) strategy or a predominantly R&D-oriented strategy - have their own pros and cons. Clearly, an R&D-oriented

strategy presumes a certain minimum capability to perform R&D. Capability in turn arises over a period of time, partly from a deliberate attitude to learn and allocate resources for learning (ch.2) i.e. an R&D-oriented strategy over time itself generates R&D capability.

In the auto industry, TC is of an evolutionary kind, and changes are introduced incrementally. This is even more true in IC firms such as those we are studying. Gradually, each firm develops an idiosyncratic production function, which increases in degree over time. These factors tend to favour in-house generation of TC, ceteris paribus, since each increment of TC is built within the existing production function and culture of the organization. Besides the above features, the TC process is necessarily iterative, involving a great deal of trial and error. The transfer of technical knowledge from one organization to another is always incomplete, owing to the element of tacitness, incomplete understanding and inimitability (ch. 2). All this means that the transaction costs of the TIA strategy can be quite high.

In ch. 5, we had suggested a model where, given the choice of research strategy (R&D or TIA), and the nature of the innovation, the firm could choose its level and pattern of VI. Instead, the choice variable is now the research strategy, and we postulate the different scenarios wherein own R&D may be preferred to TIA.

When TC is of an incremental nature, we would expect that the cost and duration of TC would be lower with own R&D, owing to the earlier mentioned features of TC. On the other hand, when major TC is involved (say, a completely new engine), generation costs will be lower with TIA , since it is available off the shelf. Normally, the time taken for a major TC effort should also be lower under TIA. This has to be balanced by the fact that TIA would usually involve relatively greater changes in existing product and process technology, and therefore a higher productionising cost including higher transaction cost. Thus the overall cost of commercializing a major TC may or may not be lower with TIA, and would depend very much on the kind of TC being attempted (one parameter being the level of uncertainty).

As we have seen, the search for new technology carries risk and admits of the possibility of failure. It would be less risky to adopt an existing and proven technology (TIA) rather than invest

resources in uncertain-outcome R&D. However, uncertainty is usually less the more applied is the research i.e. the closer the stage of research is to commercialization[1]. Most TC in our study is incremental, and even where it is not, as in the case of Telco LCVs and ALL multi-axle vehicles, the Indian firms have borrowed freely from existing designs and concepts abroad i.e. they have done reverse-engineering.[2] This helps to reduce the level of uncertainty. Uncertainty is also less if the firm has greater know-why and technological capability, since it is then better able to handle the inevitable problems that arise in a trial-and-error research process.

So far, we have assumed that TI and R&D are substitutes. From our own study, and from the numerous studies of ICs, we know that in fact there is a significant complementarity between TI and R&D capability. At the most basic level, capability is required to adapt the imported technology to local conditions. At another level, own capability can complement discrete elements of imported technology. Given rapidly advancing international technology frontiers, greater technological capability will help in both these complementary activities. Moreover, the search for new technology is enhanced by a greater knowledge of the technology, by the ability to ask the right questions and demand a suitable technology package. Also, the greater the capability, the lesser is the asymmetry between buyer's and seller's knowledge, and is likely to lead to more competitive pricing of the imported technology (Pack and Westphal 1986). Beyond a point, of course, greater technological capabilities enable own R&D to substitute for TI.

It may also be necessary to distinguish between product and process TC. From our field study, it is evident that incremental process TC is always done in-house. On the other hand, most firms, even internationally, rely on specialist capital good manufacturers to introduce major process changes. The pros and cons of in-house process change capability in Indian conditions were spelt out in chapter 5. One of the points raised was that greater process change capability

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1. See Kay (1988) and Teitel (1984).

2. A practice followed not only by Indian firms but by firms all over the world, and is a legitimate tool of competitive strategy. Of course, in leading firms, this practice is only secondary to their main preoccupation with in-house R&D.

also helps in product TC efforts by helping to productionise innovations.

Impact of TC strategies

We can now attempt to judge the impact of the specific technological strategies followed by the different firms. In terms of competitiveness in the Indian market, it is clear that Telco's R&D strategy has given it a clear edge. This was particularly evident when its R&D capability was put to test in the 80s, and it had to diversify away from MHCVs fairly quickly. Given its deep know-why capability, its in-house capital goods production (which enhances the advantages of an R&D strategy), and its use of "simultaneous engineering", Telco is able to introduce new products and improve existing products quickly as well as cost-effectively. Other firms do not have an abiding capability to introduce completely new products on their own. Since Government policy on foreign collaborations is restrictive, and all procedures concerning foreign exchange are cumbersome and protracted, this capability has given Telco a distinct edge in the domestic market. In terms of our propositions above, restrictive policies increase the range (going up the scale of level of ambitiousness of TC) over which Telco would find own R&D desirable, since it could accomplish even major TC within a shorter span of time than with TIA, as demonstrated in the speed of introduction of LCVs in the 80s. Also, in the case of Telco, uncertainty is relatively low, owing to its liberal use of reverse engineering and its know-why capability. And any remaining uncertainty of final outcome has not deterred it from following an R&D strategy, although some uncertainty does exist with regard to the duration of R&D and the resources to be allocated to it.

The learning process with new process technologies that has been initiated in Telco is way ahead of the others, and this gives it a dynamic advantage. Moreover, should it wish to import technology, either a full package or a discrete element, it can do this more effectively and absorb it more quickly than the others. Of course, having set up an elaborate infrastructure (by Indian standards) for R&D, Telco would usually prefer to utilise its own set-up, unless its capabilities do not allow it, as in the design and manufacture of a world-class diesel engine.

There are several instances when Telco has gone it alone,and where the results have fallen

short of expectations. The 608, for example, could not match comparable 6 ton Japanese vehicles. Any attempt to match the latter's specifications and performance, implying world-class characteristics, would have proved to be too expensive and time-consuming, even if within Telco's capabilities (itself doubtful). As table 2.5 showed, the cost of designing and developing a new engine alone was £150-200 million, in 1982 prices. In the domestic market, however, Telco has other important advantages over the Japanese vehicles, such as price and service network, and these have enabled the 608 to get a foothold, with a sale of 2087 vehicles in 1989, compared to 4304 by Eicher "Canter", the market leader in this class.

In the international market, these are obviously greater handicaps. Telco cannot conceivably match world-class LCVs or MHCVs solely by its own efforts, particularly since it is deficient in engine and body design capability (partly because the domestic market has not required it to develop this capability, particularly in the case of body design). In the very process of making vehicles ideally suited to Indian conditions of overloading, low speed and frequent halts, Telco and all other CV manufacturers have ruled themselves out of contention in most of the important markets abroad. Thus, in the major export markets, TI is necessary, and Telco also realises this -- witness its discussions with D-B in 1989-90 for the joint design and manufacture of a world concept truck.[1]

As opposed to Telco, ALL's strategy has been of the classic TIA variety. This has enabled it to introduce a wide variety of models. Of course, as a percentage of sales, its TI has usually been greater than Telco's but not excessively so. Much of the technology from BL was given to ALL as part of its overall technological collaboration and did not entail a specific cost. Also, since BL was the regular source of technology (upto 1986), this meant that much less modification and adaptation was required than if the collaborator had been constantly changing. Moreover, its confidence in its absorptive capacities has been growing, as evident from its opting for diverse collaborations such as Hino and Iveco in the 80s. By 1980, it was able to introduce the multi-axle

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1. That this proposal has not gone through is another matter.

vehicle as a fruit of in-house R&D effort.

TI has therefore been an important ingredient in ALL's competitiveness. But since it is less adept than Telco in product and process technology, the cumulative sum of incremental improvements is less than in Telco. Periodically, ALL has had to replenish its technology from outside so as to not fall behind in comparable products. In the process change department, ALL is far behind Telco, both in terms of current situation as well as dynamic learning effects with new technologies. However, ALL has a head start in the introduction of a modern and fuel-efficient diesel engine.

It could be hypothesized that TI would result in vehicles more suitable for international markets than those from own R&D. But the adaptation and modification process (the A of TIA) has rendered them unsuitable, as for Telco. Moreover, most of the recent TI was for aggregates such as engine, gearbox, etc. which cannot render the vehicle as a whole internationally acceptable.

All the LCV firms have followed their variants of the TIA strategy. SMPIL has taken care not to disturb its source of TI, since it was a small firm and could not afford to make frequent changes in product and process. Likewise, BTL has always gone to the same firm or its new owner, which also imparted continuity. M&M made a major departure from the Jeep Corporation to Peugeot in 1979, and has remained with them since. Considering that Peugeot is not a producer of utility vehicles, M&M's choice of the Peugeot diesel for its Jeep has been vindicated. None of the companies has attempted very ambitious R&D efforts, although BTL has stepped up this activity since 1983.

The three firms have used a combination of TI and absorptive efforts to remain abreast of each other in terms of basic functional developments. The source of their relative competitiveness will therefore be their own R&D efforts i.e. which of them has been able to make maximum use of TI over the years to initiate a learning process and generate own knowledge-creating capabilities. Considering the evidence, it seems that BTL has been able to do this relatively more proficiently, as seen in its efforts to develop the Trax and rear-while drive vehicles. Moreover,

with all three manufacturers attempting to make direct injection versions of their pre-cumbustion chamber engines in order to improve fuel efficiency, BTL's attempts appear to be closest to fruition.[1] BTL is also a step ahead in terms of process TC efforts. With Telco becoming a major player in the LCV market, the original LCV firms may in any case need to improve upon their R&D capabilities.

SYNTHESIS AND CONCLUSIONS

It is true that TC is not the only input into competitiveness. But it can be critical and, more often than not, decisive, particularly when competitive pressures are greater. Over time, Indian CV firms have developed important R&D capabilities. In the process of operationalising the imported technologies, TC efforts were required in order to scale down plant size - done with the help of the collaborators. The time-bound indigenization programme meant that the CV firms helped in the upgradation of vendor skills. Some raw material substitution was also required in order to maximise use of local raw materials, including use of inferior quality materials. The most significant learning accrued from making the vehicles more suitable for Indian conditions, a process which all the manufacturers had to undergo in order to stay competitive. These conditions demanded functional efficiency, overloading, fuel economy, constant changes in speed and easy repair and maintenance. Over time, this resulted in vehicles with low power to weight ratios (higher power reduces fuel economy), relatively higher torque (pulling power), heavier vehicles and stronger suspension (to take care of overload and rough roads), higher tolerance of moving parts (making for easier repair and maintenance), higher gear ratios (wherein speed variations cause lesser loss of fuel economy), less sophisticated product features (to keep prices low), poor overall finish, and lesser concern for ergonomics, driver comfort (such as lack of a comfortable cab).[2]

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1. BTL received the National Prize at the Symposium on Indian Automotive Technology in 1989 for its efforts to develop a high speed direct injection engine.

2. A similar situation arises in the case of the Indian two-wheeler industry, see R.Kumar (1988), as well as the Brazilian automotive industry (EIU 1987a). Even in Japan, in the earlier stages of auto industry development, overloading was common practice.

The operating environment is also influenced by Government laws. In the 1970s, OECD Governments mandated changes in vehicle technologies to conform to improved safety, fuel emission and fuel economy standards, and these are being made more rigid over time, particularly with regard to fuel emission. Although such laws exist in India, their standards are far more lax, and their enforcement even more so. Also, laws regulating maximum axle loads are not enforced strictly, although there has been some improvement with the Motor Vehicles Act of 1988.

In the process of catering to these external operating conditions, Indian CV manufacturers have rendered their vehicles unsuitable for large OECD markets, or even the richer developing countries. But this "highly idiosyncratic production function.. (is).. capable of earning rents..." (Katz 1987,p.47) in other developing countries with similar operating conditions, an experience replicated in many Latin American countries. Another indication of the differences in demand patterns is that while in the domestic market Telco's premium/full-cab vehicles accounted for less than 5% of its MHCV sales, they accounted for 15-20% of MHCV exports.

Even though circumscribed by the above operating conditions, the TC strategy of all the firms was not alike. Telco was the most distinct, displaying a clear preference for in-house R&D as well as the ability to design and manufacture its requirements for machine tools and tooling. One indication of the level of sophistication that Telco has attained is the counter-example of Daewoo Heavy Industries, a part of one of the leading conglomerates in S.Korea, and which supplies diesel engines to Daewoo (truck and car maker). As described in Enos and Park (1988, ch.6), Daewoo had been able to absorb diesel engine technology relating to start-up, operation and maintenance of the manufacturing process, after 15 years of the licensing agreement with MAN. In contrast, Telco, after 17 years of its agreement with D-B, had been able to effect a major improvement in the engine by converting it from indirect to direct injection. Facing a large and capable competitor, ALL could not afford to be slack in its TC efforts, albeit choosing to rely more on TI than on R&D. None of the LCV firms faced a competitor like Telco. This, alongwith their smaller size as compared even to ALL, meant that TC was less frequent and the nature of

R&D efforts less ambitious than in ALL. Within LCVs, BTL has a somewhat greater R&D orientation than its rivals, particularly since the 80s. Inspite of its much smaller size, SMPIL was able to engineer significant changes into its LCVs. If anything, these were more significant than R&D done by M&M upto that time. Thus, its very small size and R&D staff were not a hindrance in developing some effective R&D capabilities. Unlike own R&D, however, any major product change (which would involve TI) would necessitate large complementary investments, which was a constraint given SMPIL's size (see also chapter 8).

With the exception of Telco, process change has received little independent impetus in the industry so far. Product engineering skills are well developed (upto a point) in all the companies, demonstrated by their ability to engineer incremental and sometimes more substantial product changes. This skill development was necessitated by the need to adapt and modify the product to suit local conditions and rules and regulations. Over time, enhanced abilities resulted in more ambitious product R&D efforts, receiving a push from more competitive conditions. All companies now wanted to expand their product range. By contrast, process technology has changed relatively little, except in Telco and to an extent BTL (ch.6). Except in Telco, investments in plant and equipment are bunched around new product (or aggregates) introduction and/or capacity expansion. Even in more recent times, changes in process technology have not received an autonomous impetus, with most firms far behind the standards required to achieve efficient quality control and good finish. At the same time, while the basic nature of process technology has not changed very much, it is possible for firms to generate incremental process TC through process engineering and industrial engineering. This kind of incremental change has been present, with all firms displaying considerable ingenuity in "equipment stretching", and allowing incremental product changes to be introduced with minimal fresh investment. Besides Telco, BTL has been fairly active in this sphere, and this has enabled it to invest in newer process technologies at relatively low cost.

Thus, Telco does not fit into the Katz (1987) stylisation that technological search activities in an enterprise begin with product engineering efforts, to be followed only somewhat later by any

substantial process engineering activity. In Telco, strong process engineering capability developed quite early on, owing to its in-house machine tool and tooling divisions, and which have been the impetus for the autonomous process change activity. The other firms conform to the Katz typology.

Even the best of Indian product engineering efforts are a long way away from developed country (DC) standards. Large as Telco is, its R&D expenditure does not compare favourably with any leading MHCV producer, and even its R&D intensity (about 1%) is far less than the international norm of 3-4%. Certainly, Indian R&D personnel are available at a fraction of (perhaps 15-20%) what they would cost to DC firms. But this situation has not been used to advantage -- for example, in 1988, R&D employees in Daimler-Benz AG (12665) were 7.4% of total employees; the corresponding figure in Telco was only 2%. Furthermore, labour is not the only element in R&D expenditure, expensive testing and engineering facilities are also required. Upto 1987, cumulative capital expenditure in R&D in Telco was Rs.14.35 crores, or only $18 mn when converted at a mid-point exchange rate of Rs.8. Given the sophisticated capital facilities required, this is clearly inadequate.

Besides lower R&D intensity, low value of turnover also reduces absolute value of R&D expenditure in India. This owes to very low unit value realisation, since the Indian market is very price conscious and is resistant to price increases, with perceived utility arising primarily from functional efficiency. In 1988, unit value realisation per C.V. in D-B was $51090 as compared to $17938 in Telco.[1] Another reason for low turnover is lack of enough economies of scope through production of cars and other related products.

All this means that Telco has to concentrate on relatively inexpensive R&D with a low level of uncertainty, making liberal use of reverse engineering. This is reflected in the nature of its R&D output. By contrast, Nissan Diesel, with a lower volume of sales than Telco, has been experimenting in the forefront of truck technology, as seen in its Advanced Truck Project. Hino,

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1. D-B output was 257,951 CVs sold at a unit value of 89,408 DMs. Telco sales were 61691 CVs at a unit value of Rs.249,649 in 1988-89.

only 20% larger than Telco in volume (apart from sub-contracted work for Toyota), was the first auto manufacturer to apply electronically controlled fuel injection in heavy-duty diesel engines, and is also doing research in ceramic engines. All major manufacturers are making increasing use of electronics, such as electronic wheel sensors to sense wheel-lock, electronically controlled gear change (Mercedes Benz), electronically controlled fuel injection, which has enabled major advances in engine efficiency, etc. Other advances are in more aerodynamic designs and material substitution. Indian R&D and TC efforts appear far removed from these trends. Even if the firms were financially and technically capable of making such TC efforts, the resulting price increase would be unacceptable in the domestic market.

Given these realities, how far should own R&D be pursued? Lall (1985) suggests that know-why development should not be carried beyond a point in ICs, since it would imply the diversion of skilled manpower and other technical resources from the assimilation of know-how. Secondly, he suggests that own know-why cannot in any case attain the levels of a shifting international technology frontier, and that after long years of expensive and iterative research, an IC firm may find that "...its ability to reproduce a given technology from first principles has become obsolete" (p.66). Similarly, Enos and Park (1988) also conclude that ICs would be better advised to channel their high opportunity cost resources into diffusion and absorption rather than into R&D. Lall (1985) goes further, contending that India has pushed learning much beyond the desirable limit, "condemning large sectors of industry to technical obsolescence" (p.67), and that many enterprises have reached the limits of their learning capability.

While we agree that know-why development should not be over-emphasised, we would argue that at least in the Indian CV industry, learning possibilities are far from being exhausted. Apart from Telco, R&D has remained subservient and complementary to TI. No firm has spent very much on R&D. Even Telco's R&D has been specific and goal-oriented (i.e. with a focus on Development rather than Research), and with a relatively low level of uncertainty. When this R&D in the form of the 407 was tested against Japanese vehicles, it was a big success. Earlier, the Ford truck of Simpson & Co. failed in the early 80s against competition from Telco and

ALL. It may be said that the CV industry has provided an efficient transport solution in the Indian context, producing durable vehicles at cheap prices (the DRCs were also efficient -- see ch.4). Its R&D efforts have been "misdirected"[1] partly as a result of policy interventions but much more due to the nature of local demand -- overloading, poor roads, and a premium on functional efficiency. It is only when such conditions change (a very gradual process, which can be accelerated by Government policy such as the Motor Vehicle Act) that the R&D efforts can be directed towards goals that are equally acceptable in developed markets.

The "efficiency" of Telco's R&D is also seen in the cheaper prices of its 407 and 608 versus comparable Japanese makes, inspite of Telco having to bear full costs of development. On the other hand, where Telco is deficient, as in world-class diesel engine technology, it can import either the complete or discrete elements of the technology -- given its know-how and know-why, it can opt for the latter, which would be a cheaper solution. What has prevented Telco from doing this so far is not its inability to do this through own R&D but the expense of going in for a new (part-imported technology) engine. Thus, in order to produce a vehicle acceptable in the DC markets, all Indian firms will have to collaborate with DC counterparts. In any case, firms all over the world are now collaborating in design, development as well as manufacture of vehicles and aggregates. This is true even of the largest firms such as GM, Ford, Daimler-Benz, and so on, and is a means of sharing the enormous cost of new product developments.

Prospects

What does the future hold for the firms as determined by their TC capabilities and strategies? In the MHCV segment, the strategies were very different, but have so far not given either firm a clear-cut edge vis-a-vis each other. But Telco's R&D strategy has given it an overall competitive edge, in that it has been able to make a successful diversification into LCVs and thus take care of its growth imperative. Its R&D edge was enhanced by its ability to commercialise its innovations

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1. See Lall (1985) and Teitel (1981).

very quickly, and at relatively lower cost, thanks to its mechine and press tool divisions. Given restrictive and cumbersome Government policies towards foreign collaborations, this is a potent competitive weapon.

The policies however were not so restrictive as to prevent ALL from using frequent TI (of specific aggregates) and a variety of models to maintain a competitive equilibrium with Telco. In the segment of premium duty vehicles, ALL's very dominant presence will stand it in good stead for the future, since in all countries there has been a historical trend towards greater usage of such vehicles over time, owing to their greater efficiency per ton-km. Also, ALL's moves towards contemporary diesel engine technology (Hino and Iveco) have yet to be matched by Telco.

Amongst the LCV firms, SMPIL will find it very difficult to resurrect itself in the very competitive LCV market today. BTL has survived the onslaught of Telco and the Japanese, but is now pursuing its R&D efforts with renewed vigour, since it now faces a very strong rival in Telco. Its advantage remains low price through efficient management of product and process TC, but it will eventually need to upgrade/scrap the Matador range, although tht process may be a few years away. It has, of course, started producing the Mercedes-Benz Traveller, but that is a niche product with limited sales so far. M&M appears to be making a serious attempt to upgrade and diversify its LCV range, which should also result in the scrapping of the FJ series, sooner than that of the Matador.

Export competitiveness has remained confined to MHCVs and jeeps. Telco has clearly demonstrated that it is the most export competitive. Vis-a-vis ALL, its better product and process change capabilities have given its products more optimised product characteristics, such as higher horsepower to weight ratio, and a lower dead weight. Again, its more frantic pace of TC activity since the mid 80s including its diversification into LCVs has allowed it to explore new product segments overseas, such as for the 407 and 206 pick-up. Besides, Telco also has advantages of scale economies in marketing and better fit and finish, the latter owing to higher level of VI, more uptodate process technology and lower reliance on small-scale suppliers (see chs.5 and 6). Overall, MHCV and jeep product characteristics in Indian conditions have allowed niche

export marketing, but the same characteristics have ruled out LCV exports.

We shall conclude by reverting to the recurring theme of R&D and TI. If the ultimate objective is to have world-class exporting enterprises, the less than 1% R&D intensity of Indian CV firms will be a handicap ralative to the international norm of 3-4%.[1] As an intermediate step, the objective could be modified to having efficient domestic enterprises which are increasingly export-oriented. Our contention is that even from the standpoint of the latter objective, none of the Indian firms have reached the limits of learning capability. All of them need to invest more in learning so that they can generate incremental improvements for an increasingly demanding domestic market, and compete better in the export market.

In fact, the firms have already displayed such a tendency, particularly ALL and BTL (Telco was already R&D oriented). These incremental improvements, such as improvements in engine efficiency, improving durability of functional parts etc. are best done in-house, owing to the specificity and tacitness of technology. Major product change can still be bought in, but even here the enterprise may be able to piece together a cheaper technology package by complementing discrete elements of imported technology with its own technological capability. This greater capability would also help in the better absorption of TI. Admittedly, size will be a constraint in devoting more resources to learning, but then

> ...innovation should be understood and practised within a long time perspective (Whipp and Clark 1986, p.211)

in which dynamic gains are maximised. In making this argument, we have abstracted from the effects on local knowledge creation, which would be a positive externality.

1.It is true that R&D expenditure does not take into account learning that takes place during production, as well as in the process and industrial engineering divisions, which is very important for generating incremental improvements in products and processes. But it could be hypothesised that R&D expenditure may be complementary to the learning generated by such activities.

CHAPTER 8 :

SYNTHESIS, CONCLUSIONS AND POLICY IMPLICATIONS

COMPETING THROUGH TECHNOLOGY AND MANUFACTURING

In discussions of Indian industrial structure, it is quite usual to attribute the survival of large numbers of firms in many industries to Government licensing and protection policies that hampered the growth of efficient firms and prevented the exit of inefficient firms. This leads to the co-existence of highly efficient and dynamic firms with inefficient and technologically backward ones.[1]

The commercial vehicle (CV) industry, however, does not lend itself to such simple conclusions. None of the firms faced any sustained barrier to growth. Moreover, the two pioneering firms, Hindustan Motors (HML) and Premier Automobiles (PAL), could not continue their challenge in CVs and faded out (but continued in passenger cars) -- implying that the less competitive firms were weeded out. This means that the five firms that remained (two in medium and heavy commercial vehicles (MHCVs), three in light commercial vehicles (LCVs)) survived not because of policy regulations but because they had strengths which enabled them to be competitive in the given environment (although it is true that the fact of being competitive would itself be influenced by the nature of the policy regime).[2] Of course, none of the firms were of the level of international best practice, particularly in LCVs. But some had greater strengths than others, and when the given conditions themselves changed, weaknesses in previously successful compet-

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1.See, for example, the World Bank (1987) study on the automotive industry, Lall (1984) and the World Bank (1987a) study on the industrial sector in India. For a discussion of the major Government policies, see appendix 1.

2.On the other hand, in a large segment of Indian industry, firms were inefficient even within the existing policy ambience, and survived only because growth and exit were hampered.

itive strategies started to appear.

What were the strategies that enabled the different firms to compete ? These strategies need to be judged in the light of the corporate objectives of each firm. Our assessment of these objectives is based on a mix of performance, strategies and any policy pronouncements that the firms may articulate. This assessment is necessarily approximate, since

> ....possession of a complete, clearly defined objective function is not a necessary condition for business operation in the real world; all that is required is a procedure for determining the action to be taken... firms in the world can get along without being entirely clear about their goals... (Nelson and Winter 1982, p.57).

This caveat will need to be kept in mind.

Telco's (Tata Engineering's) objective was to establish itself as the leading manufacturer in the shortest possible time without compromising on quality. It had a growth rather than profit objective. At the same time, it required high cash flow in order to maintain its substantial and regular investments, which it achieved by careful tax planning and consequent low taxation. These objectives needed a high level of VI (vertical integration) (and extended to manufacture of machinery), the more so in view of Telco's location in a backward area, relatively strong linkages with its suppliers, and investments in mass manufacturing techniques. Partly as a result, and partly as an independent strategy, it had a strong R&D orientation (particularly compared to the other manufacturers), and invested early on in learning to absorb and develop technology. This was true of both product as well as process technology, the latter being a feature unique to Telco. These strategies have resulted in its enjoying the broadest market base amongst all CV manufacturers, a base that has widened into LCVs inspite of the advent of new generation vehicles. It is cost competitive, a very profitable company and relatively the most competitive internationally. In particular, its international competitiveness can be traced to marketing scale economies, its VI and sub-contracting strategy (emphasising quality), and continuous development of product and process and process technology.

Telco's competitor, ALL (Ashok Leyland), had to rely on a very different approach. Its objectives were more conservative, emphasising profit maximisation and short-run over long-run payoffs. Its strategies have been greatly influenced by BL (British Leyland), its major sharehold-

er until 1987. It favoured a very low level of VI owing to its lower scale and relative risk-aversion, and relied extensively on small-scale suppliers in order to cut costs. Its production system was still oriented towards GPMs (general purpose machines) with high reliance on human engineering skills. Its TC (technological change) strategy was TI (technology import) oriented, particularly before the 1980s. A more aggressive and independent (from BL) strategy took shape in the 1980s, and ALL showed signs of incorporating a growth objective. It has been a fairly profitable company, but profitability has generally been lower than Telco in th 1980s. While not a broad-based company, it has the most varied product range, and has maintained its 25% share of the MHCV market since 1983. Its international market performance, on the other hand, is much less impressive than Telco's.

BTL (Bajaj Tempo) is the most competitive of the erstwhile LCV manufacturers. It is profit-oriented, but has maintained a very regular rate of investment at a high average level i.e. it has a minimum investment constraint. Its VI level is between ALL and Telco. Its in-house press shop with a range of amortised press tooling is an important source of advantage. It is a highly cost conscious and relatively streamlined organization, and has modernized selectively the most important production processes at low cost. In product TC, all the LCV manufacturers have kept up with each other in terms of basic improvements, but BTL is relatively more (in-house) R&D oriented than M&M (Mahindra and Mahindra) and SMPIL (Standard Motors) . Like Telco, its success is broad-based, founded on low pricing and a comprehensive dealer network. It is by far the most profitable firm in the CV industry, inspite of a decline in profitability after 1985.

Unlike SMPIL and BTL, LCVs are not the dominant product line in M&M, which is known mainly for its jeeps. It does have a profit motive, which however is less dominant than in the case of BTL, inspite of its having a monopoly in jeeps upto 1985. Perhaps this is because it has a lower family shareholding than BTL, whereby the incentive for higher profits is relatively muted. Its VI level is on the same level as BTL, but its press facilities do not include tooling for LCV bodies. Inspite of large-volume jeep production, its production system is still largely GPM-

oriented, with modernisation mainly confined to pockets such as engine machining. Its product TC was geared towards keeping up with the basic improvements undertaken by the others, and some special product engineering efforts for export markets. In jeeps, its market was broad-based, but the LCV developed as an offshoot of the jeep and was niche-oriented. Other than BTL, it was the only firm that had a consistently high return on capital as well as margin on sales. Of all the firms, it is the most difficult to impute any clear-cut objectives and strategies to M&M, at least as revealed in its performance and functioning.

SMPIL, after its failure in the car market, did not target for any ambitious goals. Given its size and vulnerability, it was essentially operating on a survival strategy of low-volume-low-margin. Inspite of being an extremely small firm, it invested in all in-house production facilities that BTL and M&M had (except for the foundry), and even made (wooden) body dies. Of course, these facilities were generally old and completely written-off financially, with SMPIL delaying new investments as long as possible and relying on GPMs and human skills. Product TC was emphasised more, and SMPIL even had some "firsts" to its credit, notwithstanding its small R&D staff. Some of these TC efforts were relatively more significant than those done by M&M. Its success was achieved within a focussed niche market. Although its margins were very low, the return on capital was more respectable since capital investments had been kept to a minimum. Both its market as well as its return to capital came under increasing pressure after the arrival of new entrants.

Technology as a Centrepiece

In chapter 2, we reviewed the literature on TC and came to the unsurprising conclusion that TC is all-pervasive, and that technological dynamism and competitiveness go hand in hand. In our own analysis, we saw that all firms have been quite active in their TC efforts and that the most successful product introductions to date (the 1210 and the Matador) have almost single-handedly carried their respective firms on their shoulders. Similarly, the most dramatic failures (the virtual exit of PAL and HML from the MHCV market) owe largely to insufficient TC ef-

forts. Within LCVs, all the manufacturers obviously felt the need to keep up with each other's TC efforts so as to not suffer an erosion in competitive strength, and BTL's lasting edge over its competitors owes in large measure to its product and process engineering efforts. We also found the econometric relationship between R&D intensity and market share to be strongly positive and implies the same for TC (assuming R&D and TC to be complementary).

There are also very strong linkages between TC, VI and process technology. One of the most important manifestations of Telco's greater VI, for example, has been its impact on its R&D abilities. Again, process technology influences both product as well as process TC efforts. Besides this, technological capabilities are also a guide to future competitiveness. Moreover, as competition increased, TC efforts became correspondingly more important as an instrument of corporate strategy (see below). Thus, it would be no exaggeration to say that the

...development of firm-level technological capabilities lies at the heart of industrial success (Lall 1990, p.25).

For all these reasons, we need to know the reasons for inter-firm differences in the nature and extent of TC efforts and capabilities. We shall attempt such an analysis for our five firms, drawing on the review in chapter 2 and chapters 5-7. To the best of our knowledge, this is the first such detailed attempt in the literature on the automotive industry.

FACTORS INFLUENCING NATURE AND MAGNITUDE OF TC EFFORTS

We have seen that all our five firms have developed important R&D capabilities over time. Process engineering efforts were required in order to operationalise imported technology and later to improve upon it in an incremental way. Product engineering helped in raw material substitution, and gradually in adapting the vehicles for Indian conditions of overloading, bad roads, speed variability, easy repair and maintenance and a premium on functional efficiency. Industrial engineering efforts were required to improve quality, reduce inventories and increase subcontracting over time. In general, product engineering skills appear to be better developed than process and industrial engineering skills, except in the case of Telco. In what follows, the

focus will be on product TC efforts unless otherwise mentioned.

Firm-Specific Factors

(i) Firm Size

Within MHCVs, Telco has a higher research intensity than ALL; between the two LCV firms (M&M is multi-product), again, the larger BTL is more research-intensive (table A.7.1). But if we consider the five firms together, there is no clear-cut relationship between size and research intensity. More interesting evidence is provided by a comparison of the research efforts across the firms.

For example, the most ambitious (and relatively most risky) R&D efforts were made in Telco, the largest firm. This is partly because there is a threshold level for setting up basic minimum facilities for doing R&D in any formal sense - Telco has the most comprehensive R&D facilities, including test track, torture test track, engine test beds, gradient track, CAD (computer-aided design), its impressive ERC (Engineering Research Centre) and other basic facilities. Smaller firms such as SMPIL are not able to afford these facilities. Thus, Telco's size has enabled it to absorb large R&D outlays for three LCV models in quick succession, which may not have been possible for any of the other firms. This is supportive of results of other studies that show that inclusion of product development costs raises the minimum efficient scales of production very substantially.

