NATURAL RESOURCE CONTENT OF FOREIGN TRADE AND STRUCTURAL BIAS; AN INTER-COUNTRY COMPARISON OF CZECHOSLOVAKIA AND AUSTRIA BY MEANS OF INPUT-OUTPUT TECHNIQUE

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Wolfson College

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ABSTRACT

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The purpose of this study is to test the hypothesis that centrally-planned economies are characterized by what is called a bias towards absorption of natural resource intensive products (NRP) which is said to affect in turn the commodity structure of their foreign trade. While the study includes a detailed analysis of foreign trade structures and the absorption of NRP by final consumers, it is the intermediate demand for NRP and its determinants which are emphasized. Following the suggestions in the literature that the technologies used by the centrally-planned and market-type economies are different, the role of technology in determining intermediate demand for NRP has been examined in detail.

Bias is defined here in terms of inter-country differences and the present comparison involves a case-study of Czechoslovakia as a centrally-planned economy and Austria as a market-type economy based on an input-output model. The use of the input-output model in international comparisons of production and use of commodities has been criticized on the following grounds: (1) The distinction between technology and substitution is ignored in the model. (2) International differences in relative prices are normally ignored or assumed away in empirical work. (3) The comparisons may be severely affected by imperfections of input-output tables. This study attempts to answer the above criticism in an original way. New methods of sensitivity analysis were designed to test for the existence of the 'triangular' and other 'fundamental' properties of the technological matrices. In addition, the assumption of temporal stability of input-output coefficients is relaxed and an attempt is made to distinguish between technology and substitution with the help of the RAS method. Further analysis of the impact of relative prices on input-output flows was derived from an analysis of indirect taxation.

The main conclusion of this study is that Czechoslovakia had a considerable NRP import bias which was primarily due to the pro-NRP absorption bias of final consumers. However, it is unlikely that 'excessive' aggregate demand for imports originated in 'NRP-biased' technology. This empirical analysis provides strong evidence that the production processes with regard to the use of NRP were highly similar in both countries.

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LIST OF ABBREVIATIONS

CMEA	Council for Mutual Economic Assistance
CPEs	Centrally-Planned Economies
ECE	Economic Commission for Europe
EEC	European Economic Community
FTE	Foreign Trade Enterprise
FTP	Foreign Trade Prices
GNP	Gross National Product
GSP	Gross Social Product
I-O	Input-Output
ISIC	International Standard Industrial Classification
MPS	Material Product System
MTEs	Market-Type Economies
NR	Natural Resources
NRP	Natural Resource Products
SEFT	Special Earnings of Foreign Trade
SNA	Standard National Accounting
USSR	Union of Soviet Socialist Republics
UK	United Kingdom
UN	United Nations
wmp	World Market Prices

PREFACE

The origin of this study goes back to the period when I lived in Czechoslovakia. But it was not until I came to Oxford that I took up the idea of natural resource product absorption more seriously. For this I am greatly indebted to Mr. M. Kaser, who provided the initial encouragement. The actual argument and the choice of methodology were shaped into their final form with the considerable help and constructive criticism of Dr. M. Bacharach, Dr. A. Zauberman, and my thesis supervisors Professor J.A.C. Brown and Dr. J. Enos. I would like to thank all of them for all their assistance.

In addition to the support I received at Oxford University I have benefited from comments of a great number of people who have read the whole or parts of the manuscript. In particular I would like to mention Professors K. Polenske, McGilvray, A. Peacock, O. Kyn and W. Brus as well as Dr. D. Skolka, Dr. H. Pesaran and Dr. V. Bulmer-Thomas.

Parts of the thesis are related to several articles which I published in various journals and I was, therefore, able to benefit also from the comments of anonymous referees. Parts of Chapter I and Appendix 3 were published as two separate papers in Public Finance, Vol. XXXIV, (1979), No. 2 and in the Jahrbuch der Wirtschaft Osteuropas, 1981, Band 9/2. Parts of Chapter III constitute a paper published in the Journal of Policy Modelling, Vol. 3 (1981), No. 1 while Chapter V was published in Greek Economic Journal (Dec. 1981). Two studies related to the material in Chapter II were published in the form of working papers at the University of British Columbia. The material in Chapter IV was published as a University College at Buckingham working paper.

The extensive computations which were required for carrying out this empirical study were undertaken partly at the Institut für Internazionale Wirtschaftsvergleiche in Vienna and partly at the Institute of Economics and

Statistics, Oxford University. I am particularly grateful to Dr. J. Skolka and Dr. B. Levcik, Director of the Vienna Institut, for making the necessary data available to me and for undertaking some of the computations. I would like to thank further Guiseppe Mazarino for his expert help with computing work presented here, mostly in Chapters IV and V.

This study was written almost entirely during my full-time work at the University College at Buckingham and I would like to thank Professor A. Peacock, the Principal, and all my colleagues for their support, understanding and assistance. Miss Julie Cakebread typed and Mrs. Irene Gray printed the dissertation and their kind help is gratefully acknowledged.

But my greatest debt is to my wife, Anne, for her continuous support over the years.

INTRODUCTION

NATURAL RESOURCE CONTENT OF FOREIGN TRADE AND STRUCTURAL BIAS: AN INTER-COUNTRY COMPARISON OF CZECHOSLOVAKIA AND AUSTRIA BY MEANS OF INPUT-OUTPUT TECHNIQUE

1. The absorption of natural resource products in the centrally-planned economies

Long before the present 'energy crisis' in the West, an extensive discussion was going on in the centrally-planned economies (CPEs) about optimal policies for the exploitation and use of natural resources.[1] The discussion, which was later joined by Western economists, was concerned with shortages of fuels, raw materials and even agricultural products in the CPEs[2] and the increasing difficulties in obtaining these commodities in the CMEA market.[3] The discussion focussed partly on 'supply-oriented' issues along the lines which can be observed currently in Western literature, i.e. concern about the optimal rate of exploitation of natural resources. However, the discussion concentrated mainly on the attempt to identify factors which represent essentially the demand side of the argument. The argument was briefly as follows.

Increasing scarcities of fuels, raw materials and agricultural commodities, called here natural resource products (NRP), were blamed partly on agricultural policies which did not provide incentives for farmers to increase their output sufficiently. On the other hand, the demand for NRP in the postwar period expanded dramatically even though

1. The centrally-planned economies include here Bulgaria, Czechoslovakia, GDR, Hungary, Poland, Romania and the Soviet Union. Several other small countries such as Albania, Cuba, Mongolia and Vietnam are also typically defined as CPEs.