The other relatively large firm is ALL -- it is effectively larger than M&M, at least for R&D purposes, since M&M is more diversified. R&D at ALL, particularly as exemplified by its multi-axle vehicles, has been more ambitious and commercially successful than amongst LCV manufacturers. Another example is R&D to substitute castings for more energy-intensive forgings, undertaken at both ALL and Telco. ALL, in particular, has an excellent facility for metallurgy.

Another advantage of size is that new aggregates (i.e. major components such as engines, gearboxes, axles etc.) can be introduced more easily, since they can be amortized faster. The

advantage of this is greater when technologies are less dedicated. For example, M&M produces its XDP Peugeot engine with less dedicated technology than BTL's D-B (Daimler-Benz) OM-616, even though M&M's volumes are larger. This has enabled it to import technology for a newer engine while BTL has not. SMPIL's scale handicap became manifest when it decided to introduce its new car by modifying the existing 2.12 litre engine rather than go in for a new one (which would have meant substantial expenditure on new plant and equipment), which resulted in the car's failure.

On the other hand, the absorptive capabilities essential for TIA (technology import and adapt) strategies were not necessarily dependent on firm size. All the firms developed the ability to match selected elements of TI (such as technology for engine, gearbox etc.) with the rest of the vehicle. Over time, even the smallest of them could put together a new vehicle through own R&D efforts, although none of the LCV firms' efforts have been commercially successful so far.

There is no doubt that all the firms have traversed a path of technological learning, as evident in their more ambitious R&D efforts in the 1980s. Firm size may influence the nature of TC efforts. Over time, however, even small firms gain experience and learning through TI, and by undertaking modest R&D efforts. Thus, SMPIL designed and manufactured the Micro lorry and the Countryman. M&M has been modifying its Jeep for sophisticated overseas markets. BTL made the rear-wheel drive Trax, where its experience with the Traveller (import from D-B) came in very handy. All these efforts came about in the 1980s. Amongst the TIA firms, ALL used to resort most often to foreign technology in the 60s and 70s, but after 1981 it has been regularly introducing premium haulage vehicles without any collaborations except for specific aggregates, implying substantial learning through the experience of importing and implementing borrowed technology. Of course, none of these match the scope of Telco's R&D efforts.

(ii) Ownership

All our five firms are public limited companies listed on the stock exchange. In terms of foreign ownership, only ALL was a FERA (Foreign Exchange Regulations Act) company, upto

1985.[1] At the other extreme, SMPIL's foreign holding was nil. The other three firms had foreign equity ranging from 13-26%. Also, BTL and SMPIL had large family shareholdings, unlike the other firms. Telco, M&M and ALL, on the other hand, have much lower family holdings and are generally considered to be more "professionally" run.

Prior to 1969, D-B's technical collaboration with Telco resulted in its becoming quite dependent on D-B. D-B, too, did not allow major changes which would not have been in keeping with the D-B image. For example, it would not encourage the conversion of the OM-312 engine to the DI (direct injection) type, which sacrifices noise and pollution for fuel efficiency (in the case of BTL's OM-616 engine, D-B refused to convert it to DI type, which eventually forced BTL to make its own R&D efforts to do so). The end of the D-B collaboration forced the Telco staff to start thinking for itself. In fact, the ERC was commissioned in 1967 in anticipation of this event. The DI engine in 1971 was the immediate consequence of Telco's own R&D and its freedom from D-B concerns.

ALL's experience with foreign ownership was mixed. The flow of information between ALL and BL has been fairly free and easy. Prior to 1969, the R&D Director was British, indigenisation was in process, and BL was still supplying some components to ALL. Dependence on BL for new designs was complete. Thereafter, an Indian R&D Director took over, indigenisation was completed, and, in 1975, the formal technical collaboration with BL ceased. By the late 70s, ALL became pre-eminent amongst BL's overseas collaborators, and BL became more supportive of ALL's R&D. An Indian Managing Director took over in 1978. The R&D expenditure jumped dramatically, from Rs. 13 and 36 lakhs in 1977 and 1978 to Rs. 104 lakhs in 1979. R&D intensity also more than doubled. Nevertheless, BL still had controlling interest in ALL, and could put pressure to not spend too much on R&D and rely instead of BL technology, such as the 400 series engines, gearboxes and the FES (front end structure). It was only in 1986, when ALL's equity share fell below 40%, and, more importantly, by when BL had probably decided to sell its

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1.A FERA company was one that had 40 % or more foreign equity ownership, and was required to seek additional clearances from the Government (see appendix 1).

ALL holding, that ALL could shop for technology outside the BL group.

Thus, many firms, irrespective of the extent of foreign equity, have had the experience that for the duration of the technical collaborations, the collaborators do not permit any major change in the products, even if the desired change is more suitable for local conditions. The most important aspect of foreign influence seems to be that it restricted the technology options of ALL, particularly at a time when BL was no longer an important player on the world stage, implying that ALL would have preferred to go to another source much earlier than 1986. As opposed to ALL, a small firm like SMPIL preferred to keep going back to the same company so as to minimise search costs as well as disruptions in the existing process technology. BTL's continual choice of D-B owed to the latter's high reputation rather than any constraint on BTL's part.

All the five firms have decades of experience in technology search and absorption. Access to foreign technology was therefore no problem for any of them, particularly since they appeared to have settled down with one major source of technology. In this respect, therefore, ALL had no particular advantage, and each had a more or less equal opportunity to become dependent on foreign technology. But ALL's additional constraint was reduced freedom of action, not just for the duration of the collaboration, but as long as it was controlled by BL. Thus, we would go beyond Katz's (1984) scenario by saying that it is not just ready access to technology that causes the subsidiary of a multinational to underplay its own product design capabilities, but also the reduced room for flexibility and freedom. The LCV firms underplayed their R&D at least partly out of choice, whereas ALL did the same partly out of choice and partly because it was constrained.

(iii) Process Technology

Our industry provides a good illustration of Abernathy's (1978) "productivity dilemma", wherein "large-scale production processes" created "strong economic forces to reduce real product variety" (p.27). This was because the cost of large-scale equipment was very high, and had to be amortized over very large volumes. ALL's choice of GPM technology allowed it to

differentiate itself from a very motivated competitor by permitting a wide variety of options both for the vehicle as a whole as well as aggregates such as the engine. Telco, on the other hand, made liberal use of SPMs and even the ultimate in large-scale processes viz. the transferline. Besides the inertia arising from familiarity of mechanics and service staff all over the country with the existing product, the transferline is a major reason for Telco not having upgraded its 1210 engine for over two decades (the vintage of the 697 engine was 1969, although it was introduced in 1980), particularly since many of the production lines between the 692 and the 697 engine are common. In general, Telco's high-volume technology is responsible in large measure for its lesser variety of models than ALL.

The transferline syndrome also appears to be affecting BTL. With M&M already starting field tests with its newer XD-3 engine, BTL has so far not taken equivalent steps to bring in the next generation of engine after the OM-616. Similarly, SMPIL, which in a sense represents the ultimate in "flexible technology" (although not in a state of the art sense, but in the sense that it relies very heavily on skilled labour), has been able to introduce several different products and product options inspite of very low volumes of production.

Another manifestation of high-volumes is the impact on design of new products. In the case of Telco's 407 and 608 LCVs, and the 807 MCV, there was pressure to utilise existing facilities as far as possible. Given dedicated technology, this often meant using the same part as originally designed for a much heavier vehicle, and explains the higher than necessary kerb weight of these vehicles.

(iv) Vertical Integration

The degree of VI is one aspect of the industrial engineering function which, alongwith product design and process engineering, are the three technical departments where knowledge-generating activities occur. Owing to the iterative nature of R&D (meaning that it involves a great deal of trial and error, and sequential narrowing down of technological options), Telco's integration has allowed it a crucial edge in terms of speed, cost and ability to undertake R&D and

also in learning to do R&D (see chapters 5 and 7). This enhanced R&D capability owes in particular to the in-house manufacture of all major machine tools and press tooling. Thus, by following an R&D oriented strategy, Telco was able to convert a historical situation of high VI into a major source of competitive strength.

At a much lower level than Telco, SMPIL's in-house body tooling capability has permitted some experimentation and allowed a change in the front face of the LCV, as well as a number of factory-built versions of the vehicle. On the other hand, lower VI alongwith more flexible technology has permitted ALL greater variety in its product range. Low VI also suits ALL's TIA strategy. The positive relationship between VI and R&D effort that is indicated by our findings is supported by a similar (statistically-tested) finding by Armour and Teece (1980).

(v) Human Skills

Given the elements of tacitness, incomplete understanding and inimitability in any technological package, human skills become the repository of uncodified knowledge, and are vital for technology absorption and upgradation. Given the low levels of R&D in Indian firms, the absolute level of R&D expenditure and R&D personnel become relevant as threshold concepts. Telco's 753 R&D employees provide a fertile ground for technology absorption.[1] Moreover, 91.7% of its 37459 employees in 1987 were "skilled" (59% in 1960). In ALL, skilled employees were only 7.2% in 1960, but semi-skilled were much higher. Its 242 R&D employees represent an R&D strength not matched by any LCV firm. BTL employed 140 R&D personnel, but its ratio of unskilled to total employees (assuming daily wage earners are all unskilled) was very high - 68.8% in 1987 - which reflects a preoccupation with cost reduction. M&M has 66 or 201 R&D employees, depending on the definition adopted, and in 1960 had 28.6% skilled employees. SMPIL's small R&D staff of 59 is backed up well by a workforce that is 75% skilled (1987),

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1.R&D employee figures are as of 1987/88 for all firms. This, as well as corresponding data for "skilled" employees, is based on our field survey. 1960 data on employees is drawn from Ad Hoc Committee (1960), p.23. It is possible that inter-temporal/inter-firm definitions of skilled do not match.

up from 12.8% in 1960. It is clear that over time, the number of skilled employees would have increased in all firms, but the very high level in Telco as early as 1960 is clearly indicative of its priorities to provide quality and absorb the technology as quickly as possible.

Equally if not more important is the degree of emphasis on renewal of skills and training in new skills via in-house or sponsored training. In this matter, too, Telco stands out. It has a very elaborate training programme, with over 50% of the work force given some form of re-training every year since the mid 80s. Over 1000 full-time trainees are also under training at any given point of time. Telco's training division has received the award of "Best Training Establishment in the Country" on several occasions. Worker training was focussed on upgrading skills, particularly of older employees. Corresponding information on training activities of other companies is not available, partly because it is simply not given as much importance as at Telco. For example, the Telco Annual Reports always give details of training activities conducted during the year, which none of the other firms document. The only comparative but fragmentary information is for 1965-66, when the Tariff Commission (1968, p.245) documented the expenditures on apprentice training schemes - these were (in Rs. lakhs) 16.9 (Telco), 3.9 (ALL, 1964-65), 1.8 (M&M, 1964-65), 0.24 (BTL) and 0.05 (SMPIL).

Telco's human-resource strength is also reflected in the fierce pride of its employees in their organization and its achievements. Moreover, all top executives and in fact almost all executives grow up with the company, which reflects loyalty and team spirit. To an extent, these attributes are also found in other companies such as M&M, but are most dominant in the case of Telco. If, inspite of this loyalty, some Telco executives are lured away by other companies, this is because they are highly sought after, owing to the high pedigree that a stint in Telco imparts. It is certainly true that here Telco is performing a social service, albeit unwillingly, and providing a positive externality to the industry. But since the company prefers to have people brought up in its own traditions, the movement of manpower away from Telco is far greater, in a relative sense, than movement towards it.

Teitel (1984) points out that although human skills are crucial, it is hard to pinpoint the pre-

cise skills or the way of organizing these skills that are key determinants of TC. It is possible to get some idea of this from the status accorded to the R&D chief in the company. Telco's R&D Director was placed on the company's Board of Directors in 1985-86. Much before that, he was a Director in the company. ALL's chief is also Executive Director and on the company Board. In the LCV companies, the status is lower, in keeping with the lower-level performance of their R&D as compared to MHCVs. In M&M, the R&D head is of General Manager status, several ranks below the Board level. Although of the same rank in SMPIL and BTL, the relative status of R&D chiefs is higher than in M&M. In both companies, all the top functional executives were of General Manager rank, reporting directly to the Managing Director. In BTL, however, there are also two Executive Directors (Works Management and Special Projects) above the General Manager level.

(vi) Top Management Orientation

It has often been suggested in the technology literature that factors idiosyncratic to firms play a very important part. One of these is the orientation of top management. This influences many of the factors identified earlier, such as skills, process technology and the degree of integration. It is itself influenced by the nature of ownership. It is difficult to give any precise dimension to this factor. In the case of Telco, its late Chairman S.Moolgaokar has been universally acknowledged as the driving force behind the company, and the reason for Telco's investment and R&D orientation rather than a profit motive.[1] Like Moolgaokar, all the chief executives (except M&M's) who are most identified with their respective companies (Moolgaokar, R.J.Shahaney of ALL, C.V.K. Narayanan of SMPIL, H.K.Firodia of BTL and K.Mahindra of M&M) had engineering degrees obtained overseas. But Moolgaokar's influence remains the most talked-about.

1.Articles on Telco's late Chairman abound. See, for example, Business World, September 14-27, 1988, and Business India, December 26, 1988 - January 8, 1989. Mr.Moolgaokar's speeches in all the Annual Reports make clear his commitment towards an investment and R&D strategy. It is also equally clear from their Annual Reports that none of the other chief executives had this kind of single-minded commitment.

Industry and Economy-wide Factors

vii) Price Controls

Some of the government policy measures such as price controls had a discriminating impact on different firms. Upto 1967, there were informal price controls on all four-wheelers. Thereafter, CV and jeep prices were only subject to price "discipline", whereas those for cars were statutorily controlled. Decontrol of car prices occurred only in 1975. Between 1968 and 1978, SMPIL's operating profits were negative. Only the other car firms, PAL and HML, were similarly affected. Thus, price controls on cars affected SMPIL's profits negatively, and may have influenced its decision to focus on CVs. It also contributed to restricting SMPIL to the "bare minimum" level of TC, at least until the late 70s.

viii) Effective Competition

We have seen that substantial TC efforts occurred as a by-product of productionising imported technology and to comply with local use regulations. Later, TC efforts responded to local demand patterns, partly because of the competition that existed, and partly because of a wider perception that they (the CV manufacturers) should be sensitive to the requirements of the consumer.

However, in the 1980s, there was a distinct discontinuity in technical behaviour. At the industry level, the degree of effective competition is the key explanation for this phenomenon. Prior to the early 80s, there was excess demand for the products of Telco, ALL and BTL. M&M was the sole producer of jeeps. Even SMPIL was producing more than ever before, output increasing every year between 1977-84.

By 1982, the MHCV boom was over. In LCVs, demand growth did not slow down, but four new entrants were licensed. All existing firms had increased capacity substantially, and felt the crunch of declines in capacity utilization at different points in the 80s. The exception was M&M, whose jeeps helped it to sustain more than 100% utilization over 1980-85 (see exhibits 6.1 - 6.5).

With the entry of new LCVs, particularly Telco's 407, the market share of existing manufacturers fell drastically. In MHCVs, too, the competition was much more aggressive. Price increases were muted in all segments, and profit margins came under pressure. Even M&M faced a rival for the jeep market since the entry of the "Gypsy" in 1986. In MHCVs, although the Isuzu FVR priced itself out of the market, its technical performance posed a challenge to Telco and ALL. All these pressures have increased the level of effective competition across the board, one indication of which is a slight but growing interest in hire-purchase schemes amongst the vehicle manufacturers.

We have already observed (chapter 6) how these changes have produced a discontinuous increase in investment in new plant and equipment. We shall now explain its effect on product TC.

The behaviour of the largest firm in the Indian automotive industry is instructive. The success and continuous growth of 1210 output meant that Telco was preoccupied with this vehicle. Its only serious competitor was ALL, whose market base was mainly in the South. As long as growth was assured, it did not worry too much about the failures of its development efforts over 1980-85. Thus, besides high prices and insufficient distinction of the new from the existing vehicles (chapter 7), another reason for failure was that Telco did not allocate enough R&D effort and time into making these vehicles a success. For example, in response to a chorus of consumer demands, Telco hurriedly put together the 807 "mini-bus", which was too heavy to qualify as a genuine 32 seater.[1] The company itself was reportedly unhappy with the product. Similarly, it did not even attempt to produce double-deckers or vestibuled buses, since these markets were too small to interest it. It did not also pay serious heed to the demands of STUs (state transport undertakings) for technological upgradation because this would have involved, inter alia, a chassis different from the truck. This was unacceptable to Telco at that time because

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1. Its kerb weight was 3095 kg as opposed to 3810 kg for the 55 seater 1210E. The 807 truck (LPT 807/32), with a GVW of 8400 kg, had a kerb weight of 3125 kg. Corresponding weights for the 1210 SEA were 16200 kg and 3840 kg.

according to it the market for such vehicles would be limited given that their price would have been higher than that of the conventional truck-chassis bus. It held this conviction because many of its earlier efforts such as power steering on buses, rear-engine bus and the 1516, had floundered because of lack of a market resulting from the higher prices.

As long as the 1210 was providing growth and profits, Telco preferred not to commit large amounts of R&D time and resources in products where the volumes were low and payoffs uncertain (we have already seen that its strength was in high volume applications). However, once it was clear that the MHCV market could no longer provide for its high growth, Telco had to look quickly for alternatives. The LCV segment, whose growth had not faltered, was the natural choice. The 407, which had been on the drawing board in the 1970s, was resurrected and Telco began work afresh on this in August 1984. The 407 hit the market in February 1986. Unlike the earlier innovations, Telco also made major commensurate investments in production technology, prime examples being the transferline for the 407's engine, in 1986-87, as well as all the toolings for the body and cab. Thereafter, in order to maximise synergies and make fuller use of capacity, successive models of LCVs were introduced. Telco's reliance on the LCVs in order to achieve growth (a structural imperative in the company) was near total, and it therefore had an absolute commitment to make these a success. This commitment was reinforced by the fact that LCVs were a completely new market segment and unlike earlier innovations such as the 1312, 1516 etc., did not compete with the company's existing product line. The broad-banding policy announced by the Government in January 1985 gave a legitimacy as well as urgency to Telco's push into LCVs.

The other market leader, BTL, was also galvanised into action, on a lower scale. Like Telco, BTL used to concentrate on upgrading its mainstay, the Matador, and offering many variants of it. Unlike Telco, BTL did not have a growth imperative, but nevertheless came under pressure for reasons mentioned earlier. Its R&D expenditure doubled in 1983, and again in 1984, and R&D intensity rose substantially. It opted for a completely new LCV, and spent a considerable amount in setting up the production facilities for that. Qualitatively, one of the changes that has

occurred is BTL's attempt to rely increasingly on its own R&D, as witnessed in the development of the Trax, the F 407, the DI engine and the recent forays into rear-wheel drive vehicles.

Similar patterns can be discerned in the other firms. ALL has always gone in for a variety of product offerings. In the new situation, however, it has opted for an expensive collaboration with Hino (which it could have conceivably done without, since it had done an engine change in the early 80s), and also signed yet another engine collaboration agreement with Iveco. Both these agreements were intended partly to expand its product range, lighter vehicles with Hino and very heavy duty ones with Iveco. Similarly, a semi-forward truck was introduced after years of procrastination. The offering of models in product ranges not attempted previously implies that even ALL, with its low break-even point, was searching for growth outside its immediate areas of operations. M&M's higher plane of TC activity is reflected in its changing its jeep body in 1985 for the first time in 30 years, and in its takeover of Allwyn Nissan wherein it got ready access to a new generation LCV. The XD-3 collaboration was another example, in which it scored a first. The Peugeot 504 collaboration also signalled an attempt to expand the product range, and its increasing efforts to tap developed country markets meant a corresponding increase in TC efforts to satisfy these demands. SMPIL, too, was relatively more active in the changed scenario of the 80s, as witnessed in its pioneering of the mini-lorry concept, and in its attempt to expand its product range by offering the 3 ton lorry and the monocoque bus. Moreover, realising that its LCV range would come under heavy pressure from new generation LCVs, it opted to produce a luxury car where the competition, at least at that time, was non-existent.

This changing behaviour for all the firms is illustrative of what Rosenberg (1976) calls the asymmetry between pressures and incentives.

> It is possible...that threats of deterioration or actual deterioration from some previous state are more powerful attention-focusing devices than are vague possibilities for improvement (p.124).

This is true, to a greater or lesser extent, for all our firms, although the nature of the response has been different for different firms. The pressure was felt most keenly in Telco owing to its high VI and break-even point, and therefore had the most dramatic impact on that firm. Earlier, most

firms preferred to continue to produce existing models and thereby realise "time economies", or what Katz (1987) calls output-stretching TC. Now, all of them want to widen their product range beyond the existing levels. Moreover, consumers have begun demanding vehicles with more options, and firms have begun to respond, as they must. Quality of the vehicles is also being slowly improved through a gradual adoption of CNC (computer numerically controlled) machines, particularly in finishing operations. However, the introduction of new vehicles has not resulted in the phasing out of the earlier ones -- the most important reason for which is that the firms have introduced complementary vehicles not intended to compete with their existing product range.

It may be noted that we have not analysed the determinants of technological capability separately, the implicit assumption being that the scope and ambitiousness of R&D efforts reflects corresponding R&D capabilities.

To sum up this section, we have enumerated the possible influence of some of the more important factors on the nature and magnitude of TC efforts. For Telco, the orientation of its top management favoured intensive development of human skills and a high degree of VI. Unlike other firms, its in-house machine tool division has meant an early orientation into process change. All these factors favoured an R&D-oriented strategy. Over time, as learning and size of firm increased, Telco became more ambitious in its R&D efforts, a process that received a decisive prod when effective competition increased substantially. ALL, on the other hand, was a foreign-owned firm, which, at least initially, constrained its own R&D as well as choice of technology. But there were many other reasons for this, such as the low level of VI and relatively small size. Also, since the strategy was one of product variety, this could have been sustained only through TIA. Own R&D received a major boost with the takeover of an Indian Managing Director.

None of the LCV firms was effectively as large as ALL (in terms of turnover), which meant that R&D was less ambitious in its scope. Also, unlike ALL, none of these firms faced a competitor with strong R&D orientation. In a protected market, all the three kept up with each other in

terms of basic improvements. Relative to the other two, SMPIL was handicapped by its size as well as price controls on cars until 1975. M&M's larger scale as well as less dedicated technology has allowed it to import technology for a more recent engine (the engine can be used on both the jeep and the LCV). Over time, the firms have enjoyed the fruits of learning and have become more adept at TC. When competitive pressure rose, firms responded by increasing TC efforts. BTL faced potentially a bigger threat than M&M, since it was dependent solely on LCVs, where a competitor like Telco was now in the fray. BTL responded by introducing a completely new LCV, attempting diversification, and by laying greater stress on own R&D.

PROSPECTS FOR THE FUTURE

Domestic Competition and Firm-Specific Prospects

In the 1980s, the Indian automotive industry finally woke up from its slumber. Competition set in, new generation technologies were licensed and consumers became more demanding. Our five CV firms suddenly found themselves confronting new competitors and also facing a demand crunch. The 1990s promise greater competition than ever, implying increased pressure to cut costs, improve quality and compete on technologies. How will the CV manufacturers face up to these conditions?

Telco is arguably the most competitive of all firms. It is the only firm that increased its overall share of the CV market after 1985 owing to its successful diversification into LCVs. More than that, it has recently become the market leader even in LCVs (in 1990, it sold 13757 407 LCVs as opposed to 13541 Matadors by BTL). This owes to its technological expertise and its ability to continually improve upon its products. However, one of its major strengths i.e. a high level of "full" VI, could also become a weakness in a more cost competitive and uncertain market. In this, Telco has much to learn from the Japanese, who have achieved dynamic technological economies (like Telco) without sacrificing on economies of specialization, scale and of buying from lower-cost suppliers. Perhaps to begin with, it could try to sell some of its products such as

machine tools, press tools and even castings and forgings on the open market. Another weakness is Telco's high-volume technology, which is a disincentive for introducing new products and phasing out earlier ones, as is the case with the 1210 engine. Here, its mastery of process technologies is helping it to improve the flexibility of its production techniques, for instance by retrofitting flexible capabilities onto previously dedicated machine tools and designing more flexible machines for the future. Not only this, Telco also needs to develop its design capabilities to develop more interchangeable parts, since its ultimate objective is clearly to become a full-line producer of vehicles. Here,it can learn from Daimler-Benz's unitary principle of final product variety with the same basic parts. Another issue is Telco's growing size and diversification of activity, which means that a multi-divisional form of organization may become more suitable than the functional structure that it currently employs. Overall, it is probable that Telco will dominate the Indian vehicle industry even more than it has so far, which will be a vindication of its strategies. In fact, it is in a more competitive environment that its strengths and its ability to adapt to changes will become more apparent.

ALL has demonstrated strengths in offering product variety. It is well positioned in important market segments of the future, such as premium duty vehicles. Its "flexibility" (in an Indian setting) of process technology has also allowed it to bring in contemporary diesel engine technology with Hino engines, and also make a move towards very high horsepower Iveco engines. However, it has to make up a major backlog of modernisation of processes and equipment requiring very large investments of money. But it also has an advantage of a late starter, in that it can go straight from GPMs to NC and CNC machines without the intermediate stage of SPMs. In an era where price competition is becoming more important, ALL will need to take care that this major modernisation does not make its vehicle prices uncompetitive. For this not to happen, it will need to upgrade its process and industrial engineering capabilities.

BTL has been quick to grab the opportunities that came its way, and has always been a step ahead of others in this respect. Its offering towards new generation technology (the Traveller) was in the market even before M&M and SMPIL had made any moves in this direction. Also, its

price competitiveness will be an asset in the more competitive market. However, it now has to reckon with a stronger competitor (Telco), which has already become the market leader. Since Telco's 407 offers a ton more carrying capacity than the Matador, it has clearly affected the latter's sales, particularly in respect of operators who used the Matador to carry loads at or above its rated GVW. Thus, BTL will have to upgrade and improve the quality of the Matador, or complement it by adding another vehicle range, particularly since its new offering, the Traveller, has not been very successful so far. It also needs to improve its quality control systems and process technology. Its transferline for the Daimler-Benz engine may prove a hindrance in bringing in more efficient engines and, unlike Telco, it does not have process engineering expertise to address this problem. It is certain that BTL will have to move to newer engine technology well before it can achieve the volumes required to utilise even a fraction of the transferline capacity. One advantage that it has in doing this is that it has the lowest debt-equity ratio of all the companies. It may also want to consider moving to a more decentralized and systems-oriented form of management, away from the top-heavy decision-making structure that currently prevails.

As a company, M&M dwarfs its competitors BTL and SMPIL. But it exploited this only to the extent of achieving synergies in marketing its LCVs. Its LCVs are under even more pressure from Telco than BTL's, since the FJ has a niche in heavier payload applications, which implies more direct competition with the 407. Another problem is a major backlog of process upgradation, and also investments in relatively more volume-oriented technologies. On the jeep front, too, the Maruti "Gypsy" has eroded M&M's market share. But it has made some important moves towards introducing newer products, such as the XD-3 engine and the 504 pick-up. It also acquired a major share in Allwyn Nissan, manufacturer of new generation Japanese LCVs, which potentially represents both marketing and manufacturing (since the XD-3 engine can be used on the Nissan Cabstar) synergy. This may also hasten the demise of the FJ series. M&M's jeeps have been exported to many developed countries after substantial product engineering efforts, but are due for a complete model change in the near future. As in the case of ALL, all these fresh investments require major financial outlays, which implies upward pressure on prices.

The future seems bleak for SMPIL, which has been shut since February 1989. It is a "sick" company with large accumulated debts. Efforts to resurrect it through an infusion of institutional capital have not proved successful so far. Even if it does re-open, the LCV market is a very difficult one, with seven competitors in the fray. Its car venture was also unsuccessful, and turning it around would mean large investments for the engine and gearbox. Also, there is fresh competition in the class of luxury cars from Hindustan Motors as well as Telco (the Tata Estate is due in 1991). For all these reasons, firms with potential interest in taking over SMPIL have opted out after deeper consideration. This turn of affairs is due to its long neglect of modernisation and inability to expand beyond a narrow niche market, and hastened by the failure of the Standard 2000 and Government excise raids.

Some General Weaknesses

Besides the specific weaknesses of individual firms mentioned above, some more general deficiencies also emerged. All firms save ALL were more integrated than their highly efficient Japanese counterparts. Also, none of the firms have achieved the cohesion and symbiosis that enables the Japanese "group" to function in unison. Thus, Indian firms, with the exception of Telco, have largely lost out on the technological and other dynamic economies that result from a closely interactive buyer-supplier relationship. Telco has achieved cohesiveness largely by being highly integrated. To tackle these weaknesses, the component manufacturing sector also needs to improve in terms of quality and reliability. Of course, it is true that the Japanese model cannot be simply transferred or replicated in India, but it is my belief that the two major features -- lower levels of "full" integration and close relationships -- are worthy of emulation, the idea being to get closer to the systemic efficiency that the Japanese have achieved. As far as lowering of full integration is concerned, the idea is to take advantage of the recent trend towards upgradation in the component supplying industry and also to render the firms less susceptible to demand variability by reducing the break-even levels of operations. The choices are varied, and could include a shift to tapered integration (part internal, part external procurement), quasi-integration (inde-

pendent supplier in which the firm has a stake, as is ALL's Ennore foundry), partial integration (in-house division which also sells in the market, and may be the suitable model for Telco) or complete external sourcing of the product concerned.

On process technology and allied issues, we saw that all firms except Telco have under-invested in process change. New microelectronic technologies are having a particularly beneficial impact on quality. For this reason alone, Indian firms need to accelerate investments in process control and quality control technology. Another reason is the dynamic impact of microelectronic technology through a process of learning. Since this technology is having an all-pervasive impact on R&D, manufacturing, quality control etc, it is important for firms to initiate a deliberate process of learning and acquisition of capabilities associated with the technology. In order to fully exploit the new technology in an Indian context, firms have to also build up stronger industrial engineering capabilities. These capabilities are particularly important in discontinuous industries such as CVs, where there is no one way of organizing production, choosing automation levels, etc.

Similarly, there is not enough attention devoted to the organization of production, plant lay-out, control systems, manning practices etc. Although these are not issues we have studied in any depth, they are partly reflected in high inventories, over-manning and poor labour productivity as compared to international standards. Inventories also arise from lack of sufficient coordination with suppliers.

Product TC has been conditioned very strongly by the nature of demand. But although much TC activity has taken place, in-house R&D and learning efforts need to go up very substantially in order to be able to better generate incremental improvements in own technology and improve the absorption and diffusion of imported technology. Part of these TC efforts and firms' attitudes towards technological improvement are reflected in R&D expenditure and R&D intensity. R&D intensities of Indian CV firms are very much lower than their developed country counterparts. But if we look at R&D expenditures, the comparison becomes even more unfavourable, owing to the low turnover of Indian firms and lack of diversification and therefore economies of scope.

But even with existing size levels, there is enough leverage as well as a necessity to increase R&D several-fold. This does not mean that any firm can or should even attempt to substitute for imported technology which represents (for the importing firm) a step-jump improvement in technology, since R&D is a highly resource-intensive activity.

In building up capabilities for generating improvements in product and process, and better absorption and diffusion of imported technology, Indian firms also need to remember that they are faced with moving targets. If the ultimate objective is to compete with world-class CV manufacturers, then the targets for improvement in say, productivity, must take account of the fact that world-class firms are constantly improving . In order to catch up, therefore, Indian firms must improve at a faster rate, which calls for increased investments in learning, as mentioned earlier.

One way for firms to reduce the disadvantage of size is to collaborate in R&D and product development. The scope of this collaboration cannot of course be very ambitious given the current capabilities of Indian firms. At present, there is very little joint activity between rival firms, owing to the business ethos in India as well as Government policy which frowns on any linkages between large enterprises. This is unfortunate, since even the largest auto firms in the world are collaborating with each other to reduce product development costs.

Collaboration need not be restricted to R&D. In fact, given prevailing conditions, it would probably be easier for firms to first collaborate in production, by producing volume-sensitive items for each other in flexible production facilities. A particularly relevant case would arise when a major new aggregate (engine, gearbox etc.) is proposed to be introduced, calling for large investments. Here, companies could even consider using a common aggregate on their different vehicles, as is often done in Europe. A beginning has been made in India on these lines, with M&M's XD-3 engine proposed for Mahindra Allwyn Nissan, and ALL's Hino engine for DCM-Toyota LCVs. Firms could also share expensive R&D facilities where feasible. All this may help in the process of reducing levels of VI as well.

Export Prospects

The Indian CV industry can be looked upon as a success story of Third World industrialisation. Set up to import-substitute and replace trucks from Europe and the USA, it fulfilled this function efficiently, particularly in the MHCV segment. However, in the process of import substitution and responding to the nature of local demand, the cheap and sturdy CV from India found its market access abroad restricted to relatively poor countries with similar demand conditions. Moreover, this access was limited to MHCVs.

Even with existing products, the industry can export more than it has so far. India's strength lies in medium-duty CVs, with Telco and ALL no.1 and no.6 respectively in the world in terms of output in the 10-16 ton GVW (gross vehicle weight) class. Within this range, more built-up vehicles such as buses, special purpose vehicles etc. would enjoy a greater edge because they demand labour-intensive operations. Geographically, too, there are a number of uncharted markets such as Eastern Europe and the USSR, but these will be difficult to enter following the scramble for them after Perestroika. In many other developing country markets such as South East Asia and China, the Japanese have a virtual stranglehold.

In the longer run, greater gains are possible through product upgradation to meet the demands in the Gulf and Western markets. Some changes are now being introduced owing to greater domestic competition, and the suggested action plans raised in the two previous sub-sections, if implemented, could also help in the upgradation process. By itself, however, this will not be enough, since the manufacturers will still cater to domestic demand. It is not possible for firms to risk major investments primarily for export markets. In the long run, policy must aim to mould the nature of domestic demand towards greater awareness of problems of safety, pollution, overloading and so on. Some suggestions towards this end follow in the next section.

The traditional Indian LCV was, like the MHCV, highly functionally-oriented and had a low horsepower to weight ratio, but these characteristics were virtual disqualifications in the LCV market abroad, which demanded comfort, aesthetics, and high horespower. More recent entrants with products embodying modern Japanese technology have had a little success. But here the

very low scales of these firms will stand in the way of any sustained export prospects. Exports of components appear to hold better promise, as already demonstrated by Eicher's recently contracting to export some components and aggregates to its collaborator, Mitsubishi (Eicher produces Mitsubishi's "Canter" LCV in India).

Telco's attempt to start LCV exports has a greater chance of long-term success. This is because it now produces a range of CVs and therefore enjoys some economies of scope, both in production as well as international and domestic marketing. Many of its facilities are being used for both MHCV and LCV production, which reduces the investment requirement for the LCVs. Its plan to produce (large) cars is in line with the dominant pattern all over the world, wherein LCV manufacturers also produce cars. As its LCV volumes increase, and as car production comes on stream, scope economies will improve. This will also help it to dominate the domestic market and gain an advantage over the other LCV manufacturers, who are not similarly placed.

Given its durable goods characteristics, exports of CVs should not be undertaken in markets where potential exports do not cross a minimum volume, since establishment of a servicing and sales network is a costly proposition. Another point to bear in mind is that many countries, especially in the developing world, like to assemble vehicles from knocked-down kits rather than import them in a fully-built-up form. This means that firms in India should think of joint ventures and the possibilities thereof as much as much as they explore the market for direct exports.

In general, Indian firms have not gone in for strategic alliances to help push exports. This has pushed up the costs of exporting, since, as mentioned above, distribution and servicing of vehicles is a very expensive activity. One method is to have a tie-up with the technical collaborator, as Maruti has done with Suzuki for export of 800 cc cars from India. The advantages of this are access to the brand name of Suzuki as well as to Suzuki's existing network of promotion, sales and service. Since some of the world's biggest names are seeking access to different markets through strategic tie-ups, this seems to be a very sensible route for Indian firms to explore.

FURTHER REFLECTIONS AND SOME POLICY IMPLICATIONS

The specific purpose of this thesis was to study firm-level behaviour. We have already made some suggestions for corporate strategies. In this section, we will, inter alia, cull out a few of the more important policy implications that have arisen as a by-product of the analysis, since the firms have operated in an interventionist policy regime. Although our sample is small, some general lessons could emerge for policy relating to metal-working industries in India. Implications could also be drawn, after further study, with respect to the public sector (see below). Moreover, there are sufficient points of similarity with the behaviour of firms in other industrialising countries for our analysis to be of wider interest.

The CV industry, particularly the MHCV segment, has most of the characteristics that are usually associated with the public (i.e. state-owned) sector in India. These include heavy capital investments (which implies an exclusion of small firms), long gestation periods, major employment possibilities and a perception that the industry is of strategic interest to the country. In fact, the 1945 Statement of Industrial Policy defined the vehicles industry as an industry of "national importance" which could have been nationalised if necessary (see appendix 1). Thus it is at least partly fortuitous that the CV industry is not in the public sector today. As such, it does provide a feel for what would happen (would have happened) if public sector industries were to privatise (would have privatised).

For example, one of the charges levelled at the public sector is that it often produces whatever it wants to without caring overly about the pattern of demand (steel being a prime example).[1] It is an open question as to whether the public sector steel industry would have been more responsive to demand if it had been in private hands **and** been given the freedom to decide its own product mix. As we have seen, the private sector CV industry has been particularly in tune with market demand. Again, many public sector firms do not make profits consistently, and

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1.Although it possesses the capability to do so, the Steel Authority of India Limited provides only a fraction of the deep-drawn and extra deep-drawn steels that are required by the automobile industry, one of its major users. This is inspite of the fact that such steels are highly profitable to produce.

some do not make profits at all. On the other hand, four out of five CV firms have always enjoyed high/comfortable profits, inspite of being in a relatively more competitive environment than most public sector firms. And it cannot be said that CV firms were not fulfilling social objectives (as public sector firms are supposed to do), since they provided the user with an efficient transport solution, which is what was expected of them. So, could some public sector firms be privatised without comprising on social or private objectives ? These and many other questions are deserving of further enquiry, in which the findings of this study should provide some insights.

As to our study, it has vividly brought out the diversity of individual firm behaviour and competitive strategies. This owed partly to the fact that import competition was non-existent, and domestic competition limited. Inspite of firms going in for regular expansion of capacity, demand always seemed to keep a step ahead. Thus, small firms like SMPIL were not threatened. The most vulnerable, SMPIL competed essentially by avoiding competition by serving a geographically limited market that did not encroach upon the major territories of its competitors. Firms like Telco and BTL, on the other hand, had broad-based strategies. This diversity of skills, endowments and behaviour makes clear that a policy change need not influence different firms in the same way.

One of the major contributions of this analysis has been the demonstration of the importance of production organization in the shape of VI. It is the cohesiveness of Telco, resulting from its high VI, that is to a large extent responsible for it being dynamically competitive. High VI has also shaped other elements of its strategy. The extent of its integration goes against conventional wisdom/practice in the automotive world. But it may not in fact have integrated to the extent it did had it not been historically necessary. Similarly, other firms such as SMPIL and BTL may also have not gone in for expensive equipment such as presses. Since competition was lacking, these firms were able to bear the cost of such machinery and amortize it over the years. Having made these investments, these companies enjoyed at least a temporary advantage when the situation turned more competitive. Today, the intense competition demands keeping prices to a mini-

mum, so the Japanese LCV firms are sourcing out as much as possible, the more so because of their low scale of production. Even Telco is now seeking to increase buying-in to the extent compatible with its objectives and its degree of VI, in order to reduce its overheads and capital requirements. This does not mean that it will give up facilities such as machine tools and press tooling, which are a great source of strength even today, but it may like to reorganize them in the manner suggested earlier. No firm set up recently would have contemplated integrating into upstream processes like machine tools, press tooling, or castings and forgings, owing to their high capital costs as well as relatively easier access in the market. Thus historical circumstances as well as competitive pressures have shaped firm strategies and attitudes towards vertical integration.

In terms of the relative impact on cost, bought-in materials (as compared to labour and capital) are by far the most important input, accounting for 60-70% of cost. Cost of materials bought in is affected by the relationship between firms. In the long run, it is not the VM (vehicle manufacturer) with a better bargaining position vis-a-vis the CM (component manufacturer) but the one with a cohesive overall relationship, who will enjoy economy in buying in terms of costs and quality as well as a more supportive attitude on the CM's part. Government policy could be supportive of such a relationship by allowing VMs and CMs to invest in each other's equity without complications such as anti-monopoly restrictions.

A related point is that firms should be free to collaborate either in R&D, sharing of facilities or producing components or aggregates for each other. Similarly, if they wish to generate scale economies by selling some of their upstream output on the open market, licensing policy should not prevent them from doing so.

The Japanese have demonstrated the advantages of a high growth strategy. Firms who increased investment, cut prices or developed products faster than their competitors achieved a "winner's competitive cycle". In the late 1950s, Honda invested much more than Tohatsu and displaced it as Japan's leading motorcycle manufacturer in less than 5 years. Tohatsu went bankrupt. A similar story is Honda's beating back Yamaha's challenge in the early 1980s by

cutting prices and introducing new products very rapidly (see Abegglen and Stalk 1987, chapter 3). Of course, such policies are far more likely to be more successful when overall demand is itself growing fast. In Japan, demand for automotive vehicles, for example, increased over ten-fold between 1950 and 1960, and similarly between 1960 and 1970.

Except for Telco to an extent, none of the Indian firms displayed any systematic tendency to use growth as a competitive strategy. Even in Telco, this strategy was not as obvious as for Japanese firms, since it was not supported by a correspondingly high growth of demand (see chapter 3). In India, the Government has not taken any important supportive measures to strengthen demand for CVs. Owing to low incomes, demand for CVs till recently exceeded that for cars. Similarly, within CVs, demand has been skewed towards MHCVs. Since Indian MHCV firms are already of reasonable size, Government policy could capitalise on this strength and help to boost demand for MHCVs by increasing and improving road-building activity,[1] and providing better access to credit for purchase (of course, these measures would boost LCV demand as well).

Unfortunately, Indian policy has always been hesitant to support winners since it goes against professed socialist goals which include the prevention of concentration of economic power. Thus, although none of the CV firms has faced a sustained barrier to growth, it is possible that they may have restrained themselves to some extent, knowing the policy environment in which they functioned. In the CV industry, policy has in any case failed to check economic concentration (equally true for much of Indian industry at large). Our suggestion is that the competitive firms should be allowed to become stronger in an unfettered environment, with policy playing a supportive role where necessary.

1.Of course, the extent to which it can do this depends on its overall transport planning, and the role which road transport is expected to play vis-a-vis railways, waterways and air transport. But it is true that road-building and maintenance have been widely acknowledged to be grossly inadequate, as brought out in the report on "Perspective Planning for Transport Development" (Planning Commission, 1988). For example, the inadequate Plan outlay for roads has resulted in excessive fuel consumption, wear and tear of vehicles, and extra accidents, all of which are estimated to cause losses of at least Rs. 30,000 million per year (according to a road users' cost study, quoted in Planning Commission, 1988, p.147).

It is not only the quantum, but also the nature of demand that requires policy intervention. The demand pattern can be moulded by designing bigger and better roads, strictly enforcing regulations on overloading, and by building in a progressive element into the legislation regarding pollution, noise and safety regulations. Some of these issues (such as overloading and pollution) have been addressed by the Motor Vehicles Act of 1988, but it is necessary that these are enforced and do not remain merely on paper. These would help to improve the horsepower to weight ratio and would result in more nearly optimally designed and safer vehicles. Also, the use of multi-axle vehicles and tractor-trailers should be encouraged, since these are more fuel efficient per tonne-km. These steps would improve efficiency and also help to make the vehicles more exportable. Of course, all this can only be a gradual and evolutionary process, since the changes involved require huge investments. Moreover, they would also result in vehicle price increases, which the market is highly resistant to, a constraint which can be relaxed only as incomes rise in the long-run.

Larger firms have, over the period of our study, not enjoyed any critical advantages in terms of production costs. But they have enjoyed an edge in marketing, and ability to absorb the costs of product and process change. However, upto the mid 1980s, when competitive pressure was lower, small firms such as SMPIL did not lose out. In this environment, it did "nuts and bolts" R&D with minimal disturbance to its process technology. Its R&D achievements which, alongwith selective TI, enabled it to keep apace with its much bigger rivals, came about with very low R&D expenditure and a small R&D staff. The lesson to be drawn is that in a not very competitive environment, with all firms doing incremental TC, a smaller firm is not necessarily worse off. Also, R&D expenditure is not fully reflective of the actual R&D activity that occurs.

Once competitive pressure mounted, SMPIL found itself increasingly at sea. Distinctly different products with a better finish were now demanded. Large firms had an edge, and were better able to survive the onslaught of the Japanese entrants. On the other hand, small specialist firms have thrived in competition in both the CV and car industry abroad, particularly in Europe. Such firms offer a unique product that caters to a specialised need, such as Porsche in cars and Sed-

don-Atkinson and Foden in MHCVs. They draw upon the technical expertise of specialised automotive consultants (Porsche is itself an engineering consultant) as well as the highly progressive CMs that abound in Europe. In India, such research expertise is not available, and technology imports are screened. This makes the survival of small firms more difficult in India today than in a far more competitive market in Europe. Thus, scale promises to be a far more important issue in the future than it has been in the past in India.

Irrespective of whether small firms can survive, India requires a more advanced central research facility than exists at the moment in the shape of the ARAI (Automotive Research Association of India). This could be done by upgrading investment and skills in ARAI which could then act as consultant to individual firms. Of course, this centralised facility is no substitute for developing own R&D expertise by the final assembler who is the "...nerve centre of the auto enterprise" (Altshuler et al 1984, p.123). Other ways of enhancing scale economies are for firms to undertake joint production, and to sell intermediate products such as castings, forgings, machine tools etc to each other and in the market. This need not be the route for all firms, but policy should not obstruct such firms as wish to do so.

In the same vein, protection and licensing policies have allowed Indian firms to neglect one of the fundamental tenets of LCV manufacture, viz. that LCV manufacturers also produce cars. This is also related to the earlier point that firms did not have a growth objective -- growth could have been achieved by diversification into related activities such as cars. Even the MHCV firms, large as they are in terms of physical output, have much lower turnover than many of the world's leading firms, owing to lack of diversification and low unit value of output. In order to promote economies of scope, Indian policy makers should actively seek alliances if not mergers between MHCV, LCV and car firms, as proposed for Japan by MITI (Ministry of International Trade and Industry) in the 1960s, resulting in one merger and several tie-ups amongst Japanese auto firms. In India, the excessive number of LCV manufacturers (seven at present in operation) also demands such a step.

One of the most striking and pervasive changes in the CV industry was a step-up in the pace

of activity after effective competition increased, and the market became a buyer's instead of a seller's market. As we have seen, firms came under pressure to reduce prices and improve quality, which they sought to do by increasing product and process TC activity, and attempting to increase out-sourcing of components. There was also added pressure to increase exports as demand constraints began to bite. The question to ask, if the results were so beneficial, is why policy did not attempt to increase competition earlier?

One reason is that there is a trade-off between competition and economies of scale, to which the Government may have been sensitive. As the number of competitors increase, the potential scale of each gets reduced. Of course, there can be competition even between two firms, as demonstrated by MHCVs after 1984. But this came about only after three decades and owed to a combination of demand stagnation and over-capacity. It could not arise earlier because output could not keep pace with demand, partly on account of conservative growth objectives of firms. The other and less charitable explanation but probably closer to the truth is that the Government was not really interested in promoting competition. This situation changed in the 1980s when Government allowed fresh entry in order to improve technology and promote competition. However, it went too far in LCVs and allowed too many firms to enter, pushing back the realisation of scale economies for all.

Several lessons can be drawn from this. One is that competition does not require a large number of firms. Secondly and contrary to the MRTP (Monopolies and Restrictive Trade Practices) philosophy that increasing capacity of dominant firms leads to monopolistic tendencies, we have seen that it can increase the degree of effective competition. Thirdly, an increase in domestic competition is sufficient to induce a step-jump in the degree of technological and other activity. The policy objective should be to continue to increase domestic competition without raising the number of firms by removing any constraints or procedural hurdles to growth. In fact, this would be a more effective way to usher in more dynamic TC behaviour than seeking to influence TC "directly" by giving incentives such as R&D write-offs. Such incentives existed even prior to the 1980s, but TC activity was decisively influenced only during the 1980s when competitive

pressures mounted.

Eventually, the industry must be made subject to import competition so that tacit market collusion does not emerge. Perhaps this could be done in the manner of Japan, where the most competitive segments (small cars) were the first to be thrown open to import competition. In India, this would obviously be MHCVs (the most competitive of all vehicle segments including motorcycles and scooters, cars and CVs). A protective import tariff roughly equivalent to the disadvantage of paying higher input and capital goods prices as compared to international norms, could be levied.

Besides the product industry, Government policy has also provided protection to indigenous R&D through licensing of technology imports and direct foreign investment. This has been less complete than for the industry, since periodic replenishment of technology was allowed. At the same time, this protection of product and technology alongwith local use regulations has spawned substantial R&D effort by CV manufacturers. Even Telco would not have developed its R&D capabilities to the extent it did had it not been for such policies. As for product, some easing of constraints on technology imports must be considered. Already, manufacturers can import technology upto a limit of Rs.30 million annually under the Technical Development Fund. We would suggest that more substantial imports of technology continue to be screened, since they would have balance of payments ramifications besides affecting local technological effort. The latter is no longer an important issue since the industry has had sufficient time to develop. However, the former consideration means that policy should be more favourably disposed towards technology imports with a greater export promise or export obligation.

We have presented sufficient evidence to show that the Indian CV industry is far less automated than its developed country counterparts. This is true of even the more automated Telco, since automation has been applied selectively. Moreover, since it has manufactured its own machinery, this does not contain an unnecessary bias towards capital intensity as imported equipment would have. In some instances, especially in LCVs, this substitution was achieved by firms buying second-hand/phased-out equipment from their technological collaborators. This

capital substitution has imparted domestic competitiveness to the firms, but it has also meant that finish and consistency has been less than of international class. So far, however, products such as Indian MHCVs have found niche markets abroad, partly because cheaper labour and capital substitution enabled them to be price competitive.

There is a view that the microelectronics revolution may render automotive production in ICs (industrializing countries) obsolete, since the lower wage and flexibility in ICs (on account of using more labour) is getting overtaken by flexible production systems with far better quality and consistency, where programmable machines are able to substitute for skilled labour.[1] This implies that the future of ICs as major exporters of automotive products (on the premise of relocation of the industry in lower wage areas) may come under a cloud, particularly in those products where flexible automation will figure prominently in the future (Nunnenkamp 1990). At the same time, there will be product segments where ICs will continue to be competitive or become relatively more competitive. We would argue that Indian MHCVs constitute one such segment and which have the potential to become more important world players than they are at the moment.

In India, road transport has always played second fiddle to the railways in terms of public investment outlays and importance accorded to it. Yet, the railways have not performed adequately, which means that demand for road transport, both passenger and freight, has always been growing faster than that for railways. The lack of attention to road development has also influenced the kind of vehicles demanded by users. These as well as other factors brought up earlier meant that on the whole, the policy regime did not play a supportive role in the growth and development of the CV industry (although admittedly it was not actively negative as in the case of passenger cars). Inspite of this, the CV industry in India has been a case of efficient import-substitution. This has happened because firms followed strategies that, although different, allowed all of them to develop capabilities for generating incremental TC. Of course, some

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1.This debate is joined by, inter alia, Jones and Womack (1985), Watanabe (ed.) (1987) and Nunnenkamp (1990). A more general discussion is in Kaplinsky (1984).

strategies were more successful than others, and this issue has been the main purpose of our study. In a more demanding environment, on the other hand, some of the strategies were not sustainable. And it is certainly true that if policy had been more actively supportive, the CV industry would have performed better.

The question remains as to why the firms followed the strategies they did. Even prior to the 1980s, there was some pressure on the firms to perform. For one, PAL and HML were also competitors upto the 1970s, particularly in MHCVs and to a lesser extent in LCVs. That they got competed out proves that some pressure did exist. Secondly, the Indian market demanded vehicles different from those initially imported, and firms responded to this in order to gain an edge over their competitors. Moreover, even if one firm in each of the MHCV and LCV segments responded to such a demand, the others would feel obliged to follow or else go the route of PAL and HML. This factor may be partially responsible (besides other advantages such as scale) for the MHCV segment having a relatively better overall performance and reputation vis-a-vis LCVs. Since Telco is known to be a progressive company owing to the orientation of its Chairman as well as the well-known "professionalism" of the Tata group of companies, this may have put added pressure on ALL to perform. Although an intangible factor, this is probably quite important in explaining the observed differences between LCVs and MHCVs.

The industrial history of the world is replete with stories of failure. The reputation of industries owes eventually to a handful of outstanding firms, such as GM and Ford for automobiles in USA, Toyota, Nissan and Honda in Japan, Volkswagen, BMW and Daimler-Benz in Europe, and so on. Thus, if the Indian environment alongwith individual firm predilections ultimately breeds even one or two world-class automobile (MHCV, most likely) firms, this should be seen as a major success story of industrialisation even if not an intended outcome of past Government policy.

APPENDIX 1

HISTORICAL PROFILE OF THE INDUSTRY AND EVOLUTION OF POLICY

In this Appendix, we shall present a factual account of the development of the Indian CV industry. This will include an account of the major events in the history of the industry, and of the evolution of Government Policy. A profile of all companies that have operated in the CV industry, both past and present, is provided in the annexure at the end of this appendix.

MAJOR EVENTS

Origins of the Industry

The pioneer automobile firms such as Hindustan Motors and Premier Automobiles have been producing CVs as well as passenger cars. The history of the CV industry is thus also generally that of the automobile industry.[1]

The first motor car was imported into India in 1898. In 1928 General Motors India Ltd. commenced assembling c.k.d. trucks and cars in Bombay. It was followed by the Ford Motor Company of India Ltd. in 1930 in Madras, and in 1931 in Bombay and Calcutta.[2] In 1936 Addison & Co. began with c.k.d. assembly of cars and trucks at Madras. Prior to World War II, the combined production (assembly) capacity of all the firms was 96,000 units per annum (HML 1966).

In 1935 Sir M.Visvesvaraya's proposal to establish an automobile industry was rejected by

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1. Our historical account relies mainly on published sources such as the various Tariff Commission Reports and Ad Hoc Committee Report.

2. There seems to be skepticism over the claim of the Peninsular Motor Corporation Ltd. that their sister company, G.Mackenzie and Co. was the first to start assembling cars and trucks in 1926 at Calcutta. See Tariff Commission (1953), p.6.

the then Central Government. However, the National Planning Committee of 1938, set up by the Indian National Congress, appreciated the "real, long-range importance of this new means of transportation and its place in India's planned economy", and emphasised the importance of setting up an "organised automobile industry in the country"[1]. The War needs also brought into bold relief the strategic usefulness of having a domestic automobile industry.

The foundations of the Indian automobile industry were laid in the inter-war period with the setting up of Hindustan Motors Ltd. in 1942 and Premier Automobiles Ltd. in 1944. Making slow initial progress, HML began its operations by assembling c.k.d. vehicles in 1948, while PAL did so in 1947. HML was producing Studebaker trucks and buses and Morris cars. PAL collaborated with Chrysler to produce CVs and with Fiat for cars. Ashok Motors Ltd. commenced assembly of Austin cars and Austin and Leyland trucks in 1950.

In 1952, the Government decided that it was time to replace its somewhat "gut-reaction" policy by a more studied and comprehensive approach to the industry. It referred to the Tariff Commission (T.C.)[2] the question of grant of protection or assistance for the encouragement of the automobile industry.

Entry of new firms and the Intra-Tariff Commission Period : 1953-68

The Tariff Commission of 1953 (the first to enquire into the automobile industry) recommended that only companies with a manufacturing programme should be allowed to continue operations. The Commission's recommendation meant that in 1953 only five firms were recognised by the Government as manufacturers, i.e. HML, PAL, SMPIL, APIL and Ashok Motors Ltd. All these firms save SMPIL were to manufacture both cars and CVs, whereas SMPIL submitted only a car manufacturing programme. Among the firms who considered demand too low to warrant manufacturing and therefore decided to withdraw were General Motors India Ltd.,

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1. National Planning Committee, Transport Services, 1949, quoted in HML (1966), pp.11-12.

2.The abbreviation T.C. in this appendix refers to Tariff Commission and not Technological Change (which is abreviated as TC, without the fullstops).

Ford Motor Co. India Ltd., French Motor Car Co. and Peninsular Motor Corporation. Initial progress for all the recognised firms was slow, partly on account of competition from the purely assembly firms.

Ashok Motors' manufacturing programme started in earnest after 1954. In 1955 its name was changed to Ashok Leyland Ltd. and assembly of Austin vehicles was discontinued. Automobile Products of India ltd. could not proceed with its programme of manufacture which resulted in the withdrawal of Government approval. However, the company was accorded approval for manufacture of diesel engines. (T.C. 1956, p.9).

The Tata Engineering & Locomotive Co. Ltd. was registered in 1945 for manufacture of locomotives, boilers and other engineering products. The automobile division started functioning in 1954 with a collaboration with Daimler-Benz for manufacture of 3 to 5 ton diesel commercial vehicles. Manufacture of components began in 1955.

Like TELCO, Mahindra and Mahindra was incorporated in 1945. It acted as the sole Indian representative of the Kaiser Jeep Corporation, USA, with a programme for progressive manufacture. It began production in 1955 with the Willys Jeep. A jeep truck, with common engine, transmission and front and rear axles was licensed by the Government in 1961. In 1965 the company introduced a one ton payload truck (FC-150) and discontinued production of the jeep-truck.

Bajaj Tempo Limited and Standard Motor Products of India Ltd. were the other firms that began producing LCVs during this period. BTL was incorporated in 1958 and commenced manufacturing the same year. It produced the three-wheeler Tempo Hanseat under licence from Vidal and Sohn Tempo-Werke of Germany and in 1966 began production of the four-wheeled Viking CV. SMPIL had been assembling passenger cars since 1952, the progressive manufacture of which began in 1954. It was licensed to manufacture the Standard 1-ton truck in 1963 and commenced manufacturing in 1965. This was to be the last of the seven companies which were permitted to manufacture CVs until the 1980s. Production increases were achieved by capacity

expansion and fuller capacity utilisation of these seven firms[1]. In fact, these same seven firms comprised the total number of firms in the automobile industry as a whole, since APIL dropped out of the industry during the second plan period (T.C. 1968, p.35).

Besides these seven firms, Simpson & Co. Ltd. (established in 1840) was recognised as a manufacturer of "automobiles" by the 1956 T.C. because it had a programme to manufacture diesel engines for automobiles and tractors. It had a technical collaboration arrangement with F.Perkins Ltd. of the U.K. Besides diesel engines, Simpson also undertook manufacture of bodies for all-metal trucks, buses, three-wheelers, vans and ambulances.

Besides the seven civilian firms producing motor vehicles, reference should also be made to the ordnance factories[2]. The Ministry of Defence started manufacturing multi-fuel Shaktiman medium-duty trucks in 1958 (collaboration : MAN of Germany), and in 1960-61 was licenced by Nissan (Japan) to produce one-ton trucks and jeeps. This was contrary to the T.C. recommendations against any new entry as the existing units could easily have been adapted to cater to defence needs.[3] The ordnance factory production was reportedly undertaken at the instance of the then Defence Minister, V.K.Krishna Menon, who felt that the civilian companies were charging exorbitant prices for their vehicles.

When the last of the three Tariff Commission enquiries began in 1966, the industry was in a stable situation at least in terms of the number of producing firms. Starting with Hindustan Motors and Premier Automobiles in the forties, Ashok Leyland, Tata Engineering and Bajaj Tempo began CV production in the fifties. Mahindra and Mahindra and Standard Motors joined the fray in the sixties. The T.C. recorded that while there was a multiplicity of manufacturers, none of them manufactured more than one basic model. "The volume of production stands

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1.The 1956 T.C. had recommended expansion rather than setting up new units in commercial vehicles. The only new unit that came up after this was BTL.

2. Ordnance factory output is not included in the available AIAM statistics. However, all production in civilian factories including that for defence needs does get included.

3. See T.C. (1953), p.57 and T.C. (1956), pp.(iii), 3.

undoubtedly in the way of the normal change in models" (T.C.1968, p.38). This also meant that the recommendations of both the 1953 and 1956 Tariff Commissions that the number of models in any class of vehicles should be kept to a minimum were respected.

The MRTP Act and Uneven Growth, 1969-1980

The Monopolies Inquiry Commission submitted its report to the Government in 1965. It observed that concentration in the production of commercial vehicles, other automobiles, and also ancillary industries in the country was "high". Similar enquiries were made for a host of other industries. The Commission recommended to the Government the setting up of an independent "watch-dog" body to be directed against restrictive and monopolistic practices in Indian industry. This led to the Monopolies and Restrictive Trade Practices (MRTP) Act in 1969, and the formation of the MRTP Commission in 1970. TELCO was one of the first companies to come under the Commission's scrutiny when, in December 1970, it applied for permission to expand capacity from 24,000 to 36,000 units.

The period 1965-77 was an indifferent one for the industry, with production increasing only marginally. The unanticipated oil shocks of 1973 and 1979 created problems of demand, exacerbating the situation created by high costs, heavy taxation and general recessionary conditions in the economy. However, the oil shock did not really harm the CV industry and in fact hastened the process of dieselisation. In 1977, there was a demand boom which continued till 1981, in no small measure due to the poor performance of the railways during this period.

A clear sign of the maturity of the CV industry (or at least of the firm in question) in India was the establishment of its first joint venture outside India. In April 1977, TATAB, an assembly plant for TELCO vehicles, was established in Malaysia. Later, in 1983, ALL was to set up an assembly plant in Sri Lanka.

New Collaborations and Easing of Restrictions : The Eighties

The eighties have been a period of change for the automobile industry. For one, the boom of

the late seventies was replaced by a demand constraint (at least for MHCVs), partly on account of the improved performance by the Railways. It was only in 1988 that the output of vehicles above 6 tons GVW has shown any significant increase (11.4%).

The most important development was liberalisation of Government policy and the entry, after two decades, of manufacturing firms in the CV sector. This had been preceded by similar developments in the two-wheeler and passenger car sectors. In 1981, four new firms were given letters of intent for the manufacture of LCVs: DCM in collaboration with Toyota, Eicher with Mitsubishi, Swaraj with Mazda and Allwyn with Nissan. Even earlier, in 1979, Simpson and Co., hitherto an engine manufacturer, had received approval for progressive manufacture of Ford trucks. At the same time, under the scheme of broad-banding extended to CVs in January 1985, existing firms could diversify within the four-wheeler segment. TELCO exercised this option and began producing LCVs in 1986. Moreover, the existing firms were also encouraged to modernise and upgrade their technology, especially via changes in the import-export policy during this period, under which imports of technology, capital goods, components and raw materials were relaxed. Norms relating to capacity expansion were also eased (the industry was exempted from the provisions of sections 21 and 22 of the MRTP Act), and the ancillary industry de-licensed in March 1985.

All the firms tried to take advantage of these developments, though some were more successful than others. Besides the four new entrants, BTL and HML began producing completely new models. HML is producing a heavy duty truck in collaboration with Isuzu, and BTL took a fresh licence for making a 3.5 ton (GVW) Daimler-Benz vehicle. Other firms modernized parts of their vehicles, particularly the engine.

GOVERNMENT POLICIES

General Regulatory Policies

The Government's 1945 Statement of Industrial Policy lists automobiles, tractors and trans-

port vehicles as one of the industries to be "centralised" in consultation with the States and Provinces. The Statement defines the industry as one of the "basic industries of national importance (which) may be nationalised provided adequate private capital is not forthcoming and it is regarded as essential, in the national interests, to promote such industries"[1].

As we have seen, private capital and initiative were available through HML and PAL. In the Industrial Policy Resolution of 1948, certain industries were listed, the locations of which had to be governed by economic factors of all-India importance, or which required high investment or technical skills. These were to be subjected to "Central regulation and control", with automobiles and tractors as one of them.

The 1956 Industrial Policy Resolution did not classify automobiles under either Schedule A or Schedule B industries - which meant that the future development of the automobile industry would, in general, be left to the initiative and enterprise of the private sector.[2] Thus, between 1945 and 1956 there was a gradual watering down of the intentions of the Government as far as investment and intervention in the automobile industry were concerned.

No doubt, private sector investment was controlled and channelled into desirable directions. The main instrument for doing so was industrial licensing. The automobile industry was included in the First Schedule of the Industries (Development and Regulation) Act of 1951. Industries included in this Schedule required a licence for carrying out manufacturing activity to optimise utilisation of the limited resources of the country. The Act was applicable to undertakings which produced in factories of 50 or more workers with power and 100 or more workers without power. A licence was needed to establish an undertaking for manufacture of a new article, substantial expansion, change of location, and for conducting business if a change was introduced in Government policies.

The industries governed by the IDRA could till 1966 expand up to 10% of the licensed capac-

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1. Statement of Industrial Policy, 1945, in Marathe (1986), Appendix 1, p.304.

2. On the other hand, road transport (services) was put in Schedule B amongst industries that were to be progressively state-owned.

ity without obtaining a fresh licence. In 1966 this percentage was raised to 25, provided no additional plant and equipment, foreign exchange or scarce raw materials were demanded. Diversification of production by manufacture of "new articles" up to 25% of licensed capacity (by value) was also allowed under this scheme.[1]

In 1969, additional restrictions were placed on large firms under the Monopolies and Restrictive Trade Practices Act. This sought to regulate monopolistic and restrictive trade practices and control concentration of economic power. Companies with net fixed assets plus gross current assets of over Rs. 20 crores or interconnected undertakings with combined assets of over Rs. 20 crores would be considered MRTP companies. This limit was raised to Rs.100 crores in August 1985. Dominant undertakings i.e. those controlling not less than one-third (amended to one-fourth in 1982) of the market were also MRTP companies. Of the five firms we are studying in detail, only SMPIL remained consistently outside the purview of the MRTP Act. BTL came out of its purview with effect from the 1985 notification.