2. See, for example, Bornstein (1970) and the more recent study of Gray (1981).

3. The Council for Mutual Economic Assistance (CMEA) refers to a form of CPE integration. For a detailed discussion of its institutions, see, for example, Kaser (1967).

the rate at which exhaustible natural resources were exploited increased at the same time. Nevertheless, the domestic scarcities of NRP in the CPEs were increasingly blamed on what became known as 'excessive' absorption of NRP in the economy as a whole and production processes in particular. The argument typically defined the absorption as 'excessive' on the basis of straightforward comparisons with market-type economies (MTEs) and, while the discussion sometimes referred to semiprocessed commodities, it is the use of NRP which has been particularly criticized. This pattern of NRP use is described as a general feature of all CPEs and it is said to reflect inefficiences of the system. The misuse of NRP in the CPEs can be identified, therefore, as a 'systemic' deficiency. Furthermore, the importance of rising demand for NRP was also reflected in the theoretical literature. For example, in his later work Kalecki (1963) incorporated the natural resource constraint as an argument in his theory of economic growth.

It was also suggested that there were two sources of the 'excessive' absorption in the CPEs. It was argued, first of all, that the absorption 'bias' originated in the composition of domestic components of final demand which, in turn, reflected a bias towards natural resource intensive commodities. Given the nature of central planning, this 'bias' in the structure of demand was identified with planners' priorities which, in turn, were said to be substantially different from the 'revealed preferences' of private consumers in the MTEs. Zauberman (1965) provides a survey of the literature on various aspects of the 'objective' function in the context of Soviet planning.

Some economists also suggested that the natural resource intensive 'bias' in demand emerged in the CPEs due to inefficient use of these resources. It was argued that the absorption of various NRP which were used as inputs in production processes was 'excessive' by international standards. Thus, the 'bias' of intermediate demand and the 'demand bias' mentioned above have contributed systematically to a rapid expansion of intermediate demand for NRP by the CPEs, particularly in the 1960s, with the trend continuing in the following decade. Moreover, in view of the balance of payments difficulties which all the CPEs have been experiencing in one way or another, the 'bias' towards NRP absorption has led to particularly severe balance of payments difficulties in the natural resource-poor countries.[4]

A typical example of CPEs in which this issue of NRP use was debated along the lines summarized above was Czechoslovakia. Czechoslovakia is a small country with a limited natural resource endowment and the concern about the efficiency of NRP use was, therefore, closely connected with the balance of payments constraint. The country depends heavily on imports of raw materials, fuels and agricultural products, the bulk of which is purchased in the CMEA market, and the demand for imports has been rising rapidly. At the same time, Czechoslovakia has been facing increasing difficulties in meeting its steadily rising demand for these commodities in the CMEA market. Moreover, the purchase of additional imports of NRP in the world market is made more difficult by the country's inability to generate sufficient resources of convertible currencies from sales of goods and services, particularly owing to the lack of competitiveness of Czechoslovak products.

The literature dealing with NRP absorption in the Czechoslovak economy is quite plentiful and the tone of the discussion is very much in line with the general argument described above. Goldman and Flek (1967), for example, argued that 'excessive' use of raw materials was one of the

4. The pattern of rapid expansion of import demand for NRP in the CPEs has been quite similar to that experienced by some developing countries. In their study of the effects of import substitution, Little, Scitovsky and Scott (1970) argued that balance of payments difficulties of these countries have not been reduced by protection and import substitution since industrialization generated rapidly expanding demand for imported raw materials. Moreover, neglect of comparative advantages has resulted in some cases in a reduction in the traditionally exportable surpluses of food. Inefficient use of industrial capacities was another factor increasing demand for NRP.

most significant causes of instability in the growth of national income during the 1960s. Empirical sources, which attempt to assess the intermediate demand for NRP include, for example, Kasik (1967) and Korda (1977), who suggest a relatively greater use of fuels and energy in comparison to Western countries. A similar point with regard to the use of raw materials in production processes is made by Divila et al. (1971), Safar and Hlavac (1967), Elias and Grabik (1980), Vintrova (1976) etc.

The 'bias' of private consumption towards NRP, i.e. primarily towards food, has also been suggested in Czechoslovak literature. Jirka and Pytel (1974), for example, argue that the higher *per capita* consumption of cereal grains in Czechoslovakia in comparison to Western countries reflects greater demand of private consumers for food. Similar arguments have been made by a number of writers with regard to consumption of meat and other types of food.

One characteristic feature of the argument is that the empirical evidence is anecdotal or that it has been obtained typically from case studies. While the case-study approach offers scope for detailed analysis, it is in the nature of such studies that they are suitable only for micro-economic assessments and, consequently, the evidence provided on that basis limits the scope for generalizations. The lack of economy-wide studies is a serious shortcoming, especially since the dependence of individual CPEs on foreign trade has been rising and the macro-economic implications of NRP intensity in general and energy intensity in particular of these countries are, therefore, of growing importance not only in the CPEs themselves, but also elsewhere.

In the context of economic theory, the argument of excessive NRP absorption' is not, however, meaningful as a statement about the utilization of natural resources and natural resource intensive commodities in the CPEs. The argument fails to distinguish among different sources of structural 'biases', such as the effects of demand patterns, substitution or technology or simply the effects of inefficiency in the use of NRP (i.e. wastage). It is quite possible, for example, that greater matrix as before. The vector $\tilde{x}^C - \tilde{m}^C$ was compared with the vector $x^C - m^C$, the actual gross output of Czechoslovakia and the differences are shown in Table IV.2. The simulation itself is not, of course, a direct test of technological similarity between both countries. However, the difference between the newly computed vector $(\tilde{x}^C - \tilde{m}^C)$ and the original vector $(x^C - m^C)$ indicates the extent of different weighting in equation (10) above.

Table IV.2 Comparison of actual and simulated gross output requirements in Czechoslovakia, 1962

Percentage difference	Number of sectors
More than -50	2
-50 to -30.1	1
-30 to -10.1	3
-10 to -0	4
+0.1 to +10	4
+10.1 to +30	1
+30.1 to +50	2
More than 50	1
Total	18

In specific terms, the differences between the two vectors fall in the range of -10 per cent to +10 percent in the case of eight (i.e. one-half) of the sectors. On the other hand, there are six sectors (i.e. 30 per cent) for which the difference is more than (±) 30 per cent. This is quite a substantial difference indicating a large impact of 'Austrian technology weight' on the simulated production pattern of Czechoslovakia.

Given the frequencies shown in Table IV.2, the differences between the actual and simulated vectors of gross output do not appear to be random. In other words, the differences tend to be distributed in a non-random pattern and, therefore, some comments concerning these differences may be in order.