As a result of the Industrial Licensing Policy Inquiry Committee Report in 1969, the Industrial Licensing Policy of February 1970 listed "core" industries to which the large industrial houses were expected to confine their attention. Neither CVs nor any other automobile industry was included in this list. However, in February 1973 the Industrial Policy Statement amended the earlier policy and enlarged the list of "core" industries of importance to the national economy which would be open for participation of MRTP companies, and also to foreign concerns and subsidiaries.[2] CVs (but not personal transport vehicles) were included in this list of Appendix 1 industries.

The 1973 Industrial Policy Statement was followed by the Foreign Exchange Regulations Act (FERA) of 1973, which became operative on 1 January 1974. Under this Act, foreign holdings in

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1. Chakraborti (1986), p. 2.145.

2. See Chakraborti (1986), pp.4.12-4.16 for the statement.

Indian companies could not exceed 40%[1].

During the remaining years of the seventies and especially in the eighties, there was a gradual relaxation of controls for the CV industry, as also for the rest of the industrial economy[2]. On 21 April 1982, a liberal scheme for re-endorsement of capacity was announced. Under this scheme, the capacity indicated in the industrial licence could be re-endorsed up to 133% of the best production of the previous five years provided capacity utilisation was at least 94%[3]. This facility was also available to the CV industry as well as to MRTP/FERA companies within it.[4]

In August 1984 automobiles (including CVs, cars, and two-wheelers) were included among those industries which would be subject to special regulation[5]. This implied that the 1982 re-endorsement scheme was no longer applicable to the CV industry, since it would be subject to usual licensing regulations.

Three other recent announcements have given automobile firms much room for manoeuvre. In January 1985, following on the policies begun in 1983, broad-banding was extended to motorised four-wheelers. The motivation for broad-banding arose from the fact that similar industries may have common aggregates and design facilities, and that there is the possibility of achieving higher capacity utilisation as well as economies of scale in response to market trends. Thus, within sub-heading (5) of heading (7) of the First Schedule to IDRA 1951, i.e., on-road vehicles such as cars, jeep-type vehicles, and light, medium and heavy commercial vehicles, a firm could

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1. We shall see that other than ALL, all the other companies in India had foreign equity much lower than 40%.

2. For example, automatic growth of capacity up to 25% in a plan period was allowed in August 1975 in 15 engineering industries (including CVs) subject to the usual stipulations and provided that the undertaking was not dominant in the line of manufacture. If import of capital equipment was involved in this process, the Government would impose export obligations. In August 1980 this list of industries was expanded and some of the stipulations made less rigorous. See CMIE (1986), pp.40-51 for details.

3. The capacity utilisation stipulation was reduced to 80% in March 1986 (Chakraborti (1986), Annexure 8.18).

4. At the same time as this scheme was announced (following the declaration of 1982 as productivity year), the Government, in its Industrial Policy Statement of 1982, enlarged the list of Appendix 1 industries to include, for the first time, personal transport vehicles. See Chakraborti (1986), pp.4.26 - 4.30.

5. The objectives of this scheme were, inter alia, to ensure better quality, encourage indigenisation and, in the case of automobiles, minimise hazards on roads. See Chakraborti (1986), pp.2.77 - 2.78.

achieve any desired product mix.[1] In June 1985, broad-banding was extended to a wide range of automotive ancillaries, and firms could diversify into any sub-category within broad categories such as auto electricals, suspension components, transmission components, fuel injection equipment, engine components and so on (Chakraborti 1986, p.2.348-2.349). In May 1985 all vehicle and component manufacturers were exempted from the provisions of Sections 21 and 22 of the MRTP Act. In other words, proposals from large industrial houses for substantial expansion or for setting up of a new unit were no longer required to seek approval under the MRTP Act, and could simply seek approval under IDRA 1951.[2] Finally, in May 1986 the Government announced a minimum economic scale of 25,000 for CV manufacturers (including MRTP companies) and stated that it would actively encourage all undertakings to achieve this scale of operations where the existing installed capacity fell short of it.[3]

Licensing procedures are also applicable to foreign collaborations, capital goods imports (those not on open general licence) and other imports of technology. Foreign collaboration proposals are screened by the Foreign Investment Board and preference is given to proposals within Appendix I industries (one example of which is the more favourable treatment accorded to CV manufacturers' collaboration or upgradation proposals as opposed to those of car manufacturers). Under FERA, foreign companies cannot hold more than 40% of a company's equity, unless they bring in high technology or are export-oriented. Moreover, there are restrictions on royalty rates (generally limited to 5%) and duration of agreement (5 years) with exceptions in special cases. However, as part of the general liberalisation, technology imports have also become easier in the last decade, both procedurally as well as in terms of range and degree of imports[4]. For example, since 1976, the Technical Development fund allows an existing unit to

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1. See Chakraborti (1986) pp.2.342, 2.382. The firms "may, if they like, apply for change of description of item of manufacture on the letter of intent/industrial licence from a particular type of vehicle to the common category".

2. Chakraborti (1986) Annexure 8.16.

3. Chakraborti (1986) Annexure 18.1.

4. See, for example, Kumar (1987a), and Chakraborti (1986), pp.2.477 - 2.487.

import technology/capital goods/consultants upto an upper limit of Rs.1.25 crore per year (raised to Rs. 3 crore w.e.f. 1 April 1989) with a simplified procedure for clearance. Similarly, import of design and drawings can be undertaken under a simplified scheme with an upper limit of Rs. 30 lakhs per unit per year. Procedural simplifications were initiated through special promulgations in 1981 and 1985.[1]

It is important to also consider some of the major changes in the automotive ancillary sector. Besides the broad-banding referred to earlier, the Government in March 1985 announced delicensing of the automotive ancillary sector for non-MRTP and non-FERA undertakings, provided the item was not reserved for small-scale industries and the firm was not located within urban or municipal limits of cities. This facility would also enable it to keep pace with the evolving requirements of the fast-changing main automobile industry.[2] Earlier, in April 1982, "specialised automotive components" such as pistons, fuel injection equipment, auto electricals, spark plugs, wheels, bimetal bearings, and so on, were included in the list of Appendix 1 industries.[3] These policies were rather different from those in the 1960s, when there was a ban on the establishment of new ancillary units. This ban was lifted in October 1969 (T.C. 1973, p.7). Another policy of relevance is the reservation of a large number of components mainly non-functional or non-critical, for exclusive production by the small-scale sector.[4] Small-scale units are exempt from licensing requirements under the IDRA, and also enjoy fiscal and credit concessions.

Protection and other Industry-specific Policies

Prior to independence, there were no quantitative import controls, any protection being only

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1. See Chakraborti (1986), Annex 20.1, 20.7.

2. Chakraborti (1986), Annex 8.13 and CMIE (1986), p.24.

3. Alongwith personal transport vehicles. See Chakraborti (1986), p.4.28.

4. The upper limit on investment in plant and machinery is Rs.35 lakhs for the small-scale sector and Rs.45 lakhs for the ancillary sector. The ancillary sector is supposed to provide at least 50% of its production as inputs to other industries.

through tariffs. The industry seeking protection had to apply to the Government, which appointed ad hoc Tariff Boards to examine the issue if it felt that there was a prime facie case for protection. If, under this system, protection was granted to the industry, the existing revenue rates of duty were converted into protective duties[1]. Motor vehicles were first included in the schedule of luxury goods in 1921, and an import duty of 11% ad valorem was levied on buses, lorries and their accessories. This was raised to 15% in 1922, 25% in 1927-28, and 30% (standard rate) in 1942. Thus the duty rates rose steadily between 1921 and 1942.[2]

In 1947, the Panel on Automobiles and Tractors recommended a graduated differential in the customs duty levied on individual components, the differential depending on the time required to establish manufacture in India. It also recommended that raw materials, certain forgings and castings, and capital equipment be allowed to be imported free of duty by automobile manufacturers[3]. No action was, however, taken on these recommendations.

In 1949, it was decided to allow import of motor vehicles only in c.k.d. condition, except in special cases. Also, further increase in assembling capacity beyond what was in existence prior to 1948 was not encouraged.[4] Customs duty on parts being manufactured or likely to be manufactured in the country in the following two years was raised in April 1950 to 60% and 90% respectively.[5]

Other moves to promote development included restrictions allowing "only three types of cars and trucks from each of the dollar and soft currency areas"[6] with a view to promoting standardization. Assemblers not having a manufacturing programme were not considered for foreign

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1. See Marathe (1986), appendix V.

2. T.C. (1953), p.62.

3. Ad Hoc Committee (1960), p.2.

4. T.C. (1953), p.1.

5. Pending an enquiry into the question of protection to the indusy. See Ad Hoc Committee (1960), p.2., and T.C. (1953), p.62.

6. T.C. (1953), p.2.

exchange allocation after 1952. Moreover, in 1951 and 1952, the two firms, HML and PAL, which had made some progress in manufacture, were shown special consideration in the matter of foreign exchange allocation, and were also given orders after 1949 to supply trucks to the Defence Forces.[1]

The Government had set up an Interim Tariff Board in 1945 in response to the need for establishing a long-term tariff body. This functioned for two years and was later replaced by the Tariff Commission. Many observers feel that the real history of the Indian automobile industry began with the submission and acceptance of the Report of the T.C. on the Automobile industry in 1953. The major recommendations were : (i) firms that did not have a progressive manufacturing programme should cease operations; (ii) to stimulate demand and encourage greater use of vehicles the import duty on all components should be a flat rate of 40% from the existing rates of 31.5%, 63% and 94.5%; (iii) the taxation system for road transport vehicles be rationalised; (iv) the types of commercial vehicles and cars for civilian requirements should be restricted to four each; and (v) for economic production army requirements should be combined with civilian ones. These recommendations were accepted with some modifications, the Government aiming at an average level of about 40% import duty on a complete c.k.d. pack but maintaining at a somewhat higher level the rates on components within the manufacturing programme. Accordingly, the rates of duty on components and parts were reduced to 50% in some cases and to 25% in others.[2]

On the question of protection to the industry, the T.C. felt that it would be best to continue the existing import restrictions (i.e., rationing of foreign exchange) in a "more intensive" form and accord weightage in the import quota of manufacturers to the progress made by them. The weighted allocation was also suggested because the T.C. realised that a partially manufactured

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1. T.C. (1953), p.2.

2. See T.C. (1956), p.4., and appendix VII for a description of the components. The duties were reduced from existing rates of 94.5% and 63% to 50%, and 31.5% to 25%.

vehicle would turn out to be more expensive than a purely assembled one.[1] The Government accepted this recommendation in principle, but retained flexibility in the allocation of foreign exchange.

The T.C. also conducted separate enquiries into various ancillary industries. These industries were accorded protective rates of duty from the mid-fifties to the mid-sixties. [2] As a result of the second T.C. Report in 1956, duties on many other ancillary industries were converted from revenue to protective rates[3] for a period of ten years (and the industry granted protection up to 31 December 1967, later extended by one year), subject to a periodical review. Expressing its concern over the relative position of manufacturers vis-a-vis pure assemblers, the Commission recommended import quotas in "fair relation" to manufacturing progress. Thus, a combination of protective duties (to provide for incentives) and import control (to ensure the "necessary take-off for the vehicles in which the components are to be used" and to deter "slackness" in fulfilling manufacturing schedules[4]) was advocated, in contrast to the approach of the earlier T.C., which suggested only the import rationing measures.

Other major recommendations of the 1956 enquiry included priority for the manufacture of commercial vehicles and dieselisation of medium and heavy commercial vehicles, and replacement of the system of price control by a more flexible one, which came to be known as "informal price control". Under this, manufacturers had to apprise the Government in advance of their intention to increase prices. In 1967 this control was abolished on CVs and Jeeps (T.C. 1968a). However, the informal control for cars was replaced by statutory control, and remained in force till 1975. This period (1969-75) was as a result disastrous for the car industry.

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1. See T.C. (1953), pp.60-62, 65-66.

2. These industries were classified under the Indian Customs Tariff Schedule as 75(12A), 75(15), 75(16). 75(17), and 75(18), and included piston assembly, leaf springs, spark plugs, hand tyre inflators, nozzles and nozzle holders.

3. I.C.T. Nos. 75(9), 75(10), 75(11), 75(12), and 75(14). These worked out to 88 components in all. See T.C. (1968), pp.4-7.

4. T.C. (1956), pp.98-99.

In 1959, an Ad hoc Committee (with L.K.Jha as Chairman) was set up to review the progress made in this sector. Its report re-emphasised that (a) commercial vehicles should be given priority, (b) taxation policies for automobiles should be influenced by long-term rather than short-term considerations, and (c) that efforts should be made to increase indigenous content and spur ancillary production.

In 1965, the Government demarcated the items that were normally to be developed in the ancillary sector (within which some items were reserved for small-scale units), and those that could be developed either by ancillary or vehicle manufacturers. This was a major incentive, and resulted in the starting up of manufacture of a number of new items, such as carburettors, fuel pumps, steering gear, transmission gears, brake systems, electrical equipment, wheels, dashboard instruments, steering wheels and lubricating equipment.

The third T.C., which began its enquiries in 1966, found that the industry had not yet matured, and recommended a continuance of protection by means of quantitative restrictions for both the main and ancillary industries. Even if the industry had matured, the T.C. stated, balance of payments considerations would have necessitated continuance of protection. It also suggested that a distinction should be maintained between those components not likely to be produced in the near future, those produced but in insufficient quantities, and those produced in sufficient quantities.

The Commission also recommended that no fresh units be licensed in the industry until the existing manufacturers had reached an economic scale. For issue of import licences, it suggested that this be done in relation to both production and capacity (with licensed capacity acting as the ceiling). It sought to reduce progressively the overlap in production between manufacturers and ancillary units by calling for increasing levels of buying in on the part of manufacturers.

While accepting most of the recommendations of the 1968 T.C., the Government continued to levy protective duties on those components (the T.C. had recommended their withdrawal), the domestic production of which was inadequate and which were, therefore, partially imported.

In its review of the ancillary industry in 1973, the T.C. recommended that in order to assess

properly the progress in indigenisation, the three-fold distinction between different types of components should continue to be maintained.

In the eighties fresh collaborations (of Japanese origin) were permitted in the LCV sector, and four new firms emerged on the scene. The quality standards as well as preferences of the Japanese collaborators resulted in a surge of component imports and a spate of fresh collaborations in the components industry. To facilitate modernisation and keep down vehicle prices, the duties on components for fuel-efficient LCVs was reduced from 75% to 50%, and subsequently to 35% in 1987, owing to a rise in the value of the Japanese yen.[1] Once these components are produced in India as part of the phased manufacturing programme (PMP) their import would be effectively banned. Under the PMP, firms can enter into foreign collaboration only if they target to achieve 95% indigenisation (as a percentage of the C.I.F. value of the c.k.d. vehicle) within 5 years of starting production.

In regard to import of fully built-up (FBU) vehicles, this was virtually banned after 1949. Then, as now, exceptions were allowed only in special cases. Currently, complete vehicles can only be imported under special circumstances like transfer of residence, or by foreign nationals and organisations, embassies, approved tourist hotels, physically handicapped people, etc.[2] The total duty on various types of vehicles ranges from 65% for tractors and shuttle cars to 110% for CVs to 200% for cars. Quantitatively, FBU imports are very minor - in 1985-86, only 453 cars, 73 trucks and special purpose vehicles, 8 buses, 4 tractors for trailers, and 52 chassis with engines, were imported.

The two main instruments of industrial policy in India have been industrial licensing and protection from foreign competition. Being a key industry, the automobile sector has received a great deal of attention from the Government. The basic premises of the policies have been (a) protection via quantitative restrictions and a graduated differential in customs duty on compo-

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1. In December 1986 the Government had also reduced the excise duty on these LCVs from 20% to 10%.

2. See Import and Export Policy, 1988-91, Vol.I, pp.38-39.

nents; (b) restrictions on entry of new manufacturers with relative ease of entry within the ancillary sector; (c) encouragement of indigenous production through a mandatory indigenisation programme while attempting to keep the cost of essential imported components within limits; (d) encouragement of indigenous technological development by restrictions on foreign collaborations; (e) priority for commercial vehicles over personal transport vehicles, at least until 1982; (f) encouragement for independent ancillary production as well as reservation for small-scale sector; (g) formal/informal control on selling prices in the 1950s and 1960s.

Annexure to Appendix 1

Brief Profiles of Indian Commercial Vehicle Manufacturers

HINDUSTAN MOTORS LTD. Incorporated in 1942. Part of India's second largest industrial house, the Birlas. However, in actual practice the Birlas are not a unified group. HML is managed by the GP/CK Birla group, which is the second largest sub-group within the Birla empire. Began assembly in 1948. Collaboration with Studebaker Corporation of USA for cars and CVs, and Morris Motors of UK for the "Morris Oxford" car. In 1957, the foreign exchange crisis forced HML to abandon the Studebaker programme. In 1958, it began production of Bedford light trucks in collaboration with Vauxhall, General Motors' U.K. subsidiary. Despite initial success, Bedford trucks were not successful, unlike its cars. In 1983, it signed a fresh agreement with Isuzu Motors of Japan to manufacture heavy duty trucks and also for Isuzu engines which it is using in its new passenger car, the "Contessa Classic". The company also produces earth-moving equipment, cranes, steel structures and steel products such as forgings and alloy steel. The headquarters are in Calcutta in Eastern India, and its main automobile factory is next door in Uttarpara. Foreign equity is nil.

PREMIER AUTOMOBILES LTD. Incorporated in 1944. Part of the Walchand Group. Began assembly in 1947. Collaboration with Chrysler Corporation of the USA for LCVs and cars and with Fiat of Italy for cars. As for HML, the 1957 foreign exchange crisis resulted in PAL's giving up manufacture of Chrysler's Dodge, De Soto and Plymouth cars. Like HML, PAL gradually gave way to competitors in the CV market, but, unlike HML, it has allowed its CV production to fizzle out completely. It introduced a new model car, "118 NE", through new collaboration agreements (including Nissan for the engine) in 1985. In 1987, it also acquired the machine tool division of Walchand Industries. All its production as well as corporate headquarters are based in and around Bombay. Foreign equity is nil.

ASHOK LEYLAND LTD. Incorporated in 1948 as Ashok Motors Ltd. Collaboration with

Austin Motor Company, UK, for cars and trucks and Leyland Motors, UK, for trucks. It is not a part of any industrial house like Telco, M&M, HML etc. Austin collaboration was discontinued in 1955 and its name was changed to Ashok Leyland Ltd. Its PMP for Leyland heavy duty vehicles began in 1956. It was a FERA company (greater than 40% foreign equity being permitted on grounds of high technology) until 1985, the foreign shareholder being Leyland. In October 1987, the foreign stake was sold to Hindujas of UK and Fiat-Iveco of Italy. In 1985, the Government approved a new collaboration agreement with Hino Motors of Japan for manufacture of a range of diesel engines. ALL also produces diesel engines for marine and industrial applications. Headquarters are in Madras, and its main plants are in the vicinity.

TATA ENGINEERING AND LOCOMOTIVE CO. LTD. Incorporated in 1945 as a manufacturer of railway locomotives, boilers and other engineering products. Collaboration with Daimler-Benz for 3 to 5 ton (payload) CVs was signed in 1954, and manufacture began in 1955. Part of India's largest industrial house, the Tatas. The Tatas are the most respected industrial house in the country. This owes to their reputation for professionalism and a sense of social purpose. Telco is India's largest automobile company in terms of sales. Manufacture of locomotives stopped in June 1970. Daimler-Benz continues to hold foreign equity in Telco, 12.5% in 1988. Other products manufactured include machine tools, diesel engines, excavators and a range of electronic equipment and controls. Two major plants, first in Jamshedpur and later in Pune. Headquarters in Bombay.

MAHINDRA AND MAHINDRA LTD. Incorporated in 1945 to represent Kaiser Jeep Corporation (earlier Willys Motors) of USA. Part of the Mahindra group. Assembly of jeeps began in 1955. Manufacture of a jeep-truck was approved by the Government in 1961 and of a one-ton payload truck (which replaced the jeep truck) in 1965. Foreign equity in 1987 was 14.4%. The shareholders are Chrysler Corporation, 8.04% (through ownership of American Motors), International Harvester, 6.4%, and Dana Corporation, 0.36% (this adds upto 14.8%, the difference being on account of inclusion of Dana Corporation). Engine modernisation was undertaken with a new collaboration with Peugeot of France in 1979. M&M's main interest continues to be in jeeps, but

it is also a significant producer of LCVs and tractors. Like PAL, its factories and headquarters are centred around Bombay.

BAJAJ TEMPO LTD. In 1950, NK Firodia acquired the right to represent Vidal and Sohn Tempo Werke, West Germany. The application to manufacture the Tempo three-wheeler was approved only in 1957, following which Bajaj Tempo Ltd. was incorporated in 1958. Foreign equity share, held by Vidal and Sohn, was 26%, 28% went to the Firodia family, and 35% to Kamalnayan Bajaj and his associates. A fresh collaboration for Viking 4-Wheel vehicles was signed in 1965. Engine upgradation occurred in 1971 through an agreement with Hanomag, and again in 1983 following a collaboration with Daimler-Benz, who also control the 26% foreign equity of BTL. BTL manufactures engines for industrial and marine applications. Its factory and headquarters are in Pune, and a more recent factory opened up in Pithampur in Madhya Pradesh.

STANDARD MOTOR PRODUCTS OF INDIA LTD. Incorporated in 1948. Collaboration with Standard Motor Company, U.K. Began assembly of Standard Vanguard Cars and Ferguson tractors in 1952. Tractor production was discontinued in 1961. In 1965 it commenced production of the Standard 1 - ton truck, coinciding with a major decline in its car market. In 1979, technology for a 2.5 litre diesel engine was purchased from Austin Rover. The company also signed a fresh agreement with Austin Rover for manufacture of the Rover Saloon, in 1983, in a bid to recapture the car market. Its production and administration are all in one location in the suburbs of Madras. Foreign equity is nil.

ALLWYN NISSAN LTD. Incorporated in 1983. Promoted by Hyderabad Allwyn Ltd. in collaboration with Nissan Motor Co., Japan. Production commenced in April 1985 with the "Cabstar", a 5 ton GVW vehicle. In February 1989, M & M took over 26% of the company's equity from Allwyn and took over the management. The company's name was changed to Mahindra Nissan Allwyn Limited. M&M signed a fresh collaboration agreement with Nissan in November 1988. Foreign equity holding of Nissan was 15.1% in 1988. M&M recently increased its shareholding to 40%.

DCM TOYOTA LTD. Incorporated in 1983. Promoted by the DCM group alongwith Toyota

Motor Corporation, Japan. Commercial production began in July 1985 with the "Dyna", 6 ton GVW. Toyota's share of the equity was 26% in 1988.

SWARAJ MAZDA LTD. Incorporated in 1983. Promoted by Punjab Tractors Ltd. alongwith Mazda Motor Corporation, Japan and Sumitomo Corporation, Japan. Commercial operations began in 1986 with manufacture of the 6 ton GVW "T" Series. Shareholding of Mazda and Sumitomo was 13.6% in 1985.

EICHER MOTORS LTD. Incorporated in 1982. Promoted by Eicher Goodearth Ltd. (like Punjab Tractors, also a manufacturer of tractors) and Mitsubishi Motor Corporation, Japan. Commercial production began in May 1986 with the manufacture of the 6 ton GVW "Canter". The joint equity share of Mitsubishi Motors and Mitsubishi Corporation was 15% in 1988.

(Further details on many of the firms and Business Houses can be found in Piramal and Herdeck (1985), which, inter alia, covers the House of Tata, Birla, Mahindra and Walchand).

APPENDIX 2

FIRM-LEVEL DETERMINANTS OF PERFORMANCE: AN ECONOMETRIC EXERCISE

INTRODUCTION

One of the major preoccupations in industrial economics has been the explanation of inter-industry differences in profitability arising from seller concentration and barriers to entry. This viewpoint has found some statistical support in the traditional industrial organization literature, albeit with important qualifications, for

> ...the results are not uniform, the data have many shortcomings, the statistical tests leave much more variation in profitability unexplained than they explain...[1]

One reason for the latter conclusion was the focus on the industry as the unit of analysis. Of late, firm-level panel data has generated much interest, since intra-industry profitability differences are often greater than inter-industry average profitability differences.[2] Schmalensee (1989a) writes that at the firm or business unit level in the USA, industry characteristics account for only 10-25% of the cross-section variation in accounting rates of return, and that there are complex firm-specific effects. He argues that systematic differences among firms deserve more attention than received so far.

This analysis represents an attempt to understand firm-specific differences in behaviour within a single industry in India. The objective is a limited one: to see whether any empirical regularities can be uncovered to support the more detailed analysis in chapters 5 to 8.

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1. Scherer (1980), p.295. For a more recent review, see Schmalensee (1989a).

2. Schmalensee (1988), p.649.

DATA AND HYPOTHESES

Received Literature

Previous literature at the firm level has focussed on firm size or market share as factors explaining inter-firm profitability differences. The evidence is not conclusive, with some studies finding that firm size is positively related to profitability, but others finding an insignificant or negative relationship. (Schmalensee 1989a, pp.981-82).

In a number of studies, market share emerged as a key determinant of profitability, and demonstrated its superiority to the conventional concentration measure.[1] At the same time, it appears that within particular manufacturing industries, profitability may not generally be strongly related to market share, suggesting that the former conclusion may result from domination by a small number of industries in the cross-section regressions.[2]

Very little work has been done on Indian industry within this framework. Siddharthan and Dasgupta (1983) analyse inter-industry profitability differences, and find the coefficients of concentration and of average firm size to be statistically insignificant. Kumar's (1990) study is also at an industry level, using data from the same source i.e. Reserve Bank of India. He also finds concentration to be insignificant, but firm size is a significant determinant of profitability (negative for multinational firms and positive for local firms, which the author explains by the smaller average size of the latter). To the best of our knowledge, no firm-level study exists in the Indian context.

Our data consists of a pooled set of 54 observations for 5 firms in the Indian Commercial Vehicle industry for the period 1977-87. It has been constructed from the balance sheets of individual firms and enables us to include a number of variables not usually considered in the litera-

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1. See Scherer (1980), PP.282-85, Schmalensee (1989a), P.984, and Allen and Hagin (1989).

2. Schmalensee (1989a), reporting on several studies done for the USA and UK.

ture. The theoretical underpinning of our model is an eclectic mix of industrial economics and managerial theories.

The Dependent Variables

These are based on our measures of performance developed in chapter 3. Two are profit measures: gross profits to sales (π_s) and gross profits to gross capital (π_c) and the third is market share (MKTSH). In econometric studies, the latter is normally considered as an independent variable to explain profits, but in our view it can be very useful as an additional indicator of performance (hence its use as a dependent variable), particularly in view of the known deficiencies of balance-sheet-based measures, as also the uncertainty of managerial objectives.

Independent variables (see Annexure for details of data and variables)

a) Production-related measures

AGE: accumulated depreciation to gross fixed assets. Since gross profit = revenue - salaries - materials, a more "aged firm" with greater share of depreciated machines may see its per unit realization falling in the long run owing to poorer quality of finished output. Thus π_s and π_c would decline, and market share would also suffer.[1]

MOD: modernization, proxied by percentage change in gross fixed assets. This will be negatively correlated with age, and is therefore expected to be positively related to the dependent variables. We also expect that more recent investments embody later vintage technologies. Greater investment may also reduce the share of wages in cost, which would be another reason for π_s increasing. But the overall effect on π_c is more uncertain, since both the numerator and

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1. This as well as other variables which use balance sheet figures for capital may not always give the right indications, as we discussed in chapter 3. Also, in case an older company has a higher ratio of depreciation to assets, then there would be opposing tendencies such as learning economies which would counteract the hypothesized negative effect of age.

denominator would be increasing.

CAP : capital-labour ratio i.e. gross fixed assets to total wage cost. This is one measure of capital-intensity of production, and should have a positive effect on gross profits since capital will substitute for labour (wages). The effect on π_s should be positive, uncertain for π_c, and possibly positive for MKTSH if an increasing CAP implies a firm that is investing higher amounts on new machines.

CAPREV : Capital-sales ratio, gross fixed assets to sales. An alternate measure for capital intensity. It can also be interpreted, in the case of π_s equations, as a control for the cost of capital, since π_s does not embody any element of capital cost.[1] Same effects as in the case of CAP.

b) Production Organization

VINT : Salaries, depreciation and other expenses as a share of total cost. This is hypothesized to affect π_s and π_c negatively because a firm that buys more from outside can reap the advantages of specialization and/or cheaper wage costs. On the other hand, a more integrated firm can have better quality control and respond faster to the market, and should affect MKTSH positively.

INVSAL : inventories to sales. Inventory practices occasionally affect material bought in, such as when there is a sharp increase (or decrease) in sales. In such a situation, a firm with a higher inventory to sales ratio would need to buy more materials in order to maintain its inventories at the desired level. This means a higher share of materials to sales, and lower gross profits. Some extra expenditure on men and machines will also be incurred to handle higher inventory holdings. INVSAL can also be taken as a general indicator of efficiency of the company, since lower

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1. See Waterson (1984), pp.190-92.

INVSAL could reflect better organizational efficiency, layout, production control etc. For all these reasons, its sign for π_s and π_c is expected to be negative. In the case of MKTSH, higher inventories could lead to transitory increases, but this is not expected to be a long-run phenomenon. Only a weak relationship, if any, is expected.

c) Technology-related Variables

TECSAL : imports of capital goods plus payments for royalty and technical knowhow as a share of sales. This is an indicator of imports of technology, and is expected to lead to higher profits (lower costs and/or higher prices) and higher market share.

SKILL : wage costs of "skilled" employees (earning more than Rs.3000 per month) to total costs. A possible indicator of the importance attached to human resource development activity. Since skilled human resources are the key to effective deployment of technology, we posit this to be positively related to all the variables. Similar hypotheses relate to the average WAGE rate.

RNDSAL : R&D expenditure as a share of sales. Since R&D contributes to new product development and/or decline in costs, it should be positively associated with π_s and π_c as well as with MKTSH.

(d) Others

SPARSL : Sales of spare parts (by the vehicle manufacturer) to total sales. Since sales of spare parts are more profitable than vehicle sales, this is hypothesized to be positively related to π_s and π_c. It is not expected to have any relationship with MKTSH.

IMPCNS : imported to total consumption of raw materials and components. Hypothesis is that the Indian consumer prefers foreign-made parts, so a higher IMPCNS would mean higher

MKTSH.

PROD : value of production in rupee terms. Meant to represent economies of scale not only in production, but also in R&D, sales, distribution. Hypothesized to relate positively to π_s and π_c.

CAPUT : capacity utilization i.e. actual output to installed capacity. Positive impact expected on π_c and, to a lesser degree, on π_s(as CAPUT increases, revenue increases with the same amount of capital, and material consumption goes up but wages do not increase commensurately). If all competing firms are creating fresh capacities at a more or less similar pace, then CAPUT increase may also result in an increase in MKTSH. CAPUT is affected not only by supply-side factors such as input availability, capacity creation and product quality but also by demand factors. These demand factors impinge differently on different firms because of the varied growth rates of the LCV, MHCV, and Jeep segments (see ch.3). An alternative variable, NKUTN was also tried in place of CAPUT, where a peak level of capacity utilization is treated as 100% utilization (see annexure for details).

MKTSH : hypothesized to relate positively to π_s and π_c. This is because higher market shares reflect greater scale economies (at least upto a point), and monopoly power (see Allen and Hagin 1989).

GRTH : Growth of sales for each firm. In periods when demand is buoyant, firms may be tempted to raise margins. Positive impact expected on π_s and π_c.

(e) Dummy Variables.

D_1 ,D_2 ,D_3 , and D_4 : These are dummy variables for Telco (Tata Engineering), M&M (Mahindra), BTL (Bajaj Tempo) and ALL (Ashok Leyland) respectively, taking the value 1 or 0 as required. The fifth dummy, that for SMPIL (Standard Motors), is implicit in the constant term. The hypothesis is that there are important firm-specific effects that we have not been able to capture in our pooled sample specification.

D_5 ,D_6 and D_7 : These are time dummies with different cut-off years.

For D_5, 1977-1985 = 0, 1986-1987 = 1

D_6, 1977-1983 = 0, 1984-1987 = 1

D_7, 1977-1982 = 0, 1983-1987 = 1

The hypothesis is that in the 1980s, increased competition and the pressure of demand has squeezed market share and profit of existing firms. Different cut-off years are tried for the three dependent variables since demand pressure preceded slightly the advent of new firms (see ch.3). A summary of the hypotheses is given in Table A2.1.

THE RESULTS

Data Sorting

The equations were run in linear and log-linear form. Preliminary results indicated counter-intuitive results for many of the production-related measures. This occurs because of the difficulties of valuation of capital and the time profile of investments. AGE shows up as positive though rarely significant in different equations for $\overline{\pi}_s$ and $\overline{\pi}_c$, and negative and occasionally significant for MKTSH. We observe that the accounting data is unable to reflect correctly the age mix

of the machines, and we had to drop the variable.[1] AGE is also negatively correlated with MOD (-0.47).

MOD reflects somewhat better the percentage change in gross fixed assets since the numerator is an increment and not an accumulation of past biases. Nevertheless, there is still a substantial bias against firms investing regularly (see ch.6).

CAP is another variable that, on consideration, we have dropped. This is because locational differences in average wages distort the capital-labour ratio (wage rates in M&M and Telco are high, see ch.3)[2]. The preferred variable is the capital-output ratio, CAPREV, with which in any case CAP is highly correlated (0.73). CAPREV has a high positive correlation with D_1 (0.61), negative with D_2 (-0.54) and negative but very small with D_3 and D_4 . This is in keeping with Telco's (D_1) high-investment image.

Amongst the time dummies, the one that was most consistently significant was D_5 (1986 and 1987 = 1). Equations with D_6 and D_7 are not reported here. Similarly, the natural log of PROD was tried as an alternative to PROD, but was always less significant.

GRTH was tried in several equations and was always insignificant. It was dropped because its presence did not affect any of the other variables, and some of its effect would in any case be captured by the CAPUTN variable.

Foreign equity (i.e. the extent of foreign shareholding in total share capital) could have been another possible variable to be used in our equations. However, the data on foreign equity reveals very little temporal changes for CV firms, except in the case of Telco (for SMPIL, it is 0 throughout, and for BTL it is 27% for all but 2 years). This would result in very high correlation with at least some of the firm dummies -- with D_4 (ALL) it is 0.85 and with the implicit dummy

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1. Telco, which we found was consistently updating its plant, has according to the AGE variable, the oldest mix of machines (correlation of AGE with D_1, D_2, D_3 and D_4 is 0.51, -0.23, -0.35, and -0.39). This reflects higher depreciation charges and also more regular upgradation of plant (a spurt in recent investments, as done by other firms, biases the AGE variable downwards) as compared to other firms.

2. We could have tried capital to number of employees, but this would also have been biased against over-manned firms such as Telco and ALL (see ch.6).

for SMPIL it is -0.57. On consideration, this variable has been dropped.

Regression Results

In general, the linear estimates proved superior to the log-linear ones. We shall therefore concentrate on the former.

With π_s as the dependent variable, equation 1 in table A2.2 shows that the all the firm dummies are positive and significant, including the dummy for the fifth firm which is implicit in the constant term. The time dummy (D_5) is also negative and significant as predicted, implying that since 1986 profit margins have witnessed downward pressure.

SKILL is positive and significant, but the other significant variables prove to be negative and counter-intuitive. These include MOD, CAPREV, PROD, CAPUT and MKTSH. Before interpreting this, we should go over the specification. It is possible that there are lags in the operation of capital-related variables such as MOD, CAPREV and TECSAL. This was tested by lagging these variables 1 and 2 periods, in turn. In the first instance, we tested with MOD1 only (i.e. MOD lagged one period), which made no material difference except to render MOD1 statistically insignificant. When all 3 variables are lagged 1 period (equation 2), MOD1, CAPREV1, PROD and MKTSH are no longer significant (all the t-values lying between 1.4 and 1.6, just short of significance at the 90% level). SKILL (+) and CAPUT (-) and all the dummies and constant term continue to be significant. A 2 period lag was also tried for each of the variables, MOD, CAPREV, and TECSAL. However, this reduces the number of observations from 54 to 43. We compared equation 1 run with 43 variables with its 2 period lagged version. In both equations, only the constant term (+), D_3 (+) and the time dummy (-) are significant. However, the coefficients for MOD2, CAPREV2 and MKTSH are positive in the lagged equation (equation 3), although not significant.

Another possible, and important, specification error was the omission of the R&D variable owing to data paucity. R&D expenditure data was available for only 38 out of our 55 observations. Equation 1 was re-tested with these 38 observations and RNDSAL was later added to it.

Expectedly, the reduction in the degrees of freedom renders many of the variables insignificant. RNDSAL does not turn out to be statistically significant, and $\bar{R}^2$ also declines slightly, from 0.81 without RNDSAL to 0.80 with RNDSAL.

We also explored the possibility of CAPUTN behaving in a non-linear fashion, the hypothesis being that beyond a certain level of capacity utilization, there is no more slack in the system and costs increase more than proportionately (e.g. wage costs go up because of overtime, and general efficiency is impaired since people are not accustomed to high levels of CAPUTN). The equation

$$PROFSL = 0.08 + 0.14\ CAPUTN - 0.08\ (CAPUTN)^2\ ,\ \bar{R}^2 = -0.15$$

shows that while the signs of the coefficients are as hypothesized, the variables and the equation as a whole are not significant. When we added $(CAPUTN)^2$ to the list of variables in equation 1, there was no substantial change and the variable was statistically insignificant.

Finally, the chance of any systematic relationship amongst the independent variables was looked at. A priori, as CAPUTN increases, there is an increase in revenue without a corresponding increase in capital, which implies that CAPREV should decline. The simple correlation coefficient between the two is -0.5, and a univariate regression between the two variables is highly significant. Moreover, VINT is also likely to increase as CAPREV increases, since depreciation charges would be higher (correlation is 0.52). Thus, equation 1 was re-estimated without CAPREV (equation 4). This results in MOD, CAPUTN, and PROD becoming insignificant. SKILL(+) and MKTSH(-) continue to be significant, as do all the dummies and constant term except D_4. Moreover, with a one-tail test, VINT(-) and INVSAL(-) are very close to being significant at the 90% level.

We will now consider the dependent variable π_c i.e. gross profits to gross fixed assets. Equation 5 shows that the only non-significant variables are VINT, TECSAL, and SPARSL. CAPREV is negative and highly significant, and, unlike in the case of π_s, INVSAL is also negative and significant, as predicted. The other significant variables have the same sign as for π_s(equation 1).

Similar experiments as in the case of π_s were then made. With 1 period lags, only MOD1,

CAPREV1 and VINT are (negatively) significant, besides D_1 - D_3 and the constant (equation 6). Equation 7 embodies 2 period lags (and compared with equation 5 re-run with 43 variables). The major difference is that SKILL becomes negatively significant (positive and insignificant in re-run equation 5), TESCAL 2 and VINT are negative and significant (insignificant), but many of the other variables turn insignificant. Statistically, equation 5 is far superior to equation 7.

RNDSAL turns out to be negative and insignificant when we estimated equation 5 with the addition of this variable (38 observations).

CAPUTN should be more strongly related to π_c than π_s, substantiated by a positive and significant coefficient for CAPUTN in a univariate regression with π_c as dependent variable (correspondingly, for π_s, CAPUTN is negative and insignificant). However, the non-linear hypothesis turns out, as in the case of π_s, to be inapplicable:

PROFCP = -0.05 + 0.65 CAPUTN - 0.23 $(CAPUTN)^2$ $\quad \bar{R}^2 = 0.08$

Equation 8 attempts to take care of the CAPREV multicollinearity by dropping it from our originally estimated equation. The results are strikingly different, with CAPUTN and SPARSL becoming positive and significant, and MOD, SKILL and PROD turning insignificant. VINT(-) is also significant with a 1-tail test. In equation 9, CAPUTN is dropped instead of CAPREV, which gives results very similar to equation 5.

With MKTSH as dependent variable, the only significant variables in equation 10 are VINT(+), CAPUTN(+), and the dummies (firm dummies positive, time dummy negative). When 1 period lags are introduced (equation 11), the only difference is that SKILL also becomes significant with a 1-tail test (however, this is not because of the lags, but because of the reduction in the number of variables to 48). With 2 period lags (equation 12), only SKILL(+) and CAPUTN (+, 1 tail) are significant (besides dummies).

When equation 10 was re-run with only 38 variables, the only significant variables were the dummies and constant term. When RNDSAL was added to this, it was highly significant (equation 13), but the other variables continued to be insignificant. This means that reduction in the degrees of freedom imposes a price in terms of significance of the variables, but RNDSAL is

nevertheless significant.

When CAPREV is dropped, CAPUTN and VINT are the only variables that continue to remain significant (equation 14).

Explanation of the Results

MOD and CAPREV are strongly significant for π_c, occasionally so for π_s and never for MKTSH. The negative values in the case of π_c indicate that the capital-expanding effect of these variables outweighs their profit-enhancing effect (i.e. capital assets increase without a corresponding decrease in wages and/or increase in unit value realization, leading to a decline in π_c as CAPREV or MOD increase). With π_s as the dependent variable, the immediate impact of MOD and CAPREV appears to be negative, owing perhaps to a tendency of the firm to increase investments when (gross) margins are falling. However, a model where the impact of investments would be positive would certainly need to incorporate a pattern of lags/distributed lags. In the CV industry, much of the investment expenditure has been towards new vehicles or engines, which take at least three to four years to fructify. Some indication of this is provided by the positive albeit insignificant coefficients of MOD2 and CAPREV2 in equation 3 with π_s (the lack of significance may be due to reduction in the degrees of freedom). In the case of MKTSH, MOD and CAPREV are never significant, possibly because competing firms are following similar investment strategies, implying that investment is unable to make one win market share at the expense of the other in the period studied. The other possibility is the operation of a lagged effect which we are unable to capture. With π_c as the dependent variable, the negative effect of CAPREV and MOD is likely to persist even after the equation is lagged. [1]

VINT behaves as hypothesized in all the equations. It is particularly significant in the MKTSH equations, except when the number of variables is less (equations 12 and 13). This

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1. A univariate regression of the form y = a+ bx finds CAPREV to be negative and significant even with 3 and 4 period lags. (MOD is negative but not significant). For π_s and MKTSH, on the other hand, MOD and CAPREV are insignificant, both with and without lags.

means that greater in-house production enables a firm to expand its market share. VINT does not appear to affect π_s so strongly, but it is (negatively) significant in the 1-period lagged case (equation 2). Its effect on π_c is more pronounced, since greater integration also implies a higher capital base (correlation coefficient between VINT and CAPREV is 0.52), which dampens the ratio π_c Our result is at odds with Kumar's (1990) finding that across Indian industries, a higher value added to sales ratio leads to higher profitability. This could be because of firm and industry level data differences.

INVSAL has, in most cases, the correct sign (negative for π_s and π_c, positive for MKTSH), but it is rarely significant except for π_c . This could be because higher inventories require a somewhat larger capital base (need for more space, machines), which would tend to depress π_c.

TECSAL is usually insignificant, with a negative sign. Like MOD and CAPREV, it needs to be incorporated with appropriate lags, since the numerator includes imports of capital goods. A priori, both TECSAL and RNDSAL are very important variables in the firm's competitive strategy, particularly in the context of gaining market share -- CV firms have devoted greater efforts towards product rather than process technical change (see chs.7 and 8). Thus, while RNDSAL is not significant for either π_s or π_c it is positive and significant for MKTSH. SKILL, which is a loose approximation of the firm's skilled human resources and embodies its ability to make effective use of technology, is positive and significant in 50% of the equations.

SPARSL does not appear to be important in improving profitability and IMPCNS likewise in the case of MKTSH. Although spares are undoubtedly sold at a higher profit margin than complete vehicles, their small share in total sales (7-15%) precludes pushing spare sales as an effective profit enhancing strategy. The insignificant coefficient of IMPCNS indicates that in a discerning market where the vehicles are intended for commercial rather than personal use, imported components do not guarantee improved market share.

PROD usually has a negative coefficient which, however, is rarely significant. This means that total production (in value terms) of a firm does not influence its profitability. This is evident from a comparison of ALL and Telco, two firms operating in the same market, vastly different in

size, and yet comparable in terms of profitability (see ch.3). In any case, our PROD measure is unable to effectively capture economies of scale since it is not a direct measure of relative costs. Another problem is that while PROD shows a natural tendency to increase with time, π_s and π_c exhibit a downward movement in the 80s, which probably accounts for the negative coefficient of PROD.

The consistently negative and often significant sign of MKTSH indicates that in the CV industry, larger firms with higher market shares have not enjoyed market power or, if they have, have been unable to use it to push up profit margins. In fact, the results show that lower market shares could have made some contribution towards higher profits. However, in the case of the MKTSH variable , the inter-firm variability is very high, Telco's share being thrice that of ALL and SMPIL. Statistically, therefore, inter-firm effects would dominate temporal effects. Firms like BTL as well as ALL and M&M over a number of years, have a higher profitability than Telco which has a higher market share. The implication is that for firms entrenched in an industry, inter-firm variations in profitability are not likely to depend significantly on market share (the explanation is also valid for the variable PROD). In an industry where there is no competition from imports and where inter-firm competition increased only in the last few years of the period being studied, each firm can follow a relatively independent pricing strategy which would depend on its profit motives. It also implies that market share in this industry has been gained more through product than pricing strategies. This is also supportive of Schmalensee's (1989a) "stylized fact" that within particular manufacturing industries, profitability is not generally strongly related to market share (p.984).

CAPUTN is positively significant for MKTSH, and negative and less significant for π_s and π_c. The most profitable firm, BTL, has amongst the lowest rates of capacity utilization. Similarly, SMPIL, with very low rates of utilization, is sometimes more profitable than Telco, particularly in the case of π_c. There are two problems in the case of the CAPUTN variable. One is the usual inter-firm variability which, albeit not as high as for MKTSH, is nevertheless significant. Secondly, the firm's definition of capacity that we have employed is always a subjective view of the

firm's management, and varies from firm to firm, and could do so even over time within the same firm.[1] It is generally defined on the basis of machine output (i.e. labour is not considered), which implies an overestimate of capacity and an underestimate of utilization. A new series, NKUTN, was constructed on the basis of peak utilization ratios (see Annexure), but even this did not yield a positive coefficient for CAPUTN in most of the π_s and π_c equations. It does therefore seem that inter-firm variation sometimes leads to a significant negative coefficient for CAPUTN for the profit equations (but when CAPREV is dropped, CAPUTN becomes positive and significant for π_c and insignificant for π_s). A somewhat different explanation would rely on the possible decline in monopoly power resulting from an increase in CAPUTN (and hence in total output), and a consequent decline in profit margins. This is not however in line with our earlier conclusion that market power has not been an important determinant of profitability.

Expectedly, the firm dummies are highly significant in most equations. In the case of BTL (D_3), the dummy is positive and significant at 99% in all the equations. For Telco (D_1) and M&M (D_2), the dummies are positive and significant at 99% on most occasions. However, the ALL dummy (D_4) is significant (at 90% or more) in fewer equations. The time dummy (D_5) is usually negative and significant, as predicted, which means that after 1985, there has been a substantial decline in market shares as well as profitability. The constant term is always positive and significant for π_s and π_c, but it is of varying sign and never significant for the MKTSH equations. This suggests that the excluded variables (besides those captured by firm dummies) may not be significant for MKTSH.

A few equations were also run with exports to sales as the dependent variable. Except for PROD, which had a negative sign, none of the variables tried was significant. Firm dummies D_1 and D_2 were highly significant (these are the biggest exporters) and D_4 was significant at 95%. The lack of significance of most variables lends support to the hypothesis that exports are crucially influenced by factors such as dealer network and after-sales service, quality and prices (see

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1. See, for example, Christiano (1981) and Nelson (1989) for problems with capacity utilization measures.

ch.4), none of which have been captured by our variables.

Caveats

We have implicitly assumed that the estimated parameters are stable both cross-sectionally and temporally. More often than not, temporal stability is taken for granted in pooled data, and the tests focus on cross-sectional stability.[1] It is not possible in our case to statistically test for either kind of stability, since we cannot run regressions with only 5 (number of firms) or 11 observations (number of years) to do the required F-tests.

By incorporating dummy variables for each firm we have made the assumption that the slope coefficients are the same for each firm but the intercepts are different. We tested this by running the basic equations with and without the firm dummies, and then running an F-test.[2] The F-values for equations 1,5 and 10 were 21.9, 75.1 and 13.2 respectively, thus rejecting decisively the null hypothesis that firm-specific intercept effects are not significant.

Specification errors may have arisen since it was not possible to obtain a data series for crucial factors such as price of output, dealer network and after-sales service. This could result in biases in the estimated coefficients, unless the missing variables are orthogonal to the ones included.

We sought to control for firm-specific effects which we noted were occasionally giving rise to counter-intuitive results. This was done by taking first differences of all variables and re-running the equations. However, the resulting equations were not significant (the F statistic was extremely low).

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1. See Maddala (1979), pp.322-26. Kuh (1971), ch.5 and 6, however, does a detailed investigation of the temporal stability of cross-section data.

2. $$F = \frac{(RSS^c - RSS^u)/n}{RSS^u/d.f.}$$

Where RSS^c is the residual sum of squares in the constrained equation i.e. without the firm dummies, RSS^u is the RSS unconstrained, n is the number of restrictions (4 in this case), and d.f. is the degrees of freedom in the unconstrained equation. If F exceeds a critical value, then we reject the null hypothesis that firm-specific effects are not important. With n = 4 and d.f. = 38, $F_{0.95} = 2.63$. See Rao and Miller (1972), pp.141-45.

Finally, the lack of sufficient number of observations has not allowed us to explore in enough detail the possible lagged effects of some variables.

Conclusions

The objective of our exercise was to try and understand the reasons for differences in performance of firms in a single industry, functioning within the same overall environment. Performance was interpreted in a broad sense, particularly since the objectives of the firm itself are multiple and not readily apparent. The intra-industry character of the study obviates the necessity to control for industry effects which are a major problem in inter-industry analysis. The use of different performance criteria, particularly market share (in most studies, it is treated as an independent variable only), has enabled us to get closer to empirical realities and demonstrate that different corporate strategies demand rather different conduct or behaviour by firms.

Notwithstanding the caveats and problems in the analysis, some tendencies have emerged. Perhaps the most consistent is with regard to vertical integration. Firms which have been successful in buying more inputs from outside were more profitable -- as were the Japanese firms (ch.2) -- since suppliers' wage costs are lower. At the same time, market share considerations would dictate that the firm be more integrated, since more integrated firms can achieve better quality control and respond faster to market changes, at least in the Indian context. This is a subject which have examined in detail in chapter 5.

The investment (MOD) and capital intensity (CAPREV) variables show that higher investment tends to depress π_c but does not affect π_s or MKTSH, at least in the immediate period. R&D appears to have a strongly positive impact on MKTSH, but not on π_s and π_c. Similarly, inventories (INVSAL) have a negative effect on π_c but a positive and insignificant effect on MKTSH. Capacity utilization (CAPUTN) is positive and significant for MKTSH, negative and less significant for π_s and π_c. Skilled employees (SKILL) have a positive and often significant impact on all the variables.

In other words, firms pursuing a high market share strategy may require high vertical integra-

tion and an R&D orientation. Those wanting to maximise gross profits per unit of gross assets may want to minimise on fresh investments, keep inventories to the minimum, and buy in as much as possible. Whatever the strategy, including the maximising of gross margins, employing more skilled labour (as proxied by higher paid labour) seems to have a beneficial impact.

It is also clear that there are many black holes in the above. The suggestions made in the previous paragraph can by no means constitute a complete approach to different strategies, since there are many other strategic decisions that the firm has to take. These are the black holes that have resulted in the firm-specific dummies becoming highly significant. This inspite of the rather detailed firm-level data that we have been able to put together.

While providing a few interesting and general tendencies, this econometric analysis at the same time provides strong justification for pursuing our subject in greater depth if we are to understand more fully the forces that lead to intra-industry, inter-firm differences in performance. This we shall do in chapters 5-8.

Table A2.1

Predicted Signs of Coefficients

Independent Var	Dependent Variables: Gross Profits/ sales	Gross profits/Gross capital	Market share
AGE	-	-	-
MOD	+	?	+
CAP	+	?	+
CAPREV	+	?	+
VINT	-	-	+
INVSAL	-	-	(weak) +
TECSAL	+	+	+
SKILL	+	+	+
RNDSAL	+	+	+
WAGE	+	+	+
SPARSL	+	+	no relation
IMPCNS	no relation	no relation	+
PROD	+	+	no relation
CAPUT	+	+	+
NKUTN	+	+	+
MKTSH	+	+	same variable
GRTH	+	+	no relation

Table A2.2 REGRESSION RESULTS: OLS ESTIMATES

	DEPENDENT VARIABLE	SMPL SIZE	INDEPENDENT VARIABLES C	MOD	MOD1	MOD2	CAPREV	CAPREV1	CAPREV2	VINT	INVSAL	TECSAL	TECSAL1	TECSAL2	RNDSAL	SKILL	SPARSL	IMPCNS	PROD	CAPUTN	MKTSH	D1	D2	D3	D4	D5	$\bar{R}^2$	F
1	PROFSL	54	0.31[a]	-0.04[c]	-	-	-0.13[a]	-	-	-0.08	-0.04	-0.07	-	-	-	0.20[a]	-0.17	-	-0.08[b]	-0.08[b]	-0.14[a]	0.18[a]	0.07[a]	0.13[a]	0.04[b]	-0.04[a]	0.77	12.6
2	PROFSL	48	0.29[a]	-	-0.03	-	-	-0.06	-	-0.20[c]	-0.01	-	0.57[d]	-	-	0.12[b]	-0.37	-	-0.06	-0.08[b]	-0.09	0.16[a]	0.08[a]	0.13[a]	0.04[c]	-0.03[b]	0.76	10.9
3	PROFSL	43	0.16[b]	-	-	0.02	-	-	0.01	-0.06	0.05	-	-	-0.51	-	0.04	-0.30	-	-0.01	-0.05	0.01	0.04	0.03	0.11[a]	0.02	-0.02[b]	0.84	15.7
4	PROFSL	54	0.22[a]	-0.02	-	-	-	-	-	-0.13	-0.08	-0.21	-	-	-	0.11[b]	0.02	-	-0.04	-0.03	-0.13[b]	0.13[a]	0.07[a]	0.13[a]	0.02	-0.04[a]	0.72	10.7
5	PROFCP	54	1.13[a]	-0.16[a]	-	-	-1.03[a]	-	-	-0.27	-0.28[c]	-0.43	-	-	-	0.45[a]	0.03	-	-0.26[a]	-0.15[c]	-0.51[a]	0.60[a]	0.24[a]	0.34[a]	0.10[b]	-0.10[a]	0.89	28.8
6	PROFCP	48	1.08[a]	-	-0.16[c]	-	-	-0.53[a]	-	-1.06[b]	-0.3	-	-0.01	-	-	0.05	-0.47	-	-0.17	-0.12	-0.20	0.44[a]	0.27[a]	0.33[a]	0.04	-0.04	0.75	10.2
7	PROFCP	43	0.61[b]	-	-	0.02	-	-	-0.20	-0.65[d]	0.12	-	-	-2.66[c]	-	-0.47[b]	-0.76	-	0.06	-0.07	0.15	0.02	0.20[b]	0.29[a]	-0.00	0.02	0.82	14.0
8	PROFCP	54	0.48[b]	-0.06	-	-	-	-	-	-0.61[d]	-0.6[b]	-1.51	-	-	-	-0.25	1.46[c]	-	0.05	0.25[b]	-0.47[b]	0.18	0.26[a]	0.30[a]	-0.06	-0.04	0.68	8.9
9	PROFCP	54	0.91[a]	-0.16[a]	-	-	-0.91[a]	-	-	-0.04	-0.29[c]	-0.68	-	-	-	0.32[b]	0.41	-	-0.02[b]	-	-0.60[a]	0.53[a]	0.23[a]	0.33[a]	0.08[c]	-0.09[a]	0.88	28.9
10	MKTSH	54	-0.08	-0.03	-	-	0.14	-	-	0.89[a]	0.07	-0.68	-	-	-	0.10	-	-0.08	-	0.17[c]	-	0.39[a]	0.24[a]	0.24[a]	0.09[a]	-0.07[c]	0.93	52.0
11	MKTSH	48	-0.06	-	0.02	-	-	-0.09	-	0.59[b]	0.18	-	-0.14	-	-	0.15[d]	-	-0.36	-	0.17[b]	-	0.43[a]	0.25[a]	0.27[a]	0.07[b]	-0.07[b]	0.94	56.4
12	MKTSH	43	0.08	-	-	0.04	-	-	-0.04	0.20	0.09	-	-	-1.1	-	0.21[b]	-	-0.35	-	0.14[d]	-	0.46[a]	0.25[a]	0.27[a]	0.03	-0.07[b]	0.95	65.3
13	MKTSH	38	0.25	0.04	-	-	-0.14	-	-	0.27	-0.11	-0.05	-	-	5.32[b]	-0.04	-	-0.36	-	-0.02	-	0.50[a]	0.41[a]	0.23[a]	0.07[b]	-0.04[d]	0.98	114.4
14	MKTSH	54	-0.14	-0.00	-	-	-	-	-	0.79[a]	0.02	-0.95	-	-	-	0.05	-	-0.16	-	0.22[a]	-	0.38[a]	0.26[a]	0.26[a]	0.08[b]	-0.07[c]	0.93	55.9

Notes : a Significant at 99%
b Significant at 95%
c Significant at 90%
d Significant at 90% with a one-tail test

ANNEXURE : THE DATA AND VARIABLES

The data has been drawn from the annual reports of the various firms for 1976-77 to 1987-88. The variables are described below:

AGE : accumulated depreciation/gross fixed assets. The fixed assets figure is at book value and is net of revaluation, if any.

MOD : percentage change in gross fixed assets.

CAP : gross fixed assets/total expenditure on personnel including welfare expenses and bonus.

CAPREV : gross fixed assets/total sales net of excise duties. Excise duties have been netted because they are different for different kinds of vehicles.

VINT : X/(X+Raw Materials Consumed) where X is total personnel expenses, change in stock, other manufacturing expenses and depreciation.

INVSAL : inventories of finished goods and raw materials to total sales (net of excise).

TECSAL : imports of capital goods, royalty payments and payments for technical knowhow as a share of sales (net).

SKILL : costs of employees earning more than Rs.3,000 per month to total personnel costs.

RNDSAL : R&D expenditure as a share of sales (net).

SPARSL : sales of spare parts and "other" items as a share of sales (net).

IMPCNS : imported consumption as a share of total consumption of raw materials and components.

PROD : value of production i.e. sales adjusted for stock changes.

CAPUT : actual output (in numbers) as a share of installed capacity as certified by management. The same procedure is also adopted for companies that are "multi-product", since the products are very similar (LCVs and 3-wheelers for BTL, tractors and LCVs for M&M, cars and LCVs

for SMPIL), and the share of the secondary product is in any case minor.

NKUTN : this ratio is calculated on the assumption that the firm gets used to a certain level of capacity utilization. When this is exceeded, then the firm is assumed to adjust itself to that level. Thus, peak levels of capacity utilization are assumed to have 100% utilization. Any increase in capacity thereafter is adjusted by this level of utilization, and the new capacity utilization then calculated. This is a modification of the Wharton method detailed in Christiano (1981). Thus,

$$NKUTN_t = \frac{O_t / C_t}{(O/C)_p}$$

where O_t and C_t are output and capacity (as certified by management) in year t, and $(O/C)_p$ is the previous peak output-capacity ratio.

GRTH : percentage change in net sales.

MKTSH : weighted market share of companies, calculated as

$$\sum_i S_{if} \cdot S_i$$

where S_{if} = share of product i in the firm's total output in physical terms (jeeps, LCVs and tractors for M&M, and LCVs and MHCVs for Telco in 1986 and 1987 only).

S_i = share of product i in the total output of the same industry.

One caveat is that the market share data, which has been drawn from the usual AIAM and ACMA statistics, relates to calendar years. However, the balance-sheet data pertains to the financial years of companies. Nevertheless, there is sufficient overlap in terms of number of months in the year so that the trend is adequately reflected.

PROFSL (π_s) : gross profits (before interest, depreciation and tax) to net sales.

PROFCP (π_c) : gross profits to gross fixed assets.

TABLE A-2-1 - UNITED STATES - SALES 1986

Retail Sales of Trucks by Weight Groups (In Pounds)

	6,000 & less	6,001-10,000	10,001-14,000	14,001-16,000	16,001-19,500	19,501-26,000	26,001-33,000	33,001 & over	Total
DOMESTIC[1]									
Chrysler Corporation	378,877	129,197	4,811	-	-	-	-	-	512,885
Ford Motor Company	778,508	546,377	-	-	-	12,643	29,877	11,286	1,378,691
Freightliner Corporation	-	-	-	-	-	-	-	17,473	17,473
General Motors Corporation	1,014,897	518,321	-	-	5,841	14,198	26,757	7,760	1,588,575
Jeep Corporation	188,745	18,769	-	-	-	-	-	-	207,514
Kenworth Truck Company	-	-	-	-	-	-	-	10,457	10,457
Mack Trucks, Inc	-	-	-	-	-	-	-	17,247	17,247
Navistar Int'l Transporation Corp	-	-	-	-		12,789	31,539	26,303	70,631
Nissan Motor Mfg. Corp., USA	96,827	-	-	-	-	-	-	-	96,827
Peterbilt Motors Company	-	-	-	-	-	-	-	9,992	9,992
Volvo-White Truck Corporation	-	-	-	-	-	-	-	10,304	10,304
Other Domestic Manufacturers	-	-	-	-	-	20	-	992	1,012
T O T A L	2,457,854	1,213,664	4,811	-	5,841	39,651	88,173	111,814	3,921,408
IMPORTS									
American Isuzu Motors, Inc	88,720	-	-	-	-	-	-	-	88,720
Chrysler Corporation	83,474	-	-	-	-	-	-	-	83,474
Ford Motor Company	-	-	-	-	-	-	2,747	-	2,747
General Motors Corporation	-	-	1,798	-	-	-	2,267	-	4,065
Hino Motors (USA), Inc	-	-	-	-	54	344	640	-	1,038
Isuzu Truck of America, Inc	-	-	4,948	-	8	-	-	-	4,954
Mack Trucks, Inc	-	-	-	-	-	2,623	2,678	-	5,301
Mazda Motors of America, Inc	157,127	-	-	-	-	-	-	-	157,127
Mercedes-Benz of North America, Inc.	-	-	-	-	-	2,087	1,929	-	4,016
Mitsubishi Motor Sales, Inc	34,985	-	-	-	-	-	-	-	34,985
Navistar Int'l Transporation Corp	-	-	-	-	-	-	391	-	391
Nissan Diesel Motor Co	-	-	-	-	204	91	429	-	724
Nissan Motor Corporation	126,604	-	-	-	-	-	-	-	126,604
Suzuki of America	47,732	-	-	-	-	-	-	-	47,732
Toyota Motor Sales, U.S.A., Inc	384,198	-	-	-	-	-	-	-	384,198
Volvo-White Truck Corporation	-	-	-	-	-	-	1,459	1,057	2,516
Total Imports	922,838	-	6,747	-	264	5,145	12,540	1,057	948,591
Total Trucks[2]	3,380,492	1,213,664	11,558	-	5,905	44,796	100,713	112,871	4,869,999

NOTE: Includes school bus chassis.
[1] Units produced in the United States, Canada and Mexico.
[2] Incomplete. Sales data for several manufacturers are not available.

MOTOR VEHICLE MANUFACTURERS ASSOCIATION OF THE U.S., INC. AND WARD'S AUTOMOTIVE YEARBOOK

Source: MVMA (1988), p. 369.

Table A.3.1 PRODUCTION OF COMMERCIAL VEHICLES, 1950-1988

Year	Total CV	MHCV	LCV	Year	Total CV	MHCV	BUSES	TRUCKS	LCV
1950	1891	n.a	n.a.	1966	35127				
1951	2181			1967	31464				
1952	2681			1968	34940	149805	35894	113911	29161
1953	2754	5731	17707	1969	35243	(29961)	(7179)	(22782)	(5832)
1954	5300	(1146)	(3541)	1970	40972				
1955	9262			1971	41854	34081	11481	22600	7773
1956	14301			1972	38703	30375	8491	21884	8328
1957	16033			1973	44909	33868	9186	24682	11041
1958	15230	73064	24452	1974	41874	35110	10836	24274	6764
1959	20351	(14613)	(4890)	1975	43034	36257	12251	24006	6777
1960	27518			1976	46761	37987	14721	23266	8774
1961	25740			1977	41702	33281	11000	22281	8421
1962	26894			1978	53470	42318	14139	28179	11152
1963	28482	126283	27881	1979	59696	46091	14243	31848	13605
1964	33517	(25257)	(5576)	1980	68311	48652	14478	34174	19659
1965	37408			1981	89752	65852	20272	45580	23900
				1982	90246	61813	15864	45949	28433
				1983	87365	60333	18391	41942	27032
				1984	94660	61989	21466	40523	32671
				1985	101228	66106	21870	44236	35122
				1986	95088	56791	20694	36097	38297
				1987	106952	64762	21569	43193	42190
				1988	117303	70102	20031	50071	47201

Notes: MHCV-over 6 tons GVW , LCV - upto 6 tons GVW ; Buses + Trucks = all MHCV
LCVs include three-wheeler "Tempos", drive-away chassis and "Trekker" and "NC" vehicles. For 1950-70, MHCV and LCV may not add up exactly to total owing to different data sources.
Figures in parentheses denote annual averages.

Sources: AIAM (1985), for data from 1971-84, and total output 1950-84
Motor Indi(September 1989) for 1988 data.
ACMA (1988) for all remaining data.