In general, most coefficients in the I-O matrices of Czechoslovakia and Austria are not so significantly different as to generate discrepancies between the simulated and actual gross output requirements beyond the range of 0 to +10 per cent or 0 to -10 per cent. Thus, eight out of 18 sectors are centred use of wood products as inputs in CPEs production processes in comparison to MTEs (and hence greater absorption of this NRP) is economically 'rational' and, therefore, not excessive. For economists, the claim that the CPEs absorb more or less NRP in production processes becomes interesting once the 'absorption' is put into the context of relative (input) prices, costs and profitability. Alternatively, at the other extreme, economists would like to know the contribution of various factors which determined NRP absorption since only then does the concept of absorption become meaningful for policy purposes. Unfortunately, the distinction is made only rarely in the literature and this practice has been 'picked up' by journalists both in the East and in the West.[5]

2. The impact of technical progress on the demand for intermediate inputs in the centrally-planned economies: economy-wide studies

The general concepts of 'technology' and 'technical change' have been surrounded by some degree of confusion. This has been due undoubtedly to ambiguities and difficulties in measuring and hence quantifying the effects of what is essentially a qualitative variable. There are no unambiguous units of measurement of 'technology' as a factor of production and from this stem difficulties in relating the impact of the independent variable - 'technology' - and the dependent variable - 'output'. In addition, technical progress may not be an exogenous process which is independent of output, which further complicates the empirical assessment. These and other issues concerning the effects of technical change have been the subject of a large number of studies which attempt to make the concepts of 'technology' and 'technological change' unambiguous and operational. The literature has been surveyed in a number of review articles, including Mansfield (1968), Nadiri (1970) and Kennedy and Thirlwall (1972).

In the literature the assessment of the impact of technical progress

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5. See, for example, the leader in Lidova Demokracie, 7 August 1981.

around zero. Nevertheless, some of the differences are large and they are likely to arise from the presence of anomalous coefficients in the difference matrix (see Table IV.1). In other words, there are several coefficients in the difference matrix which are considerably different from zero and their effect on gross output requirements in the present simulation is cumulative.

Moreover, the above differences in simulated gross output requirements can arise from differences in further characteristics of the transaction matrices which have not been considered up to now. In particular, they may arise from differences in overall production linkages in the two countries and from differences in intra-industry deliveries (i.e. entries on the main diagonal). Indeed the existence of differences between MTEs and CPEs in both these characteristics has been suggested by Berka and Zvacek (1970), Jilek (1970) and Stratil et al. (1970). It should be pointed out, however, that the 'linkage indices' of transaction matrices computed for MTEs and CPEs are likely to be affected considerably by institutional specifics in each country in addition to technology and prices.[13]

On the other hand, the relatively large percentage difference between the simulated and actual gross output requirements are not entirely surprising. Thus, the non-zero entries in the difference matrix of direct coefficients are most likely to have a cumulative effect on the simulated gross output requirements. This appears to be confirmed by Harrigan et al. (1980) who find

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13. The problem of production linkages in CPEs and MTEs was studied in detail, for example, by Stratil et al. (1970), Jilek (1970) and Berka and Zvacek (1970) who found considerable difference in linkages in countries under consideration and explained them mainly on the basis of institutional differences. In their comparison they used primarily the 'Rassmussen' indices of backward linkage (u_j) and forward linkage (u_i), i.e.

$$u_j = \frac{N \sum_{i=1}^{N} b_{ij}}{\sum_{j=1}^{N} \sum_{i=1}^{N} b_{ij}} \qquad u_i = \frac{N \sum_{j=1}^{N} b_{ij}}{\sum_{i=1}^{N} \sum_{j=1}^{N} b_{ij}}$$

on NRP absorption or, more generally, on demand for intermediate inputs, has come primarily from two sources. The first group of studies measures the contribution of technical progress to output and its effect on the efficiency in the use of intermediate inputs in the framework of input-output (I-O) analysis, originally developed by Leontief (1941). The second group of studies employed the production function approach, which attempts to generalize the study of the role of technical progress by extending the analysis from examination of the impact on productivity of primary inputs to the multifactor case incorporating intermediate inputs. All the literature has been adequately surveyed in a recent article of Sato and Ramachadran (1980) and a survey of the literature is not therefore included here. However, it may be useful to quote one of their main conclusions: 'The production functions give a more detailed structure to the technology' (compared with I-O analysis). The problem still to be faced in the use of this approach is how to introduce it so that it is possible to handle more than two inputs simultaneously; to differentiate between scale elasticity and technical progress; and to measure substitutability between inputs accurately. In spite of many studies using aggregate production functions with two primary inputs, few attempts have been made to measure technical progress using a multifactor production function (Sato and Ramachadran (1980), p. 1022).

Following these developments in the literature, there has been a number of attempts both in the West and in the East in the past decade or so to separate quantitatively the contribution of technical progress to output in the CPEs. The studies which followed the pioneering work of Bergson (1953)[6] are based on the production function approach and include, for example, Weitzman (1970), Toda (1974), Desai (1976), Gomulka (1978), Green (1979). Moreover, further techniques from outside the field of

6. Bergson was the first to examine empirically the (total) factor productivity in the USSR but the approach he adopted was not based on the production function approach technique.

economics have been developed and applied in the literature to assess the 'level of technology' in the CPEs. All these techniques together with various production function estimates have been adequately described by Amann (1977).

Yet, the empirical evidence provided by this more recent research is not satisfactory. First of all, it is by no means clear that there exists a technological bias in the CPEs towards material consumption in general and NRP in particular. A recent study of Cameron (1981) points out rather serious inconsistencies in the empirical literature which attempts to estimate the contribution of technical progress in CPEs to their economic growth by means of the production function approach. Similar criticism can be found in Nove and Gomulka (1980) and Amann (1977). In addition the empirical literature which deals with the question of input efficiency and technical progress in the CPEs has concentrated exclusively on estimating productivity of primary factors excluding, therefore, precisely the issue of intermediate inputs. In this respect, literature concerned with measurement of the role of technical progress in the CPEs has followed Western literature dealing with the same issue, but has failed to incorporate more recent advances regarding the role of intermediate inputs in production processes.

The only evidence concerning the impact of technical progress on the demand for intermediate inputs in the CPEs comes from several economy-wide studies based on the input-output model. In Eastern Europe itself, the approach has been adopted, for example, by Koumarova, Bernovsky and Vaner (1967), Berka and Zvacek (1969), Stratil, Durer and Mokrasova (1970) or Jilek (1970). These studies assess the role of technology in determining demand for intermediate inputs on the basis of inter-country comparisons, using as a case study Czechoslovakia and Hungary on the one hand, which are compared with France, Italy and West Germany on the other. The studies do not refer specifically to intermediate demand for NRP but they tend to confirm the argument of higher use of (all) intermediate inputs in the CPEs which is attributed to a large extent to the role of technology. In explaining this phenomenon, Stratil, Durer and Mokrasova (1970, p. 220) write: 'The higher use of material inputs in Czechoslovakia is brought about partly by higher use of own output within sectors (i.e. intra-industry turnover). It appears that this is the result of methodological differences in computing the output volumes in the countries under comparison. The remaining intermediate use of material inputs originates in different technological level of industrial sectors.'