CHART A.3.2

CURRENT PRODUCT AND COMPANY PROFILE - COMMERCIAL VEHICLES

(all weights in GVW unless otherwise stated. GTW is gross trailer weight)

COMPANY	PRODUCT LINE: HEAVY COMMERCIAL VEHICLES — GOODS CARRIERS: ARTICULATED VEHICLES (25-100T GTW)	GOODS CARRIERS: MULTI-AXLE VEHICLES (24-26T)	GOODS CARRIERS: HEAVY DUTY (13-16T)	PASSENGER VEHICLES: STANDARD (HEAVY)	PASSENGER VEHICLES: OTHERS	MEDIUM DUTY VEHICLES (6-12T)	LIGHT VEHICLES (3-5T)	CAR-DERIVED & OTHER VERY LIGHT VEHICLES (UPTO 2.5T)	SPECIAL APPLICATION VEHICLES	DIVERSIFICATION	COMPANY WISE REMARKS
TELCO	Two vehicles in range, the 1612 and 1616, GTW from 25 to 32 T.	Introduced the 2416 in 1986-87	1210 is the mainstay and dominates this market, 80% share in 1988	Derivative of 1210 is the mainstay. Share is 59% in 1988	Makes chassis for 11,14,25 and 28 seaters. Also makes rear-engines luxury buses.	807 and 909 range not very popular, 8T and 9T GVW. Launched 608 in 1987, 6T (14% market share in 1988).	Indigenously produced 407 launched in 1986, 4.8T, 2.6T payload. Good market acceptance, 30% in this class in 1988.	Tatamobile introduced in July 1988 as a light pick-up, 2T (car-derived). Car version of this to be introduced in 1990.	Smaller range than Leyland-produces fire engines, defence vehicles, earth-moving vehicles etc.	Excavators, Marine Engines	Telco strategy is to diversify into a wide range of vehicles, partly in order to be able to fully utilise its very extensive infrastructure.
ALL	Wide range : Comet, Tusker, Beaver, Hippo and Rhino ranging from 26 to 100 GTW. Market leader in this range owing to its high torque engines.	First to introduce multi-axle vehicles At present there is the Taurus, Gaur & Hippo, 24-26T GVW. Market leader.	Comet main model. Only 19% of market Decline in absolute sales steadily after 1983, strong recovery in 1988.	Cheetah & Viking range. Market share 42% in 1988.	Only producer of double-decker, vestibuled and integral buses. Total market about 200 per year. Also makes Chital minibus.	--	--	--	Earthmoving vehicles, defence, fire-tenders, oilfied trucks aircraft refuelling etc.	Engines	Has widest range of basic models of commercial vehicles of any manufacturer. Is least integrated of established firms.
HML	--	--	Fresh collaboration with ISUZU for its 15.4T FVR truck.	Phased out earlier production. Isuzu vehicle being brought out only in a goods version so far.	--	J-5, T-230 & T-120 series. Production largely for exports (Bedford J-5). Actual capacity of J-5 less than rated capacity.	--	Sells about 1000 indigenously developed Trekkers. Sales of car-derived Porter (2T) negligible.	--	Cars, Excavators/ Shovels, cranes, steel products, scrapers, crawlers tractors, loaders, dumpers.	Is attempting a come-back into the CV business, which will be hampered because of high ven. Also faces a demand crunch in its main line product: its car.
PAL	--	--	Roadster was being produced until 1985-86.	Phased out	--	Roadster, no longer produced (5.6T).	--	Phased out production of drive-away chassis.	--	Produces Cars	Has faded out of Commercial Vehicles scene
SIMPSON & CO	--	--	Produced some Ford trucks in the 80's but was a failure.	A few hundred Ford buses sold	--	--	--	--	--	Produces Perkins engines and bodies for vehicles.	Was unsuccessful in its bid to introduce Ford Trucks, has a few CKD packs which it is trying to dispose.
BTL	--	--	--	--	Launched the 15 seater Mercedes Traveller in 1987. Luxury vehicle, but sales have not picked up.	--	Single-most popular LCV: Matador, GVW of 3.5T & payload 2T, sold 11878 in 1988; 41% of market share in this class.	'Tempo' Hanseat three wheeler, 1.5T GVW ancient model, still sells 2000 to 2500 p year.	--	Diesel engines. Recently began production of indigenously developed jeep.	Focus on light vehicles, but has a wide range of factory-built models. Has been squeezed somewhat by launch of Traveller.
M&M	All companies have passenger versions of their light and medium-duty vehicles.				--		FJ series with GVW of 3.9T & payload in the range of 2.2 to 2.4T. Current sales 4700 in 1988, 16% share.	MC Series-jeeps with extended wheel-base, station wagon kind. 2- 2.3T GVW, peak output of over 6000 in 1985 but dropping rapidly now.	Aircraft ladder, diamond core drill	Largest producer of jeeps in the country. Also produces tractors & process control instruments.	Its jeeps have helped it to survive in the CV market. Has recently acquired 26% share in Allwyn Nissan. Plans to introduce Peugeot 504 pickup in 1990.
STANDARD MOTORS					--		Standard 20 Mini-lorry, GVW 3.8T, Microlorry, 4.8.T. Sales dropping continuously since 1984.	--	--	Produces a luxury car - Standard 2000, which has performed badly in the market.	Has lagged behind Bajaj & Mahindra. volumes too low, its survival in the LCV market is now in question. Lock-out since February 1989.
EICHER MITSUBISHI	These are used mainly in up-market applications such as tourist coaches or by companies to transport their executives.					Canter' 5.9T. Market leader in 6T class, 34% share in 1988.	--	--	Tippers, tankers, fire-tenders	--	Last among the Japanese LCVs to enter the market but quickly became leader. Sister group produces tractors.
DCM TOYOTA						'Dyna' 6T, share 28% in 1988. Introduced in newer and more powerful engine in 1989.	--	--	Tippers	--	DCM group has no previous experience in automobiles (except in components) but it is the largest (as a group) amongst the Japanese LCV manufacturers.
SWARAJ MAZDA						T-3500 - 5.9T, 2% share in 1988.	--	--	Dumpers	--	Sister group produces Tractors. Has made good progress in indigenisation.
ALLWYN NISSAN							Cabstar, 4.9T, 3T payload, 7% share in 1988.	--	Water tenders, refuse compactors.	--	26% of Allwyn equity recently acquired by M&M. The market has been less receptive because the payload is less than other new entrants.
PRODUCT LINES	Total demand for these vehicles is limited because of road network. Used in applications like containerisation, bulk cement carriers, vehicle carriers & other bulk commodities.	The multi-axled vehicles cause less damage to roads because load is spread more evenly. Statistics do not allow a full disaggregation between different categories of CVs.	This forms the largest category of vehicles sold in the CV market. Has been upgraded in the 1960s and 1970s to carry heavier payloads.	Common complaint is that these are not really 'buses' because it is a truck chassis. The demand for buses in India is larger than anywhere else in the non-communist world, but the product lags far behind world standards.	Total market for double-decker, vestibuled and integral buses limited because of width & condition of roads, over-bridges. Application in airport, tourist, Bombay transport	The new generation LCVs, although rated at 6T, are used to carry upto 9 to 10T GVW. The latent demand in this category is proved by the market acceptance of the new vehicles. The 6 T class is the most fiercely competitive in the Indian automotive industry. The 9-12T range (807, 909, J-5 is not popular).	There has been little change in the 3-4 T class and it is being put under some pressure by the newer 4-5 T vehicles. The low cost of 3-4 T vehicles is their strongest point.	The only serious and deliberate effort in this range is the Tatamobile, which is being targeted for the overseas market also. M&M and perhaps DCM-Toyota also plan to introduce light pickups.	No separate statistics for this range. Market size seems to be a few hundred vehicles per year.	Possible economies of scope in these operations with CVs.	In the 60s & 70s the range of vehicles was mainly at two extremes: either 3.5-4T or 12-15T. Liberalisation and entry of Japanese vehicles has awakened the industry from its slumber & even the HCV mfrs. are going in for a lighter range. Currently market in a state of flux & new entrants fighting to get entrenched.

Table A.3.3 : PRODUCTION OF ALL COMMERCIAL VEHICLES BY MANUFACTURER, 1950-88

Year	TELCO	ALL	PAL	HML	BTL	M&M	SMPIL	ANL	DCMT	EML	SML
1950	-	-	847	1044	-	-	-	-	-	-	-
1951	-	-	1812	369	-	-	-	-	-	-	-
1952	-	-	1512	1169	-	-	-	-	-	-	-
1953	-	199	1523	1032	-	-	-	-	-	-	-
1954	120	531	3531	1118	-	-	-	-	-	-	-
1955	2338	670	3887	2360	-	7	-	-	-	-	-
1956	5153	847	5285	2712	-	304	-	-	-	-	-
1957	7401	982	5944	1137	-	569	-	-	-	-	-
1958	7694	1117	4219	1431	200	569	-	-	-	-	-
1959	7880	1426	5409	4382	533	721	-	-	-	-	-
1960	9665	2071	6347	7079	927	1429	-	-	-	-	-
1961	12000	2371	5528	4096	793	952	-	-	-	-	-
1962	12196	2835	5387	4947	850	679	-	-	-	-	-
1963	12424	2732	6316	5815	888	307	-	-	-	-	-
1964	14367	3728	8749	4940	1688	45	-	-	-	-	-
1965	17328	4285	9152	4891	1681	-	71	-	-	-	-
1966	18900	3857	4775	4101	1562	953	979	-	-	-	-
1967	19140	4618	4076	1535	1665	1057	373	-	-	-	-
1968	21669	4393	3355	1981	1641	1453	458	-	-	-	-
1969	20497	4865	3563	1836	2578	1483	421	-	-	-	-
1970	24463	5264	4893	1733	3497	966	156	-	-	-	-
1971	24654	5472	4578	2559	3322	922	347	-	-	-	-
1972	22441	4244	3582	2670	3416	912	1438	-	-	-	-
1973	23107	5639	5735	3161	5005	1299	963	-	-	-	-
1974	22277	7691	4900	2078	3779	954	195	-	-	-	-
1975	25269	7711	2917	1220	4456	696	765	-	-	-	-
1976	26444	9179	2319	1110	4654	1338	1717	-	-	-	-
1977	23419	8083	1881	969	4770	953	1627	-	-	-	-
1978	29108	10947	1264	2383	6507	1354	1907	-	-	-	-
1979	31685	12315	1079	2599	6509	3084	2425	-	-	-	-
1980	31768	12928	1235	4880	9801	3617	3491	-	-	-	-
1982	43097	16363	2797	2496	11708	9034	4751	-	-	-	-
1983	46074	13411	1293	1908	9626	9658	5395	-	-	-	-
1984	46740	14430	952	2307	12906	11515	5810	-	-	-	-
1985	49235	15938	475	2411	13987	11577	4583	1099	1323	-	600
1986	44122	15265	46	2253	13344	10928	2807	1654	2385	754	1530
1987	55666	16347	1	2091	16045	6776	1530	1139	3073	2375	1909
1988	60924	18689	0	1492	14958	5570	1657	2338	3448	4621	3155

Notes: Output includes 3-wheeler "Tempo", drive-away chassis and "Trekker", and "NC" vehicles.
Simpson & Co. produced 591 trucks in 1980 and 820 in 1981.

Sources: AIAM (1985) for 1950-84
ACMA (1988) for 1985-88

Table A.3.4 : MARKET SHARE BY MANUFACTURER, 1951-88

(All figures in %)

	MEDIUM & HEAVY COMMERCIAL VEHICLES												LIGHT COMMERCIAL VEHICLES									
	TOTAL MHCVs				TRUCKS				BUSES													
Year	TELCO	ALL	HML	PAL	TELCO	ALL	HML	PAL	TELCO	ALL	HML	PAL	ANL	BTL	DCMT	EML	HML	M&M	PAL	SML	SMPIL	TELCO
1951-55	42.9	18.8	2.7	35.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-	-	-	-	40.9	1.6	57.4	-	-	-
1956-60	51.7	8.2	15.6	24.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-	6.8	-	-	27.7	27.2	38.3	-	-	-
1961-65	54.1	12.6	16.0	17.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-	21.2	-	-	16.0	14.9	47.8	-	0.2	-
1966-70					67.6	12.1	7.4	12.9	60.6	30.5	1.8	7.2	-	38.1	-	-	14.2	20.2	20.2	-	7.4	-
1971-75					69.7	12.7	6.8	10.8	62.5	32.7	1.4	3.4	-	48.6	-	-	11.1	9.1	22.4	-	8.8	-
1976-80					73.5	20.8	1.8	3.9	56.8	42.3	0.6	0.4	-	51.7	-	-	10.8	15.5	4.2	-	17.9	-
1981					73.2	19.2	2.8	4.8	60.8	38.5	0.3	0.5	-	36.0	-	-	11.5	29.0	5.0	-	18.5	-
1982					77.2	18.4	0.9	3.6	53.1	46.6	0.2	0.2	-	41.1	-	-	8.4	29.4	4.2	-	16.9	-
1983					80.0	18.0	0.8	1.3	62.9	36.9	0.0	0.2	-	34.5	-	-	6.4	36.8	2.8	-	19.5	-
1984					78.3	18.3	0.8	1.0	63.1	36.4	0.0	0.5	-	41.0	-	-	5.9	33.2	1.6	-	18.3	-
1985					83.2	14.6	1.7	0.6	57.3	42.1	0.0	0.6	3.2	41.1	3.0	-	4.6	32.3	0.6	-	13.5	-
1986					81.1	16.6	2.2	0.1	54.8	45.2	0.0	-	3.6	35.1	6.6	1.7	4.9	27.9	0.1	4.4	7.4	8.3
1987					81.7	16.0	2.3	0.0	55.0	45.0	0.0	-	3.3	39.2	7.7	5.8	4.1	14.6	-	4.6	2.5	18.2
1988					79.5	18.8	1.8	-	58.3	41.5	0.2	-	4.6	31.8	7.5	9.2	2.0	10.9	-	6.6	3.6	23.5

Notes: Upto 1965, sales data is not available and production data is used instead.
Upto 1965, disaggregation between trucks and buses not available.
LCVs are vehicles upto 6 tons and include very light CVs such as Trekker, drive-away chassis, 3-wheeler Tempo and NC vehicles.
MHCVs are vehicles above 6 tons

Source: Calculated from ACMA (1986) for 1951-85 data; ACMA (1988) for 1986-87 data and Motor India (September 1989) for 1988 data.

TABLE A-3-5 : THE STATE OF THE DOMESTIC AUTOMOTIVE MARKET - 1980 - 1988.

	1988			1987			1986			1985			1984			1983			1982			1981			1980		
	NOS.	% OF 4W	%	NOS.	% OF 4W	%	NOS.	% OF 4W	%	NOS.	% OF 4WH	%	NOS.	% OF 4WH	%	NOS.	% OF 4WH	%	NOS.	% OF 4WH	%	NOS.	% OF 4WH	%	NOS.	% OF 4WH	%
PASS.CARS & VANS																											
PASS. CARS TOTAL	158954	51.45	100.00	150088	53.12	100.00	109987	47.60	100.00	102585	46.63	100.00	62679	36.61	100.00	46336	30.17	100.00	44493	30.77	100.00	41489	30.21	100.00	31279	28.10	100.00
HINDUSTAN MOTORS	27759	8.98	17.46	25198	8.92	16.79	22025	9.53	20.03	23477	10.67	22.89	24337	14.21	38.83	24667	16.06	53.24	22804	15.77	51.25	22178	16.15	53.46	22056	19.81	70.51
PREMIER	36193	11.71	22.77	33005	11.68	21.99	26099	11.30	23.73	29283	13.31	28.55	26245	15.33	41.87	20751	13.51	44.78	20842	14.42	46.84	18675	13.60	45.01	8933	8.02	28.56
MARUTI CARS	65563	21.22	41.25	62773	22.22	41.82	42045	18.20	38.23	36139	16.43	35.23	10546	6.16	16.83	-	-	-	-	-	-	-	-	-	-	-	-
MARUTI VAN (PTL)	29008	9.39	18.25	28270	10.01	18.84	18122	7.84	16.48	12996	5.91	12.67	173	0.10	0.28	-	-	-	-	-	-	-	-	-	-	-	-
DOLPHIN & STD	420	0.14	0.26	834	0.30	0.56	1628	0.70	1.48	462	0.21	0.45	919	0.54	1.47	303	0.20	0.65	123	0.09	0.28	34	0.02	0.08	59	0.05	0.19
H.M. & PAL	11	0.00	0.01	8	0.00	0.01	68	0.03	0.06	228	0.10	0.22	459	0.27	0.73	615	0.40	1.33	724	0.50	1.63	602	0.44	1.45	231	0.21	0.74
LESS THAN 2500 KG GVW																											
UTILITY VEHS TOTAL	36493	11.81	100.00	34187	12.10	100.00	34067	14.75	100.00	28429	12.92	100.00	26972	15.75	100.00	24956	16.25	100.00	19554	13.52	100.00	14745	10.74	100.00	16197	14.47	100.00
M&M PETROL	3242	1.05	8.88	4494	1.59	13.15	4903	2.12	14.39	4768	2.17	16.77	4548	2.66	16.86	4079	2.66	16.34	3099	2.14	15.85	1801	1.31	12.21	1998	1.79	12.40
M&M DIESEL	26196	8.48	71.78	25056	8.87	73.29	22813	9.87	66.97	22241	10.11	78.23	20718	12.10	76.81	19291	12.56	77.30	14535	10.05	74.33	10876	7.92	73.76	11969	10.75	74.31
M & M TOTAL	29438	9.53	80.67	29550	10.46	86.44	27716	12.00	81.36	27009	12.28	95.01	25266	14.76	93.67	23370	15.22	93.64	17634	12.20	90.18	12677	9.23	85.97	13967	12.55	86.71
H.M. TREKKER	900	0.29	2.47	1039	0.37	3.04	1450	0.63	4.26	1413	0.64	4.97	1706	1.00	6.33	1586	1.03	6.36	1920	1.33	9.82	2068	1.51	14.03	2140	1.92	13.29
MARUTI GYPSY	5097	1.65	13.97	3491	1.24	10.21	4901	2.12	14.39	7	0.00	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRAX	869	0.28	2.38	107	0.04	0.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TATAMOBILE	189	0.06	0.52																								
2501 KG UPTO 6000 KG GVW																											
LCV TOTAL	41712	13.50	100.00	35208	12.46	100.00	27766	12.02	100.00	24454	11.11	100.00	22855	13.35	100.00	20037	13.05	100.00	21655	14.98	100.00	18575	13.53	100.00	15758	14.15	100.00
MAHINDRA	4697	1.52	11.26	4834	1.71	13.73	4845	2.10	17.45	5338	2.43	21.83	5687	3.32	24.88	5848	3.81	29.19	6103	4.22	28.18	6697	4.88	36.05	3466	3.11	22.00
ALLWYN NISSAN	2015	0.65	4.83	1354	0.48	3.85	1327	0.57	4.78	1097	0.50	4.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MATADOR	11878	3.84	28.48	13019	4.61	36.98	10832	4.69	39.01	12043	5.47	49.25	11358	6.63	49.70	8794	5.73	43.89	10801	7.47	49.88	7419	5.40	39.94	8801	7.91	55.85
DCM TOYOTA	3497	1.13	8.38	3152	1.12	8.95	2493	1.08	8.98	1013	0.46	4.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STD	1684	0.55	4.04	1530	0.54	4.35	2807	1.21	10.11	4583	2.08	18.74	5810	3.39	25.42	5395	3.51	26.93	4751	3.29	21.94	4459	3.25	24.01	3491	3.14	22.15
SWARAJ MAZDA	3172	1.03	7.60	1901	0.67	5.40	1664	0.72	5.99	373	0.17	1.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TELCO 407	8585	2.78	20.58	5873	2.08	16.68	3149	1.36	11.34	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TELCO 608	1862	0.60	4.46	1195	0.42	3.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EICHER CANTER	4322	1.40	10.36	2350	0.83	6.67	649	0.28	2.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ABOVE 6000 KG GVW																											
BUSES TOTAL	19852	6.43	100.00	20228	7.16	100.00	21770	9.42	100.00	21131	9.60	100.00	20141	11.76	100.00	17851	11.62	100.00	16804	11.62	100.00	19056	13.88	100.00	14441	12.97	100.00
ASHOK LEYLAND	8235	2.67	41.48	9109	3.22	45.03	9842	4.26	45.21	8748	3.98	41.40	7347	4.29	36.48	6406	4.17	35.89	7196	4.98	42.82	6880	5.01	36.10	6426	5.77	44.50
TELCO	11576	3.75	58.31	11115	3.93	54.95	11928	5.16	54.79	12263	5.57	58.03	12703	7.42	63.07	11398	7.42	63.85	9544	6.60	56.80	11939	8.69	62.65	7829	7.03	54.21
H.M. & PAL	41	0.01	0.21	4	0.00	0.02	0	0.00	0.00	120	0.05	0.57	91	0.05	0.45	47	0.03	0.26	64	0.04	0.38	237	0.17	1.24	186	0.17	1.29
ABOVE 6000 KG GVW																											
TRUCKS TOTAL	51941	16.81	100.00	42826	15.16	100.00	37451	16.21	100.00	43414	19.73	100.00	38561	22.52	100.00	44386	28.90	100.00	42076	29.10	100.00	43473	31.65	100.00	33742	30.31	100.00
ASHOK LEYLAND	9739	3.15	18.75	6857	2.43	16.01	6223	2.69	16.62	6365	2.89	14.66	7072	4.13	18.34	7966	5.19	17.95	7832	5.42	18.61	8134	5.92	18.71	6577	5.91	19.49
TELCO	41278	13.36	79.47	34991	12.38	81.71	30370	13.14	81.09	36099	16.41	83.15	31068	18.15	80.57	36014	23.45	81.14	33421	23.12	79.43	31735	23.11	73.00	24327	21.85	72.10
H.M. & PAL	924	0.30	1.78	978	0.35	2.28	858	0.37	2.29	950	0.43	2.19	421	0.25	1.09	406	0.26	0.91	823	0.57	1.96	3604	2.62	8.29	2838	2.55	8.41
ABOVE 6000 KG GVW																											
BUSES & TRKS TOT	71793	23.24	100.00	63054	22.32	100.00	59221	25.63	100.00	64545	29.34	100.00	58702	34.29	100.00	62237	40.53	100.00	58880	40.72	100.00	62529	45.53	100.00	48183	43.28	100.00
ASHOK LEYLAND	17974	5.82	25.04	15966	5.65	25.32	16065	6.95	27.13	15113	6.87	23.41	14419	8.42	24.56	14372	9.36	23.09	15028	10.39	25.52	15014	10.93	24.01	13003	11.68	26.99
TELCO	52854	17.11	73.62	46106	16.32	73.12	42298	18.31	71.42	48362	21.98	74.93	43771	25.57	74.56	47412	30.97	76.18	42965	29.72	72.97	43674	31.80	69.85	32156	28.88	66.74
H.M. & PAL	965	0.31	1.34	982	0.35	1.56	858	0.37	1.45	1070	0.49	1.66	512	0.30	0.87	453	0.29	0.73	887	0.61	1.51	3841	2.80	6.14	3024	2.72	6.28
4-WHEELER TOTAL	308952	100.00		282537	100.00		231041	100.00		220013	100.00		171208	100.00		153566	100.00		144582	100.00		137338	100.00		111327	100.00	

NOTES: M&M "NC" vehicles are included in utility vehicles alongwith H.M.'s"Trekker".
For BTL, only Matador and Traveller vehicles are included in LCVs; its jeep-type "Trax" comes under utility vehicles.
4W stands for four-wheelers; column 2 in each year expresses the figures as a share of all 4-W; and column 3 as a share of the relevant sub-group.

SOURCE: MAHINDRA & MAHINDRA, BOMBAY.

Table : A.3.6 LCVs : MARKET SHARES BY WEIGHT CLASS 1985-88 (%)

3-5 tons GVW	1984	1985	1986	1987	1988
Matador	49.7	52.2	47.2	48.9	41.2
Telco	_	0	13.7	22.1	29.7
M&M	24.9	23.1	21.1	18.2	16.3
Allwyn	-	4.8	5.8	5.1	7.0
Standard	25.4	19.9	12.2	5.8	5.8
Total number (100)	22855	23068	22960	26610	28859
5-6 tons GVW					
Eicher	-	-	13.5	27.3	33.6
DCM	-	73.1	51.9	36.7	27.2
Swaraj	-	26.9	34.6	22.1	24.7
Telco 608	-	-	-	13.9	14.5
Total number(100)	-	1386	4806	8598	12853

Source: Derived from Table A.3.5

YEAR	PBT/SALES	PBIT/SALES	PBIDT/SALES	YEAR	PBT/SALES	PBIT/SALES	PBIDT/SALES
ASHOK LEYLAND LTD				BAJAJ TEMPO LTD.			
1970	0.0650	0.0822	0.1029	1970	0.0810	0.1105	0.1363
1975	0.1036	0.1085	0.1205	1975	0.0936	0.1143	0.1317
1977	0.1459	0.1573	0.1761	1977	0.1146	0.1378	0.1630
1978	0.1244	0.1245	0.1380	1978	0.0687	0.0867	0.1148
1979	0.0853	0.0906	0.1109	1979	0.1310	0.1434	0.1695
1980	0.0612	0.0809	0.1045	1980	0.1579	0.1713	0.1946
1981	0.0575	0.0937	0.1201	1981	0.1605	0.1889	0.2156
1982	0.0389	0.1026	0.1328	1982	0.1613	0.1816	0.2099
1983	0.0260	0.1099	0.1510	1983	0.1425	0.1669	0.2103
1984	0.0251	0.0857	0.1234	1984	0.1663	0.1803	0.2213
1985	0.0152	0.0655	0.1022	1985	0.1486	0.1634	0.2046
1986	0.0190	0.0715	0.0967	1986	0.1246	0.1477	0.1977
1987	0.0251	0.0758	0.1104	1987	0.0152	0.0528	0.1482
1988	0.0459	0.0855	0.1187				
MEAN	0.0558	0.0953	0.1237	MEAN	0.1265	0.1473	0.1865
S.D.	0.0425	0.0256	0.0228	S.D.	0.0464	0.0423	0.0334
C.V.	76.2	26.9	18.4	C.V.	36.6	28.7	17.9
MAHINDRA & MAHINDRA				STANDARD MOTORS LTD			
1970	0.0269	0.0588	0.0704	1970	-0.0384	-0.0005	0.0079
1975	0.0246	0.0728	0.0931	1975	-0.1594	-0.0406	0.0061
1977	0.0411	0.0821	0.1067	1977	0.0378	0.0804	0.1052
1978	0.0339	0.0864	0.1121	1978	0.0367	0.0743	0.0993
1979	0.0775	0.1088	0.1306	1979	0.0268	0.0730	0.0934
1980	0.0787	0.1084	0.1252	1980	0.0489	0.0902	0.1089
1981	0.0751	0.1013	0.1178	1981	0.0719	0.0980	0.1195
1982	0.0689	0.1023	0.1216	1982	0.0588	0.0874	0.1191
1983	0.0485	0.0910	0.1146	1983	0.0327	0.0648	0.1137
1984	0.0444	0.0902	0.1189	1984	0.0310	0.0705	0.1089
1985	0.0417	0.1005	0.1321	1985	0.0235	0.0579	0.0894
1986	0.0279	0.0960	0.1256	1986	-0.0767	0.0087	0.0413
1987	0.0325	0.0919	0.1189				
MEAN	0.0518	0.0963	0.1204	MEAN	0.0291	0.0705	0.0999
S.D.	0.0194	0.0087	0.0077	S.D.	0.0401	0.0249	0.0229
C.V.	37.5	9.0	6.4	C.V.	137.8	35.3	22.9
TELCO LTD							
1970	0.0279	0.0782	0.1456				
1975	0.0290	0.0716	0.1202				
1977	0.0409	0.0993	0.1437				
1978	0.0402	0.1059	0.1483				
1979	0.0442	0.0912	0.1262				
1980	0.0439	0.0976	0.1300				
1981	0.0450	0.1023	0.1322				
1982	0.0604	0.1160	0.1447				
1983	0.0459	0.1052	0.1340				
1984	0.0287	0.0844	0.1232				
1985	0.0325	0.0889	0.1357				
1986	0.0211	0.0893	0.1285				
1987	0.0030	0.0750	0.0967				
1988	0.0276	0.0942	0.1271				
MEAN	0.0361	0.0958	0.1309				
S.D.	0.0147	0.0110	0.0134				
C.V.	40.7	11.5	10.2				

Notes: PBT = Profit Before Tax
PBIT = Profit Before Interest & Tax
PBIDT = Profit Before Interest, Depreciation & Tax
S.D. = Standard Deviation
C.V. = Coefficient of Variation (SD/Mean X 100)
The Mean, S.D. and C.V relate to data beginning 1977 only
Sales figures are net of excise duty.

Source: Company Balance Sheet for the respective years; for 1970 and 1975 from Bombay Stock Exchange Directory.

Table A.3.8: PROFITS TO FIXED ASSET (GROSS & NET) RATIOS

	PBT/GFA	PBIT/GFA	PBIDT/GFA	PBIDT/NFA	PBT/GFA	PBIT/GFA	PBIDT/GFA	PBIDT/NFA
ASHOK LEYLAND					**BAJAJ TEMPO**			
1977	0.5083	0.5482	0.6136	1.0878	0.3237	0.3893	0.4604	0.7278
1978	0.5166	0.5172	0.5731	0.9572	0.1855	0.2342	0.3101	0.4765
1979	0.3084	0.3277	0.4011	0.5699	0.3780	0.4137	0.4892	0.7531
1980	0.1654	0.2187	0.2823	0.3583	0.4575	0.4963	0.5640	0.8300
1981	0.1409	0.2295	0.2940	0.3639	0.4286	0.5043	0.5755	0.8359
1982	0.0829	0.2187	0.2831	0.3470	0.4424	0.4980	0.5758	0.8126
1983	0.0454	0.1922	0.2641	0.3666	0.3009	0.3525	0.4441	0.6333
1984	0.0404	0.1379	0.1987	0.3004	0.3788	0.4107	0.5040	0.7797
1985	0.0276	0.1191	0.1856	0.3087	0.3387	0.3725	0.4665	0.6758
1986	0.0384	0.1444	0.1953	0.3386	0.2126	0.2520	0.3373	0.4990
1987	0.0499	0.1508	0.2197	0.3895	0.0250	0.0869	0.2436	0.4053
MEAN	0.1749	0.2549	0.3191	0.4898	0.3156	0.3646	0.4519	0.6754
SD	0.1861	0.1492	0.1489	0.2744	0.1302	0.1291	0.1115	0.1528
CV	106.4	58.5	46.7	56.0	41.3	35.4	24.7	22.6
STANDARD MOTORS					**TELCO**			
1977	0.0598	0.1274	0.1665	0.4989	0.0527	0.1279	0.1851	0.4110
1978	0.0645	0.1307	0.1748	0.4759	0.0483	0.1272	0.1782	0.3966
1979	0.0479	0.1304	0.1668	0.4384	0.0634	0.1306	0.1809	0.3926
1980	0.1113	0.2052	0.2477	0.5610	0.0662	0.1472	0.1961	0.3923
1981	0.1892	0.2580	0.3145	0.6805	0.0792	0.1800	0.2325	0.4319
1982	0.1614	0.2398	0.3267	0.6252	0.1171	0.2247	0.2805	0.4875
1983	0.0785	0.1556	0.2729	0.5108	0.0890	0.2040	0.2599	0.4427
1984	0.0799	0.1820	0.2809	0.5248	0.0494	0.1454	0.2122	0.3912
1985	0.0516	0.1272	0.1962	0.2233	0.0541	0.1478	0.2256	0.4341
1986	-0.1557	0.0176	0.0838	0.0738	0.0327	0.1386	0.1994	0.3389
1987					0.0046	0.1173	0.1513	0.2565
1988					0.0459	0.1571	0.2119	0.3598
MEAN	0.0688	0.1573	0.2230	0.4612	0.0585	0.1540	0.2095	0.3946
SD	0.0920	0.0688	0.0777	0.1826	0.0283	0.0328	0.0326	0.0584
CV	133.9	43.7	34.8	39.6	48.4	21.3	17.2	14.8
MAHINDRA & MAHINDRA								
1977	0.1170	0.2342	0.3043	0.4954				
1978	0.0923	0.2355	0.3056	0.4451				
1979	0.2666	0.3745	0.4494	0.6910				
1980	0.3323	0.4576	0.5285	0.7839				
1981	0.3299	0.4452	0.5176	0.7558				
1982	0.2655	0.3942	0.4684	0.6451				
1983	0.1541	0.2894	0.3645	0.4932				
1984	0.1210	0.2460	0.3242	0.4343				
1985	0.1118	0.2696	0.3544	0.5166				
1986	0.0717	0.2466	0.3225	0.4905				
1987	0.0908	0.2563	0.3317	0.5163				
MEAN	0.1775	0.3135	0.3882	0.5697				
SD	0.1003	0.0869	0.0859	0.1257				
CV	56.5	27.7	22.1	22.1				

Note : GFA - gross fixed assets
NFA - net fixed assets
NFA = GFA - depreciation + capital work in progress
Source : Company Balance Sheets

Table A.3.9. PRODUCTIVITY RATIOS AND PER CAPITA EMPLOYEE COSTS

Year	Wtd.Prd/ employees	Adj.Wtd.Prdy	Sales/GFA	Exp/L	Wtd.Prd/ employees	Adj.Wtd.Prdy	Sales/GFA	Exp/L
ASHOK LEYLAND					**BAJAJ TEMPO**			
1977	1.6410	1.3083	3.4846	0.1484	1.7533	2.5781	2.8250	0.1018
1978	1.8733	1.2967	4.1531	0.1651	1.8002	2.5208	2.7003	0.0835
1979	1.8643	1.2059	3.6170	0.1835	2.0348	2.4608	2.8860	0.0940
1980	1.7488	1.3010	2.7024	0.1995	4.9439	2.2806	2.8976	0.1007
1981	1.5656	1.2501	2.4488	0.2198	1.7951	2.3417	2.6697	0.1116
1982	1.5672	1.3212	2.1318	0.2273	2.5187	2.3518	2.7428	0.1696
1983	1.3195	1.8347	1.7491	0.2203	2.1447	2.8283	2.1119	0.1533
1984	1.3860	1.5633	1.6094	0.2347	3.0359	3.9569	2.2780	0.2075
1985	1.5411	1.3931	1.8168	0.2979	3.3327	4.0966	2.2798	0.2937
1986	1.4876	1.7216	2.0201	0.3121	3.3848	4.6181	1.7059	0.2839
1987	1.6197	1.7196	1.9900	0.3579	3.3815	5.5886	1.6442	0.2700
MEAN	1.6013	1.4469	2.5203	0.2333	2.4660	3.2384	2.4310	0.1700
STANDARD MOTORS					**TELCO**			
1977	1.0744	1.5529	1.5833	0.0934	0.9185	1.5126	1.2879	0.1216
1978	1.1588	1.6659	1.7603	0.1283	0.7874	1.5279	1.2018	0.1296
1979	1.0672	1.3194	1.7870	0.1083	0.9716	1.6275	1.4330	0.1404
1980	1.2226	1.5524	2.2747	0.1069	0.8765	1.4131	1.5086	0.1520
1981	1.5122	1.8192	2.6320	0.1379	0.9607	1.5449	1.7592	0.1652
1982	1.7799	1.8637	2.7427	0.1693	1.1978	1.5758	1.9382	0.2035
1983	1.5276	1.7856	2.3996	0.1505	1.1467	2.0603	1.9393	0.2442
1984	1.7756	1.9699	2.5798	0.1897	1.2258	2.1307	1.7227	0.2743
1985	1.7369	2.0521	2.1962	0.2264	1.2895	2.3203	1.6623	0.3126
1986	2.0669	2.6920	2.0316	0.3501	1.2826	2.0413	1.5514	0.3433
1987					1.3918	2.3491	1.5645	0.4114
1988					1.6285	2.6330	1.6674	
MEAN	1.4922	1.8273	2.1987	0.1661	1.1398	1.8947	1.6030	0.2271
MAHINDRA & MAHINDRA								
1977	1.7253	2.8201	2.8510	0.1552				
1978	1.7518	2.9574	2.7254	0.1608				
1979	2.2127	2.9007	3.4414	0.1744				
1980	2.5443	3.0648	4.2201	0.1955				
1981	2.6474	2.9247	4.3934	0.2395				
1982	2.7374	3.2978	3.8527	0.2895				
1983	3.0950	3.9746	3.1794	0.3167				
1984	3.0577	4.1251	2.7273	0.3388				
1985	3.1790	3.6374	2.6816	0.4110				
1986	2.8102	4.5490	2.5680	0.4258				
1987			2.7894					
MEAN	2.5754	3.4252	3.2640	0.2707				

Notes : Wtd.Prd = weighted production i.e. weighted sum of different products using the main product as a base.