In general it is possible to identify in the I-O literature two separate methods of measuring the impact of technical progress on demand for intermediate inputs. The first and perhaps the more frequently used method involves an assessment of changes in the level and structure of inputs in the production of commodities. The above findings were based on this approach, which may be called for convenience a 'direct approach'. On the other hand, the 'indirect approach' to the assessment of the role of technical progress in the I-O system is based on the assessment of industrial interdependence. The latter is represented in the I-O system by the so-called 'technological matrices', which are typically assumed to reflect the impact of technology.[7]

Empirical evidence concerning the similarity between production structures and industrial interdependence in MPEs and CPEs is also very fragmentary and inconclusive. Differences in the production structures

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7. According to Simpson and Tsukui, 'the structure of production of an I-O system, represented by the matrix of I-O coefficients has traditionally been held to be determined by technology. If this is, in fact, the case one should expect to discover a productive structure which is common to all economic systems having a like technology' Simpson and Tsukui (1965), p. 434. A similar point is made by Chenery and Clark: 'To the extent that we observe similarities in the pattern of relations among sectors it must be due largely to the use of common technology and to similarities in consumption patterns because other elements (varying factor prices, income levels etc.) work against a constant input structure'. See Chenery and Clark (1959), p. 202.

of MTEs and CPEs are emphasized in a study of Lamel <u>et</u> <u>al</u>. (1971). Some rather specific similarities and differences are found by Laumas and Soper (1979) who argue that (i) MTEs are better integrated in comparison to CPEs and (ii) the amount of intermediate production in the so-called 'unlinked sectors' is higher in the CPEs. On the other hand, sectors like agriculture, food processing and manufacture of machinery are the 'leading' sectors irrespective of the type of economy. Similarly, Spulber and Mbise (1979) argue that the so-called 'research-intensive complex' and 'engineering complex' play an expanding role in CPEs in line with trends observable in developed MTEs. The finding of Laumas and Soper that the share of intermediate input is larger in CPEs than in MTEs is supported by Timmerman and Scholling (1979) but they also argue that sectoral output and input structures in the CPEs do not differ due to 'systemic' factors but to random influences.

The suggestion that a different technology exists in the CPEs is surprising particularly in view of the available evidence of technological similarity among MTEs, based on a similar approach. Thus, the empirical findings based on international comparisons of the main features of the technological matrices tend to suggest that there are many similarities among MTEs. Following the findings in the pioneering study of Chenery and Watanabe (1958),[8] these conclusions are reached in later studies of, for example, Song (1977), Allen (1974), Yotopoulos and Nugent (1976), Martin and Rodriguez (1979). An interesting feature of the empirical literature is that the findings were confirmed even with reference to the comparison of developed with less developed countries (Santhanam and Patil (1972)).[9]

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8. The findings can also be found in Chenery and Clark (1959).

9. Santhanan and Patil find 'similarities in national structures, patterns of intermediate use of commodities and input coefficients in spite of differences in income levels, factor endowments, product and factor prices.

In their study of the so-called 'triangular property' of technological matrices Simpson and Tsukui (1965, pp. 442-3) reached conclusions similar to those mentioned above even though they express some doubt as to the extent to which the triangular property is determined by technology. Namely, 'fundamental structure is triangular in form and even though the triangular property of the matrix ... seems to be less directly influenced by technology, chronological order suggests a reason why an output at one stage of the process of production might not be used as input at an earlier stage'. Their point seems to be supported by Lamel et al. (1972 , p. 55).

In sum, there is a considerable shortage of evidence concerning efficiency in the use of intermediate inputs in the CPEs. But the great need for empirical studies of the impact of technical progress on the demand for intermediate inputs holds generally and it is not confined only to countries under central planning. Only recently, Sato and Ramachadran (1980) complained in their survey article about a lack of studies which would measure the impact of technical progress on the demand for intermediate inputs and concluded: 'Considering that the interest in (this) problem became visible only recently, this paucity of literature is not surprising. Hopefully, we can look forward to a more productive period in analysis of the impact of technological change on the scarcity of material inputs' (Sato and Ramachadran (1980), p. 1002).[10]

3. The aim and approach of the study

It has become quite obvious that empirical studies of demand for intermediate inputs in general and those which use an economy-wide approach in particular are needed in order to assess the economic performance of the

10. The same point was made by Carter. See the Introductory discussion in Carter (1970), Chapter 1.

CPEs. This study is an attempt in that direction. Its purpose is to investigate empirically the argument of 'excessive' absorption and the role of technology in determining intermediate demand for NRP in the CPEs.

The argument as presented above lends itself to testable hypotheses. First, NRP absorption may originate on the level of intermediate demand. The specific question with which this study will be exclusively concerned is the extent to which we can identify common elements of technology in the CPEs in comparison with other countries. Second, the 'excessive' NRP absorption can be traced to domestic components of final demand and one would expect, therefore, to observe a 'NRP bias' in domestic final demand of the CPEs. Finally, to the extent that there exists a 'bias' in domestic absorption there must also be a 'bias' in the structure of foreign trade of the resource-poor CPEs, particularly on the side of imports.

Even though this study will include empirical analysis of the structure of domestic final demand (particularly the structure of private consumption) and foreign trade, it is the general problem of intermediate demand for NRP which we shall emphasize. This seems sensible in view of the fact that, with the exception of processed food, most NRP tend to be absorbed in production processes rather than being 'used up' in various segments of final demand. More importantly, however, the study of intermediate demand should be interesting particularly in view of the surprising suggestions in the literature that technology in the CPEs is different from the technology employed by firms in competitive markets.

Thus, the aim of this study is to assess the overall NRP absorption in CPEs as well as the individual components of demand for NRP. This necessitates the use of an economy-wide approach. The author is not aware that such an analysis has been undertaken before. Since the CPEs are becoming more active participants in world markets for energy (i.e. fuels) and other NRP, it is hoped that the subject of this study will prove to be of more general interest.

For reasons given below, the analysis is restricted to the early sixties. However, the study should be of more than just historical interest. It is well known among 'Sovietologists' that CPE policies have changed quite dramatically over the last two decades. The economic policy pursued by CPEs in the first half of the sixties had a distinctive character and was part of the strategy known as the 'highly centralized model of planning'.[11] The strategy has changed in the meantime and this study should be, therefore, a statement about the strategy as much as about the 'past'.