Adj.Wtd.Prdy. = Adjusted weighted productivity, assuming a level of integration of 26%

GFA = gross fixed assets

Exp/L = total personnel expenditure per employee

Source : Company balance sheets.

Table A.3.10 PRODUCTIVITY (VALUE-ADDED RATIOS)

Year	VA/L	VA/VL	GFA/VA	VA/NFA	VA/TC	VA/L	VA/VL	GFA/VA	VA/NFA	VA/TC
ASHOK LEYLAND						BAJAJ TEMPO				
1977	0.5548	3.7378	0.8554	2.0723	0.4938	0.2922	2.8716	0.8589	1.8406	0.7120
1978	0.4920	2.9803	0.9718	1.7187	0.3524	0.2899	3.4703	0.9475	1.6220	0.6347
1979	0.6392	3.4837	0.9676	1.4684	0.3843	0.3531	3.7566	0.9113	1.6892	0.6181
1980	0.6795	3.4063	1.4289	0.8884	0.3514	0.4005	3.9774	0.8856	1.6618	0.6388
1981	0.6991	3.1804	1.5231	0.8121	0.3645	0.4265	3.8200	0.8980	1.6174	0.7158
1982	0.8353	3.6753	1.4441	0.8485	0.4420	0.6603	3.8933	0.8516	1.6572	0.7485
1983	0.8696	3.9478	1.6262	0.8536	0.5771	0.5865	3.8259	1.1453	1.2452	0.7000
1984	0.7903	3.3664	1.8615	0.8124	0.4972	0.8738	4.2116	1.0300	1.5019	0.7446
1985	0.8525	3.8620	1.7570	0.9466	0.4263	1.0775	3.6681	1.0727	1.3504	0.6816
1986	0.9743	3.1218	1.5973	1.0855	0.4689	1.0924	3.8482	1.3667	1.0826	0.7278
1987	1.1444	3.1974	1.4985	1.1832	0.4898	1.1061	4.0967	1.5298	1.0876	0.6819
MEAN	0.7755	3.3599	1.4119	1.1536	0.4407	0.6508	3.7672	1.0452	1.4869	0.6912
S.D.	0.1889	0.3336	0.3351	0.4239	0.0726	0.3315	0.3576	0.2227	0.2571	0.0447
MAHINDRA & MAHINDRA						TELCO				
1977	0.5659	3.6465	0.6207	2.6232	1.3216	0.3924	3.2270	1.7026	1.3042	0.8124
1978	0.4780	2.9730	0.7033	2.0711	1.1114	0.4283	3.3040	1.6145	1.3784	1.0815
1979	0.5030	2.8839	0.6578	2.3375	0.7891	0.4512	3.2140	1.5410	1.4083	0.8307
1980	0.6244	3.1932	0.5529	2.6826	0.7424	0.4981	3.2768	1.4993	1.3344	0.7869
1981	0.8507	3.5517	0.5001	2.9197	0.7841	0.6027	3.6489	1.3056	1.4227	0.7721
1982	0.8874	3.0656	0.6065	2.2705	0.7290	0.7911	3.8883	1.1305	1.5373	0.7349
1983	0.9797	3.0935	0.7580	1.7854	0.7076	0.8729	3.5740	1.1100	1.5344	0.9055
1984	1.0048	2.9663	0.8765	1.5280	0.7193	0.8599	3.1350	1.2665	1.4557	0.8424
1985	1.0804	2.6288	0.8792	1.6583	0.6450	1.0035	3.2101	1.3058	1.4734	0.8782
1986	1.2233	2.8728	0.8877	1.7135	0.8199	1.0550	3.0735	1.3913	1.2219	0.7852
1987		2.7507	0.8244	1.8883	0.7879	1.0857	2.6390	1.5603	1.0863	0.7125
1988						1.3745	3.1027	1.4001	1.2126	0.7383
MEAN	0.8198	3.0569	0.7151	2.1343	0.8325	0.7846	3.2744	1.4023	1.3641	0.8234
SD	0.2616	0.3112	0.1390	0.4662	0.2014	0.3133	0.3177	0.1872	0.1381	0.0998
STANDARD MOTORS										
1977	0.1471	1.5749	1.9388	1.5452	0.4946					
1978	0.1701	1.3253	1.6777	1.6227	0.5136					
1979	0.1464	1.3512	1.8815	1.3967	0.4232					
1980	0.2063	1.9293	1.3051	1.7353	0.5066					
1981	0.2820	2.0450	1.1260	1.9219	0.5081					
1982	0.3264	1.9284	1.1935	1.6035	0.4305					
1983	0.3062	2.0339	1.4158	1.3219	0.4247					
1984	0.3485	1.8370	1.3565	1.3770	0.3983					
1985	0.3810	1.6833	1.5543	0.7321	0.4134					
1986	0.4325	1.2352	1.7770	0.4951	0.3594					
MEAN	0.2746	1.6943	1.5227	1.3751	0.4472					
SD	0.1020	0.3069	0.2875	0.4425	0.0542					

Notes : VA - Value added
L - no. of employees
VL - expenditure on employees
GFA, NFA - gross/net fixed assets
TC - total consumption i.e. total expenditure on bought-in components and raw materials

Source : company balance sheets.

TABLE A.4.1

INDIA'S EXPORTS OF COMMERCIAL VEHICLES

(Qty.:Nos., Value : Rs.: '000)

	1964-65		1969-70		1974-75		1979-80		1981-82		1982-83		1983-84		1985-86		1986-87	
	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value
Vehicles for transport of goods, materials etc. & special purpose motor vehicles:	85	2524.7	876	30924.1	1424	122962.5	971	88842.0	2550	117784.0	684	130177.9	559	84900.8	646	82816.01	2477	1101
a) Lorries new	na	na	868	304455.4	1276	78186.8	470	54684.9	316	55657.2	508	105927.7	244	57028.6	243	48093.6	260	598
b) Lorries used	na	na	6	401.2	-	-	5	165.3	120	10520.3	-	-	-	-	-	-	-	-
c) Three wheelers	na	na	-	-	-	-	4	29.1	1071	9721.6	67	704.1	223	2204.9	280	3274.6	2127	283
d) S.P.Vehicles	na	na	2	67.5	148	44775.7	492	33562.7	1043	41884.9	109	22546.2	92	25667.3	123	31447.6	90	219
Buses	37	1072.6	216	11840.8	437	36434.6	917	132099.0	1345	283534.8	1309	326217.3	757	204831.8	570	202551.9	373	1097
Chassis with engines mounted for CVs	86	1735.8	465	15331.6	410	16420.9	2531	208498.3	946	128689.0	588	79291.4	298	42770.4	1248	88399.5	1131	1254
Total	208	5333.1	1557	58096.5	2271	175818.0	4419	429439.3	4841	530007.8	2581	535656.6	1614	332503.0	2464	373767.4	3981	3453

Source: DGCIS, Monthly Statistics of Foreign Trade, Annual issues.

Table A.4.2

EXPORTS AND EXPORT INTENSITY OF INDIAN COMMERCIAL VEHICLE MANUFACTURERS

YEAR	EXPORTS (Rs.lakh)	EXPORTS/ SALES
ASHOK LEYLAND LTD		
1977	591.49	0.0676
1978	935.86	0.0762
1979	750.40	0.0480
1980	659.10	0.0319
1981	737.55	0.0282
1982	2834.94	0.1027
1983	1195.12	0.0449
1984	717.84	0.0278
1985	696.35	0.0237
1986	651.45	0.0193
1987	1558.36	0.0428
1988	1454.59	0.0325
MAHINDRA & MAHINDRA LTD		
1977	376.17	0.0603
1978	437.71	0.0481
1979	591.09	0.0466
1980	1004.42	0.0577
1981	2047.92	0.0874
1982	2789.72	0.1037
1983	2925.33	0.0932
1984	2083.69	0.0566
1985	1887.57	0.0466
1986	2127.08	0.0491
1987	2231.18	0.0454
1989	3253.26	0.0407
TELCO LTD		
1977	2342.05	0.0907
1978	3727.80	0.1436
1979	3806.22	0.1112
1980	4648.38	0.1157
1981	5242.60	0.0969
1982	6059.31	0.0874
1983	5483.16	0.0723
1984	3131.26	0.0415
1985	6304.00	0.0758
1986	5095.00	0.0587
1987	3812.00	0.0384
1988	4998.00	0.0430
1989	8139.00	0.0589

YEAR	EXPORTS (Rs.lakh)	EXPORTS/ SALES
BAJAJ TEMPO LTD		
1977	10.42	0.0048
1978	68.16	0.0254
1979	50.17	0.0141
1980	48.93	0.0108
1981	54.92	0.0110
1982	50.27	0.0071
1983	31.81	0.0047
1984	37.27	0.0042
1985	29.30	0.0028
1986	73.35	0.0069
1987	70.29	0.0051
1989	149.09	0.0064
STANDARD MOTORS LTD		
1977	3.23	0.0042
1978	16.40	0.0178
1979	10.81	0.0108
1980	19.36	0.0137
1981	18.41	0.0085
1982	19.39	0.0065
1983	17.95	0.0054
1984	81.69	0.0205
1985	103.39	0.0237
1986	68.89	0.0126
1987	n.a.	n.a.

NOTES : In case of TELCO the earnings on account of exchange difference for the years 1984, 1985,1986, 1987, 1988 & 1989 are Rs.lakh 889.5 ,749, 14, 80, 20 and 214 respectively (not included in the export figures). For BTL 1989 is in an 18 month period ending March, and for M&M 1989 is a 17 month period.

Source : COMPANY BALANCE SHEETS FOR THE RESPECTIVE YEARS

Table A.4.3:DOMESTIC RESOURCE COST ESTIMATES OF AUTOMOBILES

Product	Year	DRC (Rs./US dollar)		Prevailing exchange rate
1. Transport Equipment	1963-65	11.35		4.8
2. Transport Equipment	1968	12.1		7.6
3. Transport Equipment	1964-65	i. 14.35 [a]		4.8
		ii. 8.19 [b]		4.8
4. Assemblers of Transport equipment	1968-69	7.9 - 10.9 [c]		7.6
5. Four Wheelers	1969-72	Import-substitution	Exports	7.6
Telco (7.5 t payload)		6.3	10.5	
ALL (7.5 t payload)		6.9	10.1	
BTL (1 t payload)		9.5	12.8	
BTL (1.5 t payload)		8.3	12.0	
M&M (Jeep)		7.3	10.1	
M&M (Jeep-truck)		6.9	12.2	
6. Commercial vehicles	1974-75			
- Light		8.1		8.1
- Heavy		11.1		8.1
7. Commercial vehicles	1980-81 [d]	7.1		7.9
8. Light Commercial vehicles	1985	14.9		12.4
9. Passenger and Heavy vehicles	1986	12.6		12.6

Notes:

a. Assuming steel to be imported
b. Assuming steel to be non-tradeable and hence supplied domestically
c. Krueger estimated DRCs for 6 assemblers. 4 of these 6 have DRCs lower than 9, while one has a very high DRC of 35. The category of assemblers (whether CV, cars, scooters) is not revealed.
d. Refers to some of the new Japanese collaborations.

Sources:

1,2 Panchamukhi (1978). Actual rather than shadow prices used.
3 Staelin (1974). Assumes shadow price of 0.5 for labour, 1.5 for capital, and 0.5 for other value added.
4 Krueger (1975). Range of assumptions
5 World Bank (1973)
6 ICICI (1977) | Assume shadow price of
7 ICICI (1985) | 0.5 for labour
8,9 Unpublished data from ICICI, Bombay. These are unadjusted figures which use actual rather than shadow prices.
For exchange rates, IMF (1989) Yearbook.

Table A.4.4

PRICE COMPARISONS OF INDIAN AND FOREIGN VEHICLES

Source and year of comparison	Vehicle	Indian price	Foreign price	Indian price (a) ÷	Foreign price (b)
1. World Bank (1973), 1969-72	Telco (7.5 t payload)	-	-	0.89	0.82
	ALL (7.5 t payload)	-	-	1.01	0.92
	BTL (1 t payload)	-	-	1.32	1.06
	BTL (1.5 t payload)	-	-	1.27	1.04
	M&M (Jeep)	-	-	1.04	0.94
	M&M (Jeep-truck)	-	-	0.91	0.81
2. World Bank (1987), 1985	Telco 15.66 t GVW	$15,000	$23,000(13.3 ton)	0.65	
	ALL 15.24 t GVW	$11,850	$23,000(GVW Fiat)	0.52	
3. Dubai importer, 1987	Telco bus (60 seats)	-	125,000 Dirhams	0.96(with Hyundai bus)	
	ALL bus (60 seats)	-	120,000 "	0.92 "	
	Ikarus bus (45 seats)	-	110,000 "	-	
	Daewoo bus (49 seats)	-	125,000 "	-	
	Hyundai bus (52 seats)	-	130,000 "	-	
4. Dubai importer, 1988	ALL truck (135 hp)	-	104,000 "	0.95	
	Daewoo truck (180 hp)	-	109,000 "	-	
5. Tatab Industries, Malaysia, 1987	Telco S 1313 truck	M$53482	M$60750 (Hino GF 175K)	0.88	
	Telco LPO 1313 bus	M$49559	M$58742 (Hino AK 174)	0.84	
	Telco S 1313 tractor-head	M$53047	M$60214 (Mercedes L911C)	0.88	

Notes: 1. This is a comparison between the ex-factory cost (including excise duty) of the domestic product with the estimated c.i.f. price of comparable imports. Column (a) refers to simple price comparison, and column (b) to the adjusted comparison where inputs are priced at those which would prevail under free trade. This distinction between (a) and (b) is applicable only to item 1.

2. The Indian price is ex-factory (excluding excise) and the Fiat truck is also ex-factory. The Telco truck price is its 1986 price with a synchromesh gearbox.

3,4. Obtained from Dubai importers, these are comparative landed costs in Dubai.

5. Comparisons of nett selling prices in Malaysia inclusive of excise duty and sales tax.

Table A.5.1

DEGREE OF VERTICAL INTEGRATION

Year	ASHOK LEYLAND	BAJAJ TEMPO	MAHINDRA	STANDARD	TELCO
1977	0.1965	0.3656	0.3913	0.3442	0.3919
1978	0.1798	0.3514	0.4013	0.3402	0.4682
1979	0.1631	0.3043	0.3155	0.2897	0.4066
1980	0.1754	0.2932	0.2880	0.3010	0.3850
1981	0.1751	0.3160	0.2634	0.2936	0.3815
1982	0.1620	0.3299	0.2861	0.2502	0.3009
1983	0.2993	0.3235	0.3000	0.2807	0.4321
1984	0.2445	0.3276	0.3157	0.2593	0.4193
1985	0.1922	0.3075	0.2503	0.2830	0.4355
1986	0.2592	0.3370	0.3747	0.2863	0.3711
1987	0.2345	0.4071	0.3674	-	0.3964
1988	-	-	-	-	0.3789
MEAN	0.207	0.333	0.323	0.293	0.397
STANDARD DEVIATION	0.045	0.032	0.052	0.030	0.042

NOTE:
Vertical Integration is defined as X/(X+Raw Materials Consumed) where X is total personnel expenses, change in stock, other manufacturing expenses and depreciation. The denominator is equivalent to sales less operating profits (profits before interest and tax), and helps to exclude the effects of inter-temporal or inter-firm differences in interest charges, excise and other taxes and mark-ups. The criterion of value added to sales that is sometimes used suffers from these deficiencies. See Cusumano (1985), pp.188-89 and Perry (1989), pp.236-39.

SOURCE : Annual Reports for each year.

Table A.5.2.

IN-HOUSE PRODUCTION FACILITIES

STANDARD MOTORS Perungalathur (Madras)	BAJAJ TEMPO Pune, Pithampur	MAHINDRA Kandivili (Bombay) Ghatkopar (Bombay) Nasik, Igatpuri, Kanhe	ASHOK LEYLAND Ennore, Hosur, Alwar, Bhandra	TELCO Jamshedpur, Pimpri (Pune), Chinchwad (Pune)
-- --	Foundry --	Foundry --	Ennore Foundries --	Foundry Forge
Engine	Engine	Engine	Engine	Engine
Gearbox	Gearbox	Gearbox	Gearbox	Gearbox
Rear Axle	Axles	Axles	Rear & Front Axles	Rear & Front Axles
Crankshaft	Crankshaft | only final grinding & polishing	Crankshaft	Crankshaft | only surface hardening	Crankshaft
Camshaft	Camshaft	Camshaft	Camshaft	Camshaft
Sub-assemblies	All sub-assemblies	All sub-assemblies	All sub-asemblies	All sub-assemblies
Press shop	Press shop	Press shop	Frame shop only	Press shop
Paint shop	Paint shop	Paint shop	--	Paint shop
Body shop	Body shop	--	--	--
Final assembly	Final assembly	Final assembly	Final assembly	Final assembly
Hand tooling for plastics, some other body fixtures & body dies	Part tooling	Part tooling	Part tooling	All tooling including press tools
--	--	--	--	Machine tools
Die repairing	Die repairing	Die repairing	Die repairing	Die repairing, re-conditioning of machine tools
Some test facilities	Basic testing facilities	Basic testing facilities	Excellent facilities for testing of input-- metallurgy & meterology. Vehicle testing facilities not so extensive	Extensive testing both input & output including torture test track

Source : Field Survey. The cities below the company names refer to locations of various plants.

Table A.5.3.

RELATIONSHIP BETWEEN LARGE COMPONENT MANUFACTURERS AND VEHICLE MANUFACTURERS

Component manufacturer	Telco	Ashok Leyland	Bajaj Tempo	Mahindra	Standard	Any comments
a	C	BL	BL	C	C	-
b	EC	EC	BL	BL	-	-
c	-	BL	EC	-	-	-
d	EC	-	-	-	-	-
e	EC	EC	EC	EC	EC	-
f	C	C	C	-	-	-
g	EC	EC	-	EC	-	-
h	C	EC	-	C	-	All cooperative as long as their own interests not affected
i	EC	EC	-	EC	-	Supplying to all firms for over 25 years.
j	C	C	-	-	-	Hostile on certain issues like price.
k	EC	-	-	-	-	Excellent relationship with Telco
l	EC	BL	C	EC	C	VMs have oppressive power
m	BL	C	C	BL	-	Component industry partly respons. for lack of mutual relationship because of opportunistic pricing in the 70s

NOTES: EC - Extremely cooperative; C - Cooperative; BL - Business-like; (the option of 'Hostile' was also provided).

SOURCE : Field survey. The identities of the component manufacturers have been kept confidential at their request.

TABLE A.6.1:GROSS,NET AND DEFLATED VALUE OF FIXED ASSETS(Rs.lakhs)

	ASHOK LEYLAND				BAJAJ TEMPO				MAHINDRA AND MAHINDRA			
YEARS	GROSS FIXED ASSETS	NET FIXED ASSETS	DEFLATED G.F. ASSETS	ADJUSTED DEFL.GF ASSETS	GROSS FIXED ASSETS	NET FIXED ASSETS	DEFLATED G.F. ASSETS	ADJUSTED DEFL.GF ASSETS	GROSS FIXED ASSETS	NET FIXED ASSETS	DEFLATED G.F. ASSETS	ADJUSTED DEFL.GF ASSETS
1977	2512.12	1400.89	2520.21	3250.67	771.22	479.11	773.43	809.93	2189.83	1282.26	2196.98	2951.25
1978	2957.73	1698.02	2961.06	3691.52	992.52	625.48	992.36	1028.86	3342.36	2205.04	3337.31	4091.58
1979	4325.46	2820.64	4233.37	4963.83	1230.67	797.95	1213.90	1250.40	3682.4	2271.79	3654.48	4408.75
1980	7649.22	5667.55	6906.92	7637.38	1556.43	1024.73	1475.93	1512.43	4126.47	2445.64	4011.69	4765.96
1981	10686.96	8037.82	9080.31	9810.77	1862.00	1229.12	1694.56	1731.06	5334.08	3279.95	4875.68	5629.95
1982	12951.31	9488.52	10529.49	11259.95	2576.90	1796.47	2152.09	2188.59	6984.11	4459.31	5931.77	6686.04
1983	15226.99	10695.00	11913.30	12643.76	3185.42	2117.26	2522.13	2558.63	9876.28	6621.13	7690.45	8444.72
1984	16035.00	10500.82	12369.70	13100.16	3910.40	2507.36	2931.63	2968.13	13505.65	9209.72	9740.48	10494.75
1985	16180.00	9647.59	12448.35	13178.81	4617.34	2837.60	3315.06	3351.56	15118.04	9383.05	10615.02	11369.29
1986	16688.35	9290.90	12697.36	13427.82	6231.53	4045.18	4105.75	4142.25	16877.05	10122.94	11476.66	12230.93
1987	18295.26	9676.35	13441.61	14172.07	8303.38	4826.55	5065.34	5101.84	17618.32	9717.18	11820.02	12574.29

	STANDARD MOTORS				TELCO			
YEARS	GROSS FIXED ASSETS	NET FIXED ASSETS	DEFLATED G.F. ASSETS	ADJUSTED DEFL.GF ASSETS	GROSS FIXED ASSETS	NET FIXED ASSETS	DEFLATED G.F. ASSETS	ADJUSTED DEFL.GF ASSETS
1977	490.92	147.33	492.59	635.25	20038.34	8353.02	20097.85	27005.85
1978	524.80	158.77	526.11	668.77	21602.70	8879.65	21645.50	28553.50
1979	561.57	175.89	560.39	703.05	23883.87	9988.92	23767.51	30675.51
1980	620.71	210.03	607.96	750.62	26621.76	11523.16	25969.81	32877.81
1981	822.10	366.05	752.94	895.60	30756.97	14260.98	28928.39	35836.39
1982	1079.43	536.40	916.74	1059.40	35759.08	17514.72	32129.74	39037.74
1983	1380.12	675.85	1099.58	1242.24	39127.83	18908.77	34178.23	41086.23
1984	1546.40	771.36	1193.50	1336.16	43806.55	20728.89	36820.98	43728.98
1985	1982.83	1613.38	1430.21	1572.87	50009.00	23183.00	40185.11	47093.11
1986	2700.29	2533.64	1781.66	1924.32	55953.00	26923.00	43096.70	50004.70
1987					63456.00	32542.00	46571.76	53479.76
1988					69764.00	35144.00	49355.64	56263.64

Notes:Gross fixed assets are net of revaluation, if any
Deflated assets are gross fixed assets deflated by the wholesale price index for non-electrical machinery
Adjusted deflated assets are deflated fixed assets that take into account asset formation prior to 1977

TABLE A.6.2:MODERNISATION RATIOS

	ALL		BTL		M&M		STD		TELCO	
YEARS	MODN1	MODN2	MODN1	MODN2	MODN1	MODN2	MODN1	MODN2	MODN1	MODN2
1977	0.0903	0.0899	0.2264	0.2256	0.0737	0.0734	0.0284	0.0283	0.1245	0.1817
1978	0.1774	0.1749	0.2869	0.2831	0.5263	0.5190	0.0690	0.0680	0.1486	0.0770
1979	0.4624	0.4297	0.2399	0.2232	0.1017	0.0950	0.0701	0.0652	0.0958	0.0980
1980	0.7684	0.6315	0.2647	0.2159	0.1206	0.0977	0.1053	0.0849	0.1334	0.0927
1981	0.3971	0.3147	0.1963	0.1481	0.2926	0.2154	0.3245	0.2385	0.1334	0.1139
1982	0.2119	0.1596	0.3839	0.2700	0.3093	0.2166	0.3130	0.2175	0.0953	0.1107
1983	0.1757	0.1314	0.2361	0.1719	0.4141	0.2965	0.2786	0.1994	0.1330	0.0638
1984	0.0531	0.0383	0.2276	0.1624	0.3675	0.2666	0.1205	0.0854	0.1031	0.0773
1985	0.0090	0.0064	0.1808	0.1308	0.1194	0.0898	0.2822	0.1983	0.1496	0.0914
1986	0.0314	0.0200	0.3496	0.2385	0.1164	0.0812	0.3618	0.2457	0.1495	0.0725
1987	0.0963	0.0586	0.3325	0.2337	0.0439	0.0299			0.1490	0.0806
1988									0.1252	0.0598

Notes:Modn1 is prop.in gross fixed assets (incremental increase/GFA in previous year)
Modn2 is proportional change in deflated gross fixed assets

TABLE A.6.3:FIXED ASSETS PER EMPLOYEE

	ALL	BTL	M&M	SMPIL	TELCO
1977	0.6141	0.2636	0.4733	0.3691	0.9005
1978	0.5968	0.2847	0.4115	0.3637	0.9139
1979	0.7097	0.3269	0.3962	0.3448	0.8931
1980	0.9695	0.3447	0.3988	0.3256	0.9222
1981	0.9776	0.3560	0.4490	0.3459	0.9168
1982	1.0487	0.4775	0.5153	0.3823	0.9763
1983	1.1742	0.5396	0.6350	0.3902	1.0174
1984	1.2018	0.6831	0.6844	0.4085	1.0872
1985	1.2200	0.8389	0.7143	0.4698	1.2339
1986	1.2522	0.9924	0.7870	0.5479	1.3118
1987	1.3285	1.0397	0.7724		1.4277
1988					1.5521

Note:Fixed assets are the adjusted value of deflated fixed assets
Source:Balance Sheets

TABLE A.6.4: INVENTORIES TO SALES RATIOS

YEARS	ALL	BTL	M&M	STD	TELCO
1977	0.2546	0.2900	0.1996	0.3053	0.3651
1978	0.2344	0.2884	0.2652	0.2665	0.3814
1979	0.3080	0.2965	0.2672	0.3670	0.3638
1980	0.3027	0.2872	0.2614	0.3254	0.4449
1981	0.3573	0.3417	0.2459	0.3645	0.3496
1982	0.3479	0.2575	0.2690	0.2357	0.3973
1983	0.2610	0.3037	0.2315	0.2664	0.3066
1984	0.2545	0.2427	0.2371	0.2410	0.2840
1985	0.3081	0.2305	0.3490	0.3436	0.2644
1986	0.2575	0.2491	0.3488	0.4524	0.3523
1987	0.2667	0.2059	0.2799		0.2847
1988					0.2193

Source:Balance Sheets

Table A.6.5 : **Quality Control Staff**

		ALL	BTL	M&M	SMPIL	TELCO
1967-68						
QC staff		199	32	285	107	689
QC staff/ Production Workers		9%	5%	5%	9.6%	14%
QC staff	1977	-	-	-	106	-
	1980	629	-	-	-	-
	1986	842	-	-	-	-
	1987	858	-	-	-	2466
	1988	-	157	938	146	2442
	1989	-	-	-	-	2419
QC staff/ Total Emp.	1977	-	-	-	6.2%	-
	1980	8%	-	-	-	-
	1986	7.9%	-	-	-	-
	1987	8%	-	-	-	6.6%
	1988	-	3.2%	5.8%	4.2%	6.6%
	1989	-	-	-	-	6.7%

Sources : Tariff Commission (1968), p.228
Field Survey

Table A.6.6
Relationship between Deflated Fixed Assets and Installed Capacity

Company	Constant	Coefficient of Capacity	F
ALL	0.03	1.99**	18.0
BTL	0.19	0.22*	4.4
M&M	0.09	0.86**	12.1
SMPIL	0.13	0.29	0.7
TELCO	0.10	- 0.16	1.3

Notes : Both dependent and independent variables are expressed in terms of percentage annual change.
The time period is 1977-87

* denotes 90% significance
** denotes 99% significance

TABLE A.6.7:INDICES OF WHOLESALE PRICES (VEHICLES AND PARTS,STEEL) AND UNIT COSTS, PRICES(REALIZATION) AND PROFITS

	WPI VEHICLES AND PARTS	WPI SEMI-FIN STEEL	INDEX UNIT COSTS	INDEX UNIT PRICES	INDEX UNIT PROFITS
ASHOK LEYLAND					
1977	100.00	100.00	100.00	100.00	100.00
1978	102.31	100.09	105.79	105.99	107.42
1979	111.42	109.36	124.05	119.74	89.05
1980	138.58	138.90	155.86	148.96	99.87
1981	160.38	144.50	172.82	167.24	127.55
1982	182.52	192.08	167.57	163.86	137.46
1983	188.46	215.92	189.46	186.61	166.38
1984	186.45	225.96	176.27	169.13	118.32
1985	195.50	246.00	186.55	172.08	69.18
1986	225.72	265.44	218.63	206.76	122.42
1987	236.56	265.44	218.89	207.63	127.56
BAJAJ TEMPO					
1977	100.00	100.00	100.00	100.00	100.00
1978	102.31	100.09	107.26	102.36	63.18
1979	111.42	109.36	110.51	113.30	135.66
1980	138.58	138.90	119.91	128.13	193.88
1981	160.38	144.50	133.16	141.80	210.96
1982	182.52	192.08	145.81	153.94	218.96
1983	188.46	215.92	158.33	164.53	214.18
1984	186.45	225.96	160.54	169.88	244.61
1985	195.50	246.00	191.00	198.55	258.88
1986	225.72	265.44	183.09	187.00	218.29
1987	236.56	265.44	225.97	206.92	54.62
MAHINDRA					
1977	100.00	100.00	100.00	100.00	100.00
1978	102.31	100.09	100.56	100.66	102.08
1979	111.42	109.36	103.23	105.76	141.55
1980	138.58	138.90	113.87	117.46	168.22
1981	160.38	144.50	136.14	140.19	197.50
1982	182.52	192.08	153.17	157.12	213.12
1983	188.46	215.92	156.73	158.96	190.51
1984	186.45	225.96	163.73	164.78	179.63
1985	195.50	246.00	172.37	167.42	97.41
1986	225.72	265.44	208.24	202.41	119.93
1987	236.56	265.44	223.84	217.77	131.97
STANDARD					
1977	100.00	100.00	100.00	100.00	100.00
1978	102.31	100.09	104.61	103.13	-28.62
1979	111.42	109.36	109.79	109.71	102.48
1980	138.58	138.90	113.86	119.19	593.26
1981	160.38	144.50	128.35	130.78	347.44
1982	182.52	192.08	136.69	142.28	639.93
1983	188.46	215.92	157.83	161.02	444.33
1984	186.45	225.96	160.05	162.69	397.57
1985	195.50	246.00	178.05	177.47	126.45
1986	225.72	265.44	196.23	177.91	-1451.22
TELCO					
1977	100.00	100.00	100.00	100.00	
1978	102.31	100.09	109.33	109.44	111.43
1979	111.42	109.36	108.93	108.22	96.01
1980	138.58	138.90	135.75	134.08	105.62
1981	160.38	144.50	151.90	151.62	146.84
1982	182.52	192.08	148.62	152.40	216.93
1983	188.46	215.92	171.15	173.58	215.08
1984	186.45	225.96	165.81	161.50	87.88
1985	195.50	246.00	181.49	178.17	121.47
1986	225.72	265.44	192.60	185.42	62.81
1987	236.56	265.44	209.70	200.95	51.52
1988	252.19	278.92	212.82	208.63	137.09

Sources:Balance sheets,and Reserve Bank Reports on Currency and Finance for WPIs.