Even though we shall rely on established techniques of analysis in a majority of cases, this study involves the introduction of new and, therefore, original techniques which have been developed for the purpose at hand. The study includes a new method of sensitivity analysis which is based on what we shall sometimes call 'iteration' procedure in order to triangularize I-O matrices. In addition, the sensitivity analysis will make a new use of binary numbers in addition to the actual values of the data. Moreover, the analysis of NRP absorption will also include an application of the RAS method to international comparison of production and use of commodities.

As will become apparent below, most analyses of a similar kind may be affected negatively by the foreign trade policies of countries under consideration. The CPEs which conduct their foreign trade operations through 'foreign trade monopolies' provide a classic example of such policies. Unlike most similar studies, however, the present study makes

11. For a convenient summary of the main elements of the strategy, see Brown and Neuberger (1968), pp. 406-15 and Zauberman (1962).

a careful distinction between domestically produced and imported NRP. Our tests which analyse the role of the foreign trade sector indicate that, contrary to 'established' opinion, CPE foreign trade behaviour was not radically different from that of MTEs, at least with regard to their policies toward the NRP group as a whole.

The approach adopted in this study is that of input-output analysis. In view of the unsatisfactory progress made in this respect in the 'production function literature' mentioned earlier, the I-O approach adopted here should provide a useful alternative for studying the demand for intermediate inputs in CPEs.[12] The approach has been subject to some theoretical criticism which is relevant to studies of technical change over time and also to static international comparisons of technology. This criticism will be summarized in Chapter II, which will also outline the procedure adopted to deal with the implications of this criticism.

International assessments of technology are, however, potentially subject to further difficulties, and the following two problems should be emphasized. First, no data base used in empirical research is ever perfect and the data used in technological assessments are obviously no exception. The implications of this could be quite serious since the imperfections would negatively affect the empirical tests irrespective of whatever 'good' theory or techniques were used. Second, whenever we rely on data in value terms, the international comparisons may be affected by price differences.

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12. Several I-O comparisons of countries including CPEs have been published in the West but, to the author's knowledge, none has dealt with the problem at hand. The studies will be referred to in the text. Nothing has been said until now about what may be regarded as a third alternative to measure the impact of technical progress on demand for intermediate inputs. The approach is known as the 'engineering production function' technique which was pioneered by Chenery (1949). There has been some severe criticism of the technique, e.g. Gold (1981), and, as pointed out by Pearl and Enos even its supporters have recognized its limitations. Nevertheless, there are also some easily identifiable advantages. For more details, see Pearl and Enos (1975).

It is a useful property of I-O analysis that the technique is amenable to various treatments. In fact, we shall use particular I-O techniques to find a solution to the two problems outlined above. Our solution to the first problem will be a new method of 'sensitivity analysis' referred to earlier and developed for the purpose of this study. Our proposal to deal with the 'price problem' is also an 'I-O solution' which turns out to be considerably faster and cheaper than alternatives. Both techniques will be described in detail later.

4. The concept of 'bias' and international comparisons

The present study involves a number of methodological issues. Most of these will be described and discussed in appropriate places as they are of a specific nature. However, there are several more general methodological issues which must be elaborated before we proceed. These include, first of all, a definition of 'bias'.

In principle, it is possible to define a 'bias' as a deviation from a predetermined 'paradigm'. The paradigm itself may be an outcome of a particular theory and a bias may be established by juxtaposing empirical observations against the paradigm. In the context of central planning, however, this approach to assessing economic performance is a formidable task in view of the absence of suitable theories against which actual performance can be evaluated. Some Western economists have, therefore, recently borrowed from the existing body of Western theories which has been designed to model the operation of MTEs.[13] However, this alternative approach itself is potentially subject to serious shortcomings and its normative contribution is particularly dubious.[14]

13. See, for example, Rosefielde (1974a), McMillan (1972a) and (1973).

14. In the framework of Western theories such as the Heckscher-Ohlin model it is useful to distinguish between 'welfare' and 'deterministic' predictions once these theories are applied to CPEs. For more detail, see Drabek (1980).

This approach is closely related to the way in which 'bias' is defined in terms of deviations of actual from so-called 'normal' performance. An example of this technique is use of the 'gravity-model' of international trade,[15] applied by Broner (1976a, 1976b), Hewett (1976b), van Brabant (1973) to assess the volume and structure of centrally-planned foreign trade. Quite apart from the dubious nature of the concept of 'normality', the problems with this approach are quite numerous. The concept of 'normal' performance has been limited to foreign trade flows only. In addition, there are serious econometric problems in estimating single-equation-type models in view of (i) the large number of parameters which typically have to be estimated, (ii) the ambiguity of the theoretical model underlying the functional form and (iii) the presence of several qualitative variables in the model.

The second approach to identifying 'biases' is based on the static framework of inter-country comparisons. In applying this approach, one's task is considerably simplified. In general, the performance of one country is regarded as 'inferior' only to the extent to which the performance of other countries is found to have 'better' parameters of the activity under consideration (e.g. lower I-O coefficients). It is assumed, therefore, that the criterion for assessment is given *a priori* and the evaluation is made purely on that basis. No other considerations outside the framework of the comparison affect our judgment. For example, if it can be established that the impact of technical progress on intermediate demand for NRP is more pronounced in MTEs than in CPEs, this would represent a finding (and a statement) standing on its own and no attempt would be made to assess the centrally-planned system as a whole.

This inter-country approach will be adopted in this study. At the same time, the study will be highly selective, in terms of which CPEs should

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15. See Linneman (1966) and Leamer and Stern (1970) for an elaboration of the model.

be included. In fact, it was decided to adopt a case-study approach due to serious constraints on availability of suitable data. At the time of preparing this study there were no readily available data which would be strictly comparable despite efforts made by various international agencies, other institutions and individual researchers.[16] This constraint would have meant that substantial resources would have had to be devoted to compilation of comparable statistics. For this reason, the considerable data adjustment and analysis which are required by this kind of study were possible for only two countries. The two countries are Czechoslovakia and Austria.

The disadvantages of a case-study approach are well known and have been referred to above. Thus, in order to study, for example, the impact of technical progress on demand for intermediate inputs in the CPEs and MTEs it would be useful to base the comparison on a large sample which might include several if not all CPEs and MTEs. By adopting a case-study approach we are hoping to enlarge the existing literature which is clearly insufficient by adding two 'new' countries for which the question has never been tested empirically. Moreover, as far as the CPE-MTE comparison is concerned the case-study approach is consistent with the general belief that there are many similarities among the CPEs. Consequently, the examination of Czechoslovakia as a case-study is likely to shed some light on the performance of other CPEs which pursued similar growth.[17]

The choice of Czechoslovakia and Austria for the present analysis

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16. An example of one attempt to compile comparable I-O data is provided in United Nations (1971).

17. We have obviously no grounds to argue that the performance of CPEs is identical. For example, in the light of substantial differences in factor endowments and country size between the Soviet Union on the one hand and the remaining CPEs on the other, substantial differences should be expected in trade structures. For an elaboration of basic features of a CPE, see Brown and Neuberger (1968), pp. 405-15.

was not random. The selection of Czechoslovakia is based on the belief that there is a considerable need to study the smaller CPEs, particularly those which are heavily dependent on foreign trade. Unfortunately, most empirical research until now has been concentrated on the Soviet Union whose trade dependence is substantially smaller in comparison to other CPEs and for which the access to data and the quality of data sometimes leave much to be desired.

In making the choice the following criteria were used. The countries under consideration should ideally be similar in terms of (i) factor endowments, (ii) income levels and (iii) size. Under these conditions, together with the assumption of similar consumption patterns, similarities in the pattern of relations among sectors must be due to similarity in technology (Chenery and Clark (1959), p. 202). Clearly, the observed pattern of production relations can be affected also by differences in factor and product prices, as we shall see later in the text, or by various methodological, statistical or institutional differences. However, if all the above four conditions are satisfied and similarities in production relations are found, the explanatory power of common technology becomes dominant in explaining the similarities since the methodological or institutional or price differences 'work against constant input structure'.[18] Hence, selecting comparable economies in terms of the above criteria should facilitate interpretation of the technological comparison of two countries whose institutions are so fundamentally different.

The countries selected, Czechoslovakia and Austria, are assumed to meet the first three of the above conditions most closely.[19] It would

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18. See Chenery and Watanabe (1958), pp. 487-521, especially p. 497 for more discussion of this point.

19. It has been argued that comparability of countries in terms of their social and historical background should be used as another yardstick. See, for example, Hanson (1971), pp. 327-43. The comparability of Czechoslovakia in this respect should be clear to readers familiar with the history of that area. Others may wish to refer, for example, to Drabek (1978).

be beyond the scope of this study to justify the individual assumptions but the relevant comparisons and adoption of these assumptions can be found in Nesvera (1971), Kosta, Kramer and Slama (1971), Pytel and Safar (1976), Hinke (1967), Kyn (1976).[20] Furthermore, we shall attempt to minimize the impact of whatever differences may remain by adopting suitable techniques of comparison. For example, the impact of factor endowments as well as income levels on comparisons of the industrial interdependence can be minimized by a choice of suitable techniques.[21] Clearly, absolute country comparability in terms of the above criteria would be ideal but, in practical work, it is hardly possible. This procedure is a complete contrast to international comparisons which typically refer to countries whose income levels and factor endowments are different.

The choice of Austria is particularly interesting since, in contrast to the centrally-planned economy of Czechoslovakia, Austria is a market-type economy with institutions and economic agents operating under competitive conditions. In this respect the two countries are fundamentally different in spite of all the similarities suggested above. Therefore, it should be interesting to see whether institutional differences can be associated with other systematic differences such as those in technology.

Finally, the choice of Austria was conditioned by the fact that classification of data for Czechoslovakia could be reconciled with that of Austria without further aggregation. The classification and aggregation problems will be discussed separately in Chapters I and II respectively.

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20. Czechoslovakia and Austria can also be regarded as a logical choice for such inter-country comparisons, along with only a few other examples including East and West Germany or North and South Vietnam.

21. For example, inter-industrial relations can be represented by a matrix of I-O coefficients. However, by using these coefficients rather than value of actual flows it is possible to eliminate the impact of different factor endowments and/or income levels. We shall return to this point later.

5. Definition of the natural resource factor and natural resource products

Given our preoccupation with NRP, one of our first tasks is to define NRP for the purpose of the empirical analysis. It would also be useful to 'work with' NRP which could be used as proxies for the natural resource (NR) factor. In fact, under certain assumptions it is possible to treat certain NRP as such proxies. Let us turn briefly to this issue first.

The productive services of NR enter directly into the value of commodities in two ways: they can be regarded as services rendered for their extraction or, alternatively, as services rendered for other (non-extractive) use. The extractive NR may, therefore, include both exhaustible and reproducible resources. On the other hand, non-extractive NR include, for example, land used as a construction site. In accordance with customary practice, the present emphasis will be entirely on extractive NR.

The omission of productive services of non-extractive NR has been justified by (a) the relatively small importance of 'space rent' entering into internationally traded products and (b) the absence from international trade of those activities in which the weight is relatively high (e.g., retailing), (Vanek (1959), p. 146). It is clear that, unless the relative rent components are substantially biased towards the 'space-rent', the two conditions are also valid for any CPE. There are very strong presumptions that no such bias existed in Czechoslovakia at that time as will be seen below.

Natural resources can be defined indirectly as natural resource products (NRP).[22] This assumes that changes in NRP are positively correlated with changes in the value of NR.

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22. For a detailed elaboration of problems arising from the definition, see Vanek (1959), pp. 147-51.

We can formulate the problem by using the following notation and the basic structure of Vanek's argument.

NRP	value of natural resource products
S	value of non-natural resource products
L	productive services of natural resources
T	productive services of factors other than natural resources

In order to evaluate the NR content of exports and imports by means of the NRP proxy Vanek assumes that the value of each commodity can be decomposed into two parts, namely the part imputable to the productive services of land, which is here assumed to be equivalent to our concept of natural resources (L), and that imputable to the productive services of other factors of production (T). This can be written as follows:

$$NRP = L_R + T_R \tag{1}$$

$$S = L_S + T_S \tag{2}$$

where subscripts R and S identify natural resource sector and non-natural resource sector respectively.

Now, using natural resource products as proxies for natural resources, NRP will be the better estimator of L the smaller T_r and L_S. In words, natural resource products will be the better estimator of natural resources, the smaller the share of the contribution of factors other than natural resources to the value of natural resource products and the share of the contribution of the natural resource factor to the value of commodities other than natural resource products.