Table A.6.8.

INFLUENCE ON REAL UNIT COSTS OF SCALE AND CAPACITY UTILIZATION

Equation 1 : Real Unit Costs (Dependent) on Weighted Production

	ALL	BTL	M&M	SMPIL	TELCO
Slope	-0.23(1.3)	-0.14(6.1)	-0.03(6.8)	-0.26(5.0)	-0.12(7.6)
Corr. Co-efficient	0.42	0.91	0.92	0.87	0.94

Equation 2 : Real Unit Costs (Dependent) on Capacity Utilisation

Slope	0.65(2.8)	0.27(2.8)	-0.18(3.1)	-0.36(5.6)	-0.57(2.1)
Corr. Co-efficient	0.70	0.71	0.74	0.89	0.59

Equation 3 : Capacity Real Unit Costs (Dependent) on Weighted Production

Slope	-0.26(1.4)	-0.15(5.6)	-0.03(4.4)	-0.18(4.8)	-0.10(5.7)
Corr. Co-efficient	-	-	-	-	-

Notes : Figures in parentheses are t- values
Capacity unit costs = unit fixed costs adjusted to 100% capacity utilization + unit variable costs

Data source : Balance Sheets.

TABLE A.6.9: DEFLATED UNIT VALUES OF COSTS, PRICES AND PROFITS
(Rs. lakhs, 1976-77 prices)

ALL

YEARS	DEFLATED UNIT COST	DEFLATED UNIT PRICES	DEFLATED UNIT PROFITS
1977	0.8522	0.9721	0.1199
1978	0.9007	1.0294	0.1286
1979	0.9667	1.0643	0.0976
1980	0.9563	1.0424	0.0862
1981	1.0192	1.1250	0.1058
1982	0.7435	0.8292	0.0858
1983	0.7478	0.8401	0.0924
1984	0.6648	0.7276	0.0628
1985	0.6463	0.6800	0.0337
1986	0.7019	0.7572	0.0553
1987	0.7028	0.7604	0.0576

STD

YEARS	DEFLATED UNIT COST	DEFLATED UNIT PRICES	DEFLATED UNIT PROFITS
PROFITS			
1977	0.4157	0.4204	0.0047
1978	0.4345	0.4331	-0.0013
1979	0.4173	0.4217	0.0044
1980	0.3408	0.3607	0.0200
1981	0.3692	0.3805	0.0112
1982	0.2958	0.3114	0.0156
1983	0.3039	0.3135	0.0096
1984	0.2944	0.3027	0.0082
1985	0.3009	0.3033	0.0024
1986	0.3073	0.2818	-0.0255
1987			
1988			

M&M

YEARS	DEFLATED UNIT COST	DEFLATED UNIT PRICES	DEFLATED UNIT PROFITS
1977	0.4078	0.4366	0.0288
1978	0.4097	0.4391	0.0294
1979	0.3849	0.4222	0.0373
1980	0.3343	0.3692	0.0349
1981	0.3842	0.4236	0.0394
1982	0.3252	0.3571	0.0320
1983	0.2960	0.3214	0.0254
1984	0.2955	0.3184	0.0229
1985	0.2857	0.2971	0.0114
1986	0.3199	0.3329	0.0130
1987	0.3439	0.3582	0.0143

BTL

DEFLATED UNIT COST	DEFLATED UNIT PRICES	DEFLATED UNIT PROFITS
0.3471	0.3905	0.0434
0.3720	0.3994	0.0274
0.3508	0.4046	0.0538
0.2996	0.3602	0.0606
0.3199	0.3832	0.0634
0.2635	0.3130	0.0495
0.2545	0.2976	0.0431
0.2466	0.2936	0.0470
0.2695	0.3152	0.0457
0.2394	0.2751	0.0357
0.2955	0.3044	0.0089

TELCO

DEFLATED UNIT COST	DEFLATED UNIT PRICES	DEFLATED UNIT PROFITS
0.8650	0.9156	0.0506
0.9448	1.0012	0.0564
0.8616	0.9061	0.0445
0.8454	0.8839	0.0385
0.9092	0.9607	0.0515
0.6693	0.7265	0.0572
0.6856	0.7361	0.0504
0.6347	0.6544	0.0197
0.6382	0.6632	0.0250
0.6276	0.6396	0.0120
0.6833	0.6932	0.0098
0.6600	0.6849	0.0249

Note: The deflator is the wholesale price index of semi-finished steel
Source: Company balance sheets

Table A.6.10

VEHICLES AND WAGES PER EMPLOYEE IN SELECTED FIRMS, 1987

Foreign Firms			Indian Firms		
	VEHICLES	WAGES($)		VEHICLES	WAGES ($)
Hino	7.8	-	Telco	2.6	3165
Nissan Diesel	6.3	-	ALL	1.7	2753
Isuzu	39.4	-	BTL	5.6	2077
Mazda	41.8	-	M&M	4.5	3275
Toyota	43.7	25632(1983)	SMPIL	2.6	1795
MAN (1985)	1.03	25395			
Daimler-Benz (1986)	2.62	34857			

Notes: Indian figures are adjusted for a 26% level of vertical integration, but foreign firms' figures are not. For Daimler-Benz, the productivity figure is calculated for CVs only, assuming that five of its plants were engaged primarily in CV production. Total CV employment was calculated as 55614 (including non-production workers), and CV output of 6 tons and over was 145757. The Hino figure for productivity is an underestimate because it includes a large number of workers producing pickups for Toyota. Isuzu produces the full range of automobiles, while Toyota and Mazda make cars and LCVs.

Sources : EIU (1988), p.9; Cusumano (1985), p.207; MAN and Daimler-Benz Annual Reports; and Table A.3.9.

Table A.7.1: R&D EXPENDITURES AND R&D INTENSITY

R&D Expenditures (Rs. lakhs)

Years	ALL	BTL	M&M	SMPIL	TELCO
1977	13.15	n.a.	n.a.	n.a.	327.00
1978	35.52	n.a.	n.a.	n.a.	316.00
1979	104.05	n.a.	n.a.	n.a.	405.00
1980	158.18	n.a.	n.a.	n.a.	448.00
1981	114.62	32.40	n.a.	n.a.	660.00
1982	156.26	39.68	60.00	31.12	825.00
1983	85.78	81.61	98.70	16.42	752.00
1984	84.00	166.46	78.88	29.58	726.00
1985	98.61	178.43	n.a.	6.62	783.00
1986	109.48	122.30	n.a.	25.31	1158.00
1987	161.92	129.26	n.a.	n.a.	976.00
1988	n.a.	n.a.	n.a.	n.a.	n.a.

R&D Intensity (R&D/Sales, %)

Years	ALL	BTL	M&M	SMPIL	TELCO
1977	0.15	n.a.	n.a.	n.a.	1.27
1978	0.29	n.a.	n.a.	n.a.	1.22
1979	0.67	n.a.	n.a.	n.a.	1.18
1980	0.77	n.a.	n.a.	n.a.	1.12
1981	0.44	0.65	n.a.	n.a.	1.22
1982	0.57	0.56	0.22	1.05	1.19
1983	0.32	1.21	0.31	0.50	0.99
1984	0.33	1.87	0.21	0.74	0.96
1985	0.34	1.70	n.a.	0.15	0.94
1986	0.32	1.15	n.a.	0.46	1.33
1987	0.44	0.95	n.a.	n.a.	0.98
1988	n.a.	n.a.	n.a.	n.a.	1.12

Source:Balance sheets and field survey

Table A.7.2: TECHNOLOGY IMPORTS (Rs. lakhs unless otherwise specified)

	ASHOK LEYLAND				(percent)		BAJAJ TEMPO				(percent)
Yr	Capgoods	Tech fees	Total	Sales	Tot/Sales	Years	Capgoods	Tech fees	Total	Sls	Tot/Sls
1977	28.12	34.08	62.20	8754	0.71	1977	30.17	0.00	30.17	2179	1.38
1978	64.61	0.00	64.61	12284	0.53	1978	35.12	0.00	35.12	2680	1.31
1979	174.33	16.49	190.82	15645	1.22	1979	12.04	50.52	62.56	3552	1.76
1980	576.97	36.73	613.70	20671	2.97	1980	107.36	50.53	157.89	4510	3.50
1981	193.19	24.52	217.71	26170	0.83	1981	77.81	0.31	78.12	4971	1.57
1982	473.55	18.14	491.69	27609	1.78	1982	117.06	0.00	117.06	7068	1.66
1983	263.12	8.16	271.28	26633	1.02	1983	73.64	46.24	119.88	6727	1.78
1984	101.62	13.68	115.30	25807	0.45	1984	186.66	0.00	186.66	8908	2.10
1985	29.14	32.99	62.13	29396	0.21	1985	300.66	0.00	300.66	10527	2.86
1986	68.85	18.29	87.14	33712	0.26	1986	99.29	21.22	120.51	10630	1.13
1987	971.40	21.54	992.94	36408	2.73	1987	872.89	77.86	950.75	13653	6.96
1988	n.a.	n.a.	n.a.	n.a.	n.a.	1988	n.a.	n.a.	n.a.	n.a.	n.a.

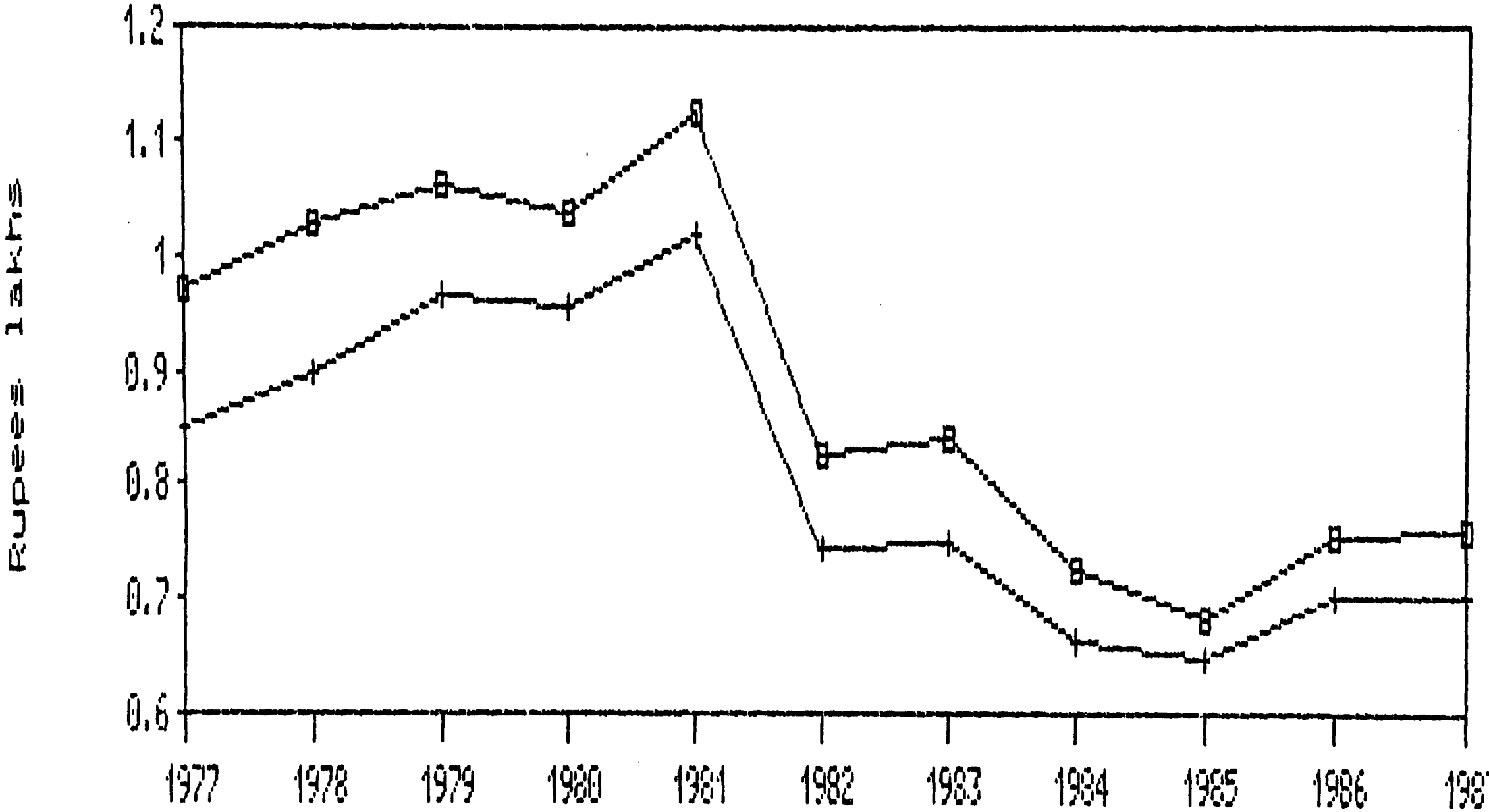
	MAHINDRA & MAHINDRA				(percent)		STANDARD MOTORS				(percent)
Yr	Capgoods	Tech fees	Total	Sales	Tot/Sales	Years	Capgoods	Tech fees	Total	Sls	Tot/Sls
1977	31.62	2.20	33.82	6243	0.54	1977	0.00	0.00	0.00	777	0.00
1978	19.81	0.16	19.97	9109	0.22	1978	0.00	0.94	0.94	924	0.10
1979	5.30	0.49	5.79	12673	0.05	1979	0.06	1.02	1.08	1004	0.11
1980	53.88	0.00	53.88	17414	0.31	1980	1.44	11.67	13.11	1412	0.93
1981	295.31	30.49	325.80	23435	1.39	1981	0.73	7.76	8.49	2164	0.39
1982	378.62	33.44	412.06	26908	1.53	1982	70.87	0.00	70.87	2961	2.39
1983	630.53	31.08	661.61	31401	2.11	1983	100.83	0.00	100.83	3312	3.04
1984	658.15	26.85	685.00	36833	1.86	1984	27.48	0.00	27.48	3989	0.69
1985	162.34	27.51	189.85	40541	0.47	1985	65.02	3.37	68.39	4355	1.57
1986	238.92	35.37	274.29	43340	0.63	1986	402.94	43.25	446.19	5486	8.13
1987	277.44	47.92	325.36	49145	0.66	1987	n.a.	n.a.	n.a.	n.a.	n.a.
1988	n.a.	n.a.	n.a.	n.a.	n.a.	1988	n.a.	n.a.	n.a.	n.a.	n.a.

	TELCO				(percent)
Year	Capgoods	Tech fees	Total	Sales	Tot/Sales
1977	589.44	26.20	615.64	25808	2.39
1978	102.74	24.89	127.63	25963	0.49
1979	196.21	46.91	243.12	34227	0.71
1980	369.24	150.01	519.25	40161	1.29
1981	529.91	8.00	537.91	54108	0.99
1982	1149.69	15.79	1165.48	69309	1.68
1983	696.13	7.59	703.72	75880	0.93
1984	205.53	10.41	215.94	75465	0.29
1985	1200.00	154.00	1354.00	83128	1.63
1986	759.00	65.00	824.00	86807	0.95
1987	470.00	28.00	498.00	99279	0.50
1988	831.00	37.00	868.00	116325	0.75

Note: Total is the sum of capital goods and technology fees (both royalty and knowhow fees)
Source: Balance Sheets

Exhibit 6.1

ASHOK LEYLAND:UNIT COSTS AND PRICES
(deflated by steel price index)



	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Capacity	9500	11000	12200	15400	19500	20500	23000	23000	23000	23000	23000
Capacity Utn (%)	86	100	101	84	77	80	58	63	69	66	71

□ Revenue per vehicle + Cost per vehicle

Exhibit 6.2

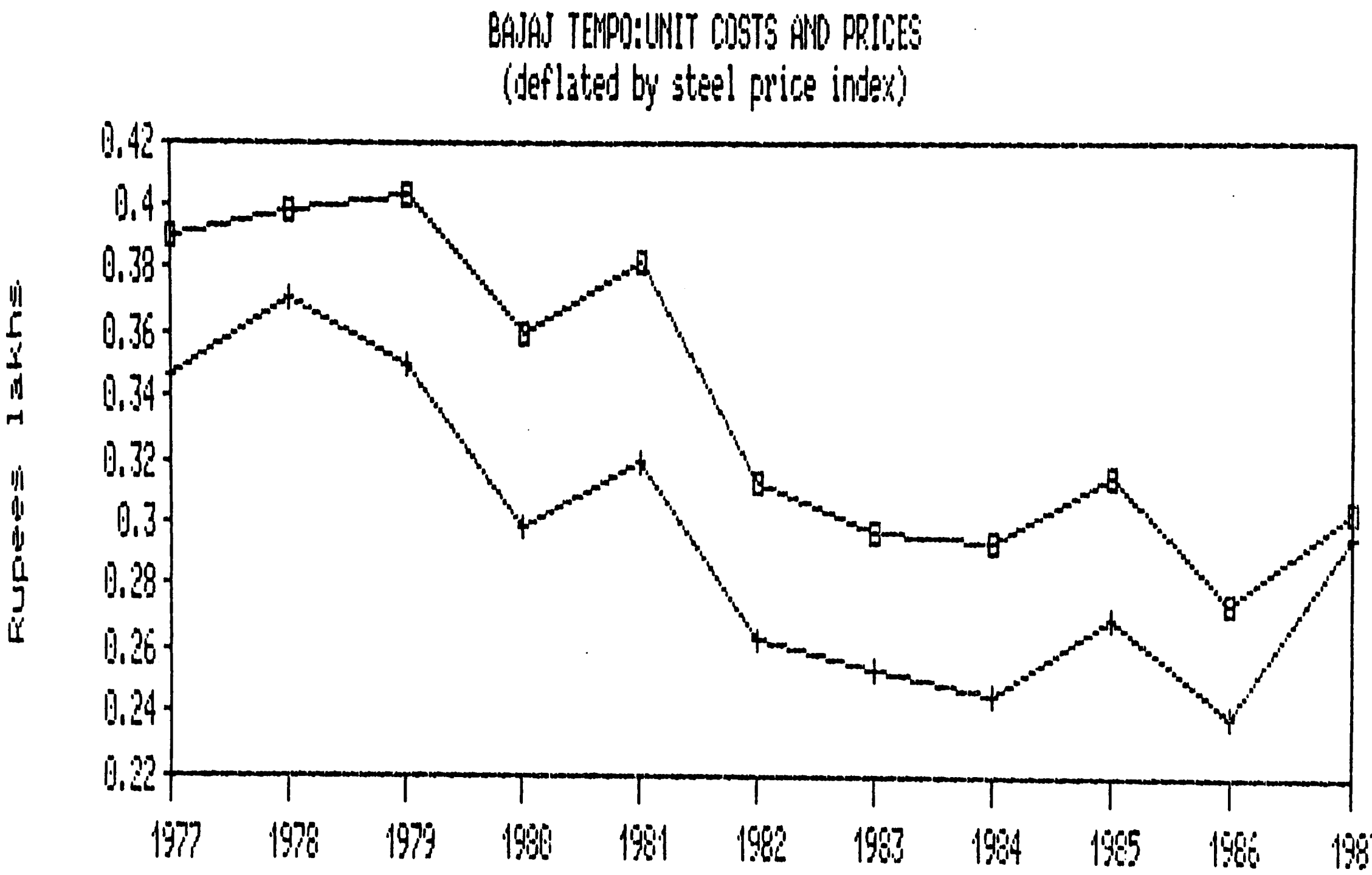
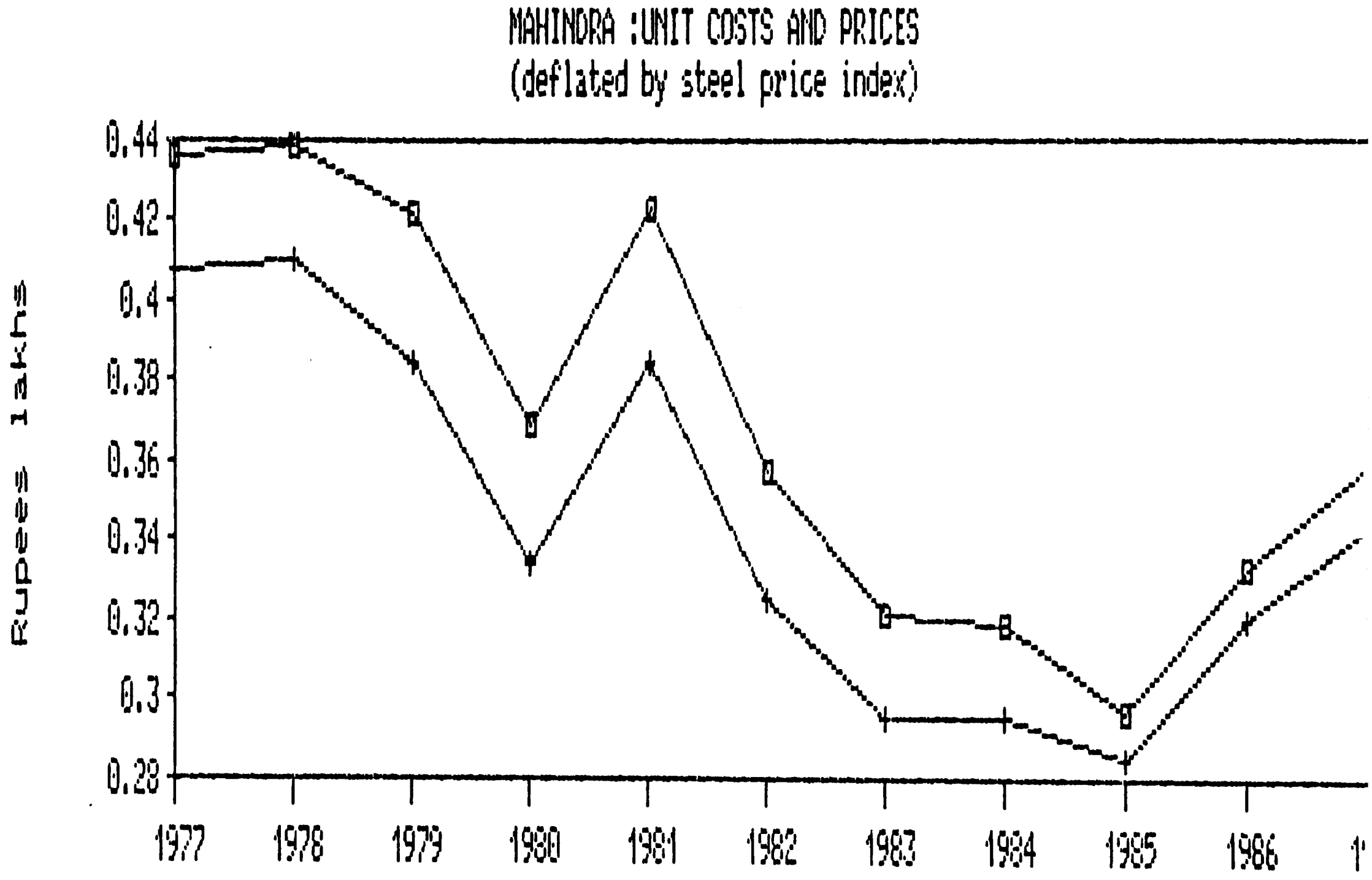
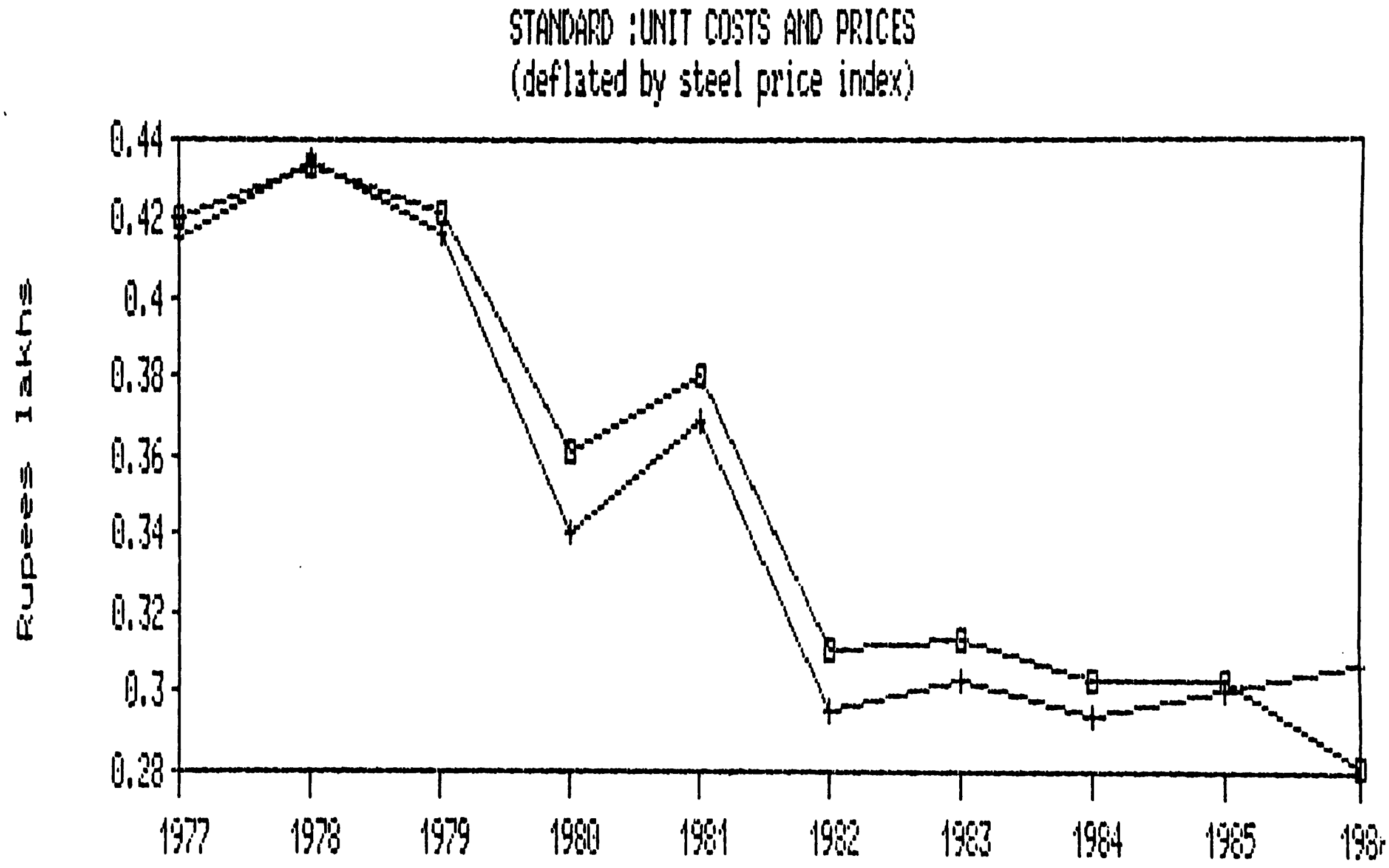

BAJAJ TEMPO:UNIT COSTS AND PRICES
(deflated by steel price index)
Rupees lakhs
0.42
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Capacity 5000 6000 8000 12000 12000 15000 15000 15000 15000 20000 20000
Capacity Utn(%) 96 98 92 68 70 76 64 85 80 66 78
□ Revenue per vehicle + Cost per vehicle

Exhibit 6.3



Capacity	12500	22500	25000	27250	30250	32250	36500	40000	40000	51000	51
Capacity Utn.(%)	85	76	97	108	121	123	121	122	137	91	1

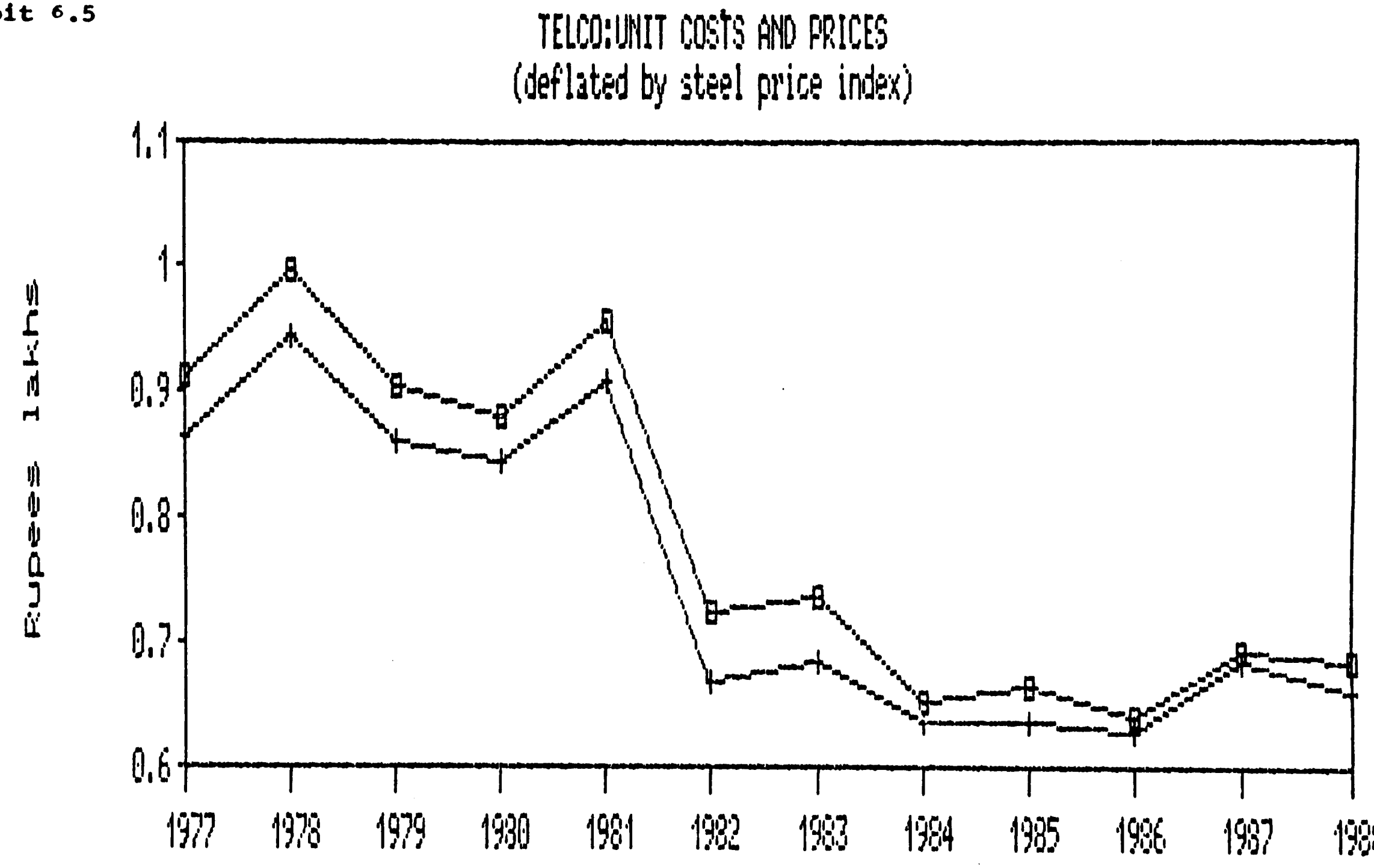
Exhibit 6.4



Capacity	4400	4400	4400	4400	5000	6250	6250	7500	7500	750
Capacity Utn(%)	43	50	50	64	78	79	78	77	78	73

□ Revenue per vehicle + Cost per vehicle

Exhibit 6.5


TELCO:UNIT COSTS AND PRICES
(deflated by steel price index)
Rupees lakhs
1.1
1
0.9
0.8
0.7
0.6
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Capacity 29160 38160 38160 38160 40160 41660 46800 46800 53640 56640 60640 68640
Capacity Utn. (%) 90 61 84 79 90 111 95 100 88 83 82 83
□ Revenue per vehicle + Cost per vehicle

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