In this respect, our I-O tables are not a good guide since, as will be seen later, intra-industry deliveries were netted out on the main diagonal.[23] As will be shown later, the NRP requirements per unit of output of NRP rank, consequently, in the bottom half of the scale in comparison with other industries. Nevertheless, it is safe to assume that NR per unit of output must be highest in sectors processing NR-based commodities. These would include our sectors to be identified under headings 101, 102 and 103, which include products of agriculture and forestry, coal, oil and natural gas and minerals respectively.[24] To these it is customary to add also food processing, as in the studies of Naya (1967) and Vanek (1959).[25] The NRP should contain a higher share of NR than non-NRP because NR enter into the latter only indirectly through NRP which themselves will contain some contribution of other production factors.[26]

In sum, using the above natural resource factor criterion, we are able to define and select among those intermediate inputs which will constitute our NRP. This procedure will restrict the analysis of intermediate and final demand to those commodities which are considerably more homogeneous and, therefore, meaningful in international comparisons than most other products. In particular, the output of natural resource industries (i.e. 'primary sectors') is usually less diversified than output of manufacturing industries (i.e. 'secondary sectors'). Thus, 'fuels' can be considered more homogeneous and, therefore, internationally more comparable than, for example, 'engineering products'. Similarly, with regard to 'agriculture products', 'mining products' and, quite likely, even processed food. In addition, and this is a problem of economies under

23. The methodology for constructing I-O tables for Czechoslovakia and Austria is discussed in Chapter I and in the Appendix.

24. The glossary of codes in the I-O tables can be found in the Appendix.

25. In the US 192-industry classification of the Bureau of Labour Statistics, Vanek's definition of NRP would include industries No. 1 through Nos. 20 and 36. Vanek (1959), p. 146.

26. For footnote 26 please see page 22.

central planning, manufactured commodities produced in CPEs are often of inferior quality while NRP (i.e. commodities produced at a low stage of processing) are not. As a consequence, the latter commodities are much more readily saleable in competitive markets.[27] Both of these problems would affect international comparisons as we shall see in more detail in Chapter II.

On the other hand, the NRP will not be used in this study to infer anything about the (efficiency of) use of natural resources as a factor of production. In contrast to the studies of Vanek (1959) and Naya (1967), the purpose of this study is not to evaluate the contributions of capital, labour and natural resources as factors of production in the determination of foreign trade flows. This also means that subject to a qualification further below, we do not need to be concerned about the implications of aggregating different NRP groups into one group called the 'natural-resource-factor', which a study of production factors would necessitate. In other words, this is an 'aggregation problem', which will be elaborated in Chapter II.

As indicated above we have identified four NRP sectors and, consequently, four groups of NRP intensive commodities. In most cases in our empirical analysis the product groups should and, indeed, will be treated in this disaggregated manner in spite of them having the common denominator of being 'natural resource intensive commodities'. Thus, the economic theory makes the distinction between 'exhaustible' and 'reproducible' resources [28]

26. According to our definition of NRP, sectors of agriculture (heading 101), fuels (102) and mining (103) will be included automatically and these will be supplemented by food processing sector (104) because of its high NRP input coefficient. But once this criterion is applied, it is clear that other sectors would also qualify (e.g. coal and petroleum processing). However, there is a strong presumption for believing that the food processing sector will contain a significantly higher share of NRP per unit of output than any other sector since intra-industry deliveries in agriculture are certainly much higher than, for example, those in mining.

27. The inferior quality of manufactured goods in CPEs compared with similar goods produced in the West has contributed to the emergence of 'hard' and 'soft' commodities in the CMEA market, i.e. commodities which are in excess demand and excess supply respectively. The problem is well documented, for example, in Ausch (1972).

28. There is a vast literature on the economics of exhaustible resources, including, for example, Stiglitz, Heal, Mirrlees, Malinvaud, Dasgupta, Enos, Solow, to name just a few examples of the more recent work which followed primarily on the original work of Hotelling. Solow (1974) outlines some of the essential points and provides a convenient starting point.

and the optimal rate at which exhaustible NRP are extracted in the natural resource sectors depends, *inter alia*, on factors which are specific to the industry and to countries. Comparisons of structure of production in general and of the rate of output of extractive industries in particular may be correspondingly affected.

Furthermore, economic theory makes the distinction between 'essential food' and other (NRP and non-NRP) consumer goods since the level of household consumption of food is disproportionately affected by the level of household income. In other words, a low level of income implies a high share of food in total consumer expenditure and vice versa. Hence, in seeking determinants of consumer demand, international comparisons should include countries with similar income levels and treat 'food' as a separate category in the total NRP group.

The intermediate demand for NRP depends on the level and pattern of economic activity. This means, however, that demand may be affected by different substitution processes and these may affect individual NRP differently. Consequently, it would not be desirable to treat all NRP as one group. Moreover, intermediate demand for NRP depends on the structure of industry which, in turn, may be affected by the level of development or commercial policies. Once again, a disaggregation of the NRP sector would be desirable. These issues will be discussed in Chapter II.

5. The plan of the study

This study is divided into six chapters. The following description of the study is presented in the context of a summary of the argument which establishes the link between individual chapters.

Chapter I is concerned entirely with various aspects of the data used. It includes a description of the methodology of the compilation of the two I-O tables to the extent that it was possible to obtain information from primary and secondary sources. It also examines the comparability of the tables and the adjustments needed to make both tables as comparable as possible. It may be useful to remind the reader that a review of the relevant literature will not be undertaken in the usual way, i.e. in the form of a separate chapter. Instead, in view of the number of issues to be treated, it was thought more appropriate to provide the relevant literature surveys as each issue comes up.

Chapter II discusses on the theoretical level various problems which pertain to international comparisons of production and use based on the I-O model. These include the concept of technology in the I-O framework, assumptions required in the I-O analysis, treatment of competitive and complementary imports and the general problem of aggregation.

The empirical analysis of NRP absorption in Czechoslovakia and Austria begins in Chapter III. We shall look first at NRP absorption through foreign trade by estimating NRP embodied in the total trade of both countries. The NRP content of foreign trade will be estimated by means of a traditional indicator, the 'Leontief statistic', which provides a measure of NRP embodied directly and indirectly in exports and import replacements. The calculations suggest that, in comparison to Austria, Czechoslovak imports were biased towards natural resource intensive commodities. Given this finding, it was found useful to estimate hypothetical claims on domestic output of NRP assuming complete autarky, i.e. complete replacement of NRP imports by domestic production. The chapter includes further discussion of the methodological problem of estimating NRP embodied in trade.

Assuming for the moment that relative NRP prices in both countries are identical, any differences in the composition of exports and imports must be due to differences in the total amount and pattern of domestic demand (and production) and technology. Therefore, Chapter III includes a comparison of final demand and technology in both countries. This takes the form of various tests of similarity of I-O coefficients.

Chapter IV follows up the discussion of the technological comparison between the two countries. The findings set out in Chapter III, which are based on the actual I-O coefficients, are subject to a problem of interpretation. Namely, they cannot be interpreted firmly because we have no measure which would distinguish between 'similar' and 'different' coefficients. Or, to put it differently, there is no unambiguous measure of the distance between matrices. It was decided, therefore, to carry out a further test of technological similarities between both countries. The test involved is the so-called matrix triangulation technique. The chapter also includes some further tests of similarity of I-O coefficients.

All the tests in Chapters III and IV are based on I-O data valued in current prices. Since price differences between the two countries may be suspected, it may be objected that such tests should not be carried out without a prior elimination of the impact of price differences. This procedure was contemplated but decided against on the following grounds. First, comparisons of the kind undertaken here are typically based on current values, which means that our approach enables easy comparability with other similar studies. Any treatment of price differences as an additional part of the comparison would seem unnecessarily to obscure the comparison at that stage. This is particularly due to the fact that any treatment of price differences among countries and their I-O tables involves further (and sometimes quite complex) methodological issues. Second, even though it is known that prices in the CPEs differ from those prevailing in MTEs, there is no evidence to suggest that NRP prices were systematically biased in one direction or another. While the prices of selected agricultural products are known to have been below world prices in the period under consideration,[29] such clear-cut evidence is not available for other NRP.[30] Moreover, the evidence was typically provided only for

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29. The evidence is provided, for example, in Plichta (1967), pp. 40-51.

30. There is, however, a considerable literature on other forms of irrationalities of the system of price formation for selected fuels and raw materials. See, for example, Safar and Vitvar (1968), pp. 31-9, Klouckova and Kloucek (1969), pp. 49-58, Hladik (1970), pp. 49-54, Hinke (1969), pp. 23-32, Jilek (1967), pp. 11-22.

selected commodities, an approach which does not allow reliable generalizations. Third, and perhaps most importantly, one aspect of the comparisons will be a study of the overall pattern of interdependence in both countries, a task which is rendered more meaningful by the comparison in value rather than in physical terms.[31]

An analysis of the impact of the 'price factor' on the technological comparison was attempted in the following way. In Chapter V the analysis is based on the application of RAS technique which under certain assumptions provides directly interpretable results. In addition, the effect of price differences will be minimised by the adoption of suitable techniques of I-O comparisons.

The purpose of the final chapter is both to provide a summary of the results of the study and to offer an economic interpretation of the findings. The results of our empirical comparisons depend on the treatment of various statistical and methodological issues and the extent to which these factors constrain or even affect our findings is evaluated. The economic interpretation has constraints of its own, namely the theoretical assumptions implicit in the I-O analysis. These assumptions will be taken explicitly into account. Ultimately, the most interesting question of this study is the extent to which the CPEs (i.e. Czechoslovakia in the present case) have been able to use efficiently fuels and other NRP which have become extremely scarce in the West and in

31. For more discussion of this argument, see Chenery and Watanabe (1958), reprinted in Chenergy and Clark (1959), pp. 201-21.

the CPEs themselves. Thus, it will be necessary to assess the impact of technical progress on these production processes which have to rely on NRP as major intermediate inputs. In view of the great need for empirical studies on this subject it is hoped that this study achieves a modest step in this direction.

CHAPTER I SOURCES AND DATA

Analysis of natural resource product (NRP) absorption in Czechoslovakia and Austria involves a comparison of the structure of production and use of commodities that will be based on a comparison of input-output (I-O) tables for these two countries. The purpose of this chapter is to provide a description of the design and construction of the I-O tables that will be used in the analysis.

In order to carry out the various calculations with the I-O tables of Czechoslovakia and Austria, it was necessary to make a number of adjustments to ensure comparability. In general, the comparability of I-O tables is dependent on treatment of the following methodological issues:

(i) aggregation of the I-O tables;

(ii) definitions;

(iii) valuation;

(iv) imports.

The following discussion of each of these issues concentrates on the description of specific features of methodology applied in the construction of each I-O table and of various adjustments. The adjustments were made in such a way as to conform as much as possible to the standardized methodoloy prepared by the Secretariat of the Economic Commission for Europe (ECE) of the United Nations (UN).[1]

The chapter is divided into six sections. Section 1 describes the basic sources available and justifies the selection of two I-O

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1. Most adjustments to the Czechoslovak I-O table were carried out by the Central Statistical Office in Prague, those relating to the Austrian table in the Institut für Wirtschaftsforschung in Vienna. In this chapter we shall concentrate only on those adjustments which were undertaken specifically for the purpose of this study. These were carried out jointly with the above Institut. Otherwise, the reader should refer to United Nations (1971).

tables chosen for this study. The remaining sections describe the main features of the tables as well as the adjustments required to ensure a high degree of comparability. Thus, Section 2 describes the aggregation of the tables while Section 3 deals with various definitions. Section 4 discusses an issue of cost valuation and Section 5 the treatment of taxes. Finally, the valuation of imports in each of these tables is the subject of Section 6.

1. Basic sources

At the time of writing this study the only year for which an I-O table was available for Czechoslovakia was 1962. In the case of Austria, no I-O table was compiled for that year but a table for 1964 is available. Even though the discussion focusses on a period about twenty years ago the analysis should be of more than just historical interest. For one thing, very little is known about the 1962 table for Czechoslovakia and the discussion in this chapter should be helpful to researchers in the field in the future. Perhaps, more importantly, however, the economic policy of Czechoslovakia in the early sixties has often been characterized as part of a 'highly centralistic model of planning', which was associated with a specific economic strategy[2] which has undergone several fundamental changes since that time.[3] Hence, the present analysis should enable an assessment of certain performance indicators under particular conditions of central planning.

The Austrian I-O table was derived from the original table compiled by the Österreichisches Institut für Wirtschaftsforschung,

2. The first fundamental changes in this respect took place in 1965. For a description of the elements of the economic strategy see Brown and Neuberger (1968), pp. 405-415.

3. See, for example, Goldman (1976).

published in 1973 under the title 'Input-Output Tabelle 1964'.[4] The 1962 data for the Czechoslovak I-O table were supplied by the Central Statistical Office directly to the ECE Secretariat which, in turn, published the table in its own study, 'Standardized Input-Output Tables for Years around 1959'.[5]

In addition to the UN version of the 1962 I-O table of Czechoslovakia, another version appeared in *Statistika* in 1966.[6] The table has several deficiencies and is not, therefore, strictly comparable with the UN version and hence with the table used in this study. First, the degree of aggregation is slightly smaller (25 as opposed to 18 sectors in the table used here). Second, the classification of industries is different to some extent (e.g. mining of non-fuel raw materials is included with ferrous and non-ferrous metallurgy). Third, entries in the I-O table do not make any distinction between domestic and imported supplies. Fourth, the description of the methodology is very limited. For example, it is not clear how imports were treated in the table, although it appears that they were included as supplies of domestic industries, but the pricing of imports as well as exports was not explained. Fifth, the second quadrant is similar to that used here in that it contains columns of private and public consumption and a column of investment.[7] However, other components of final demand are merged into a single column which may include such economically different magnitudes as those resulting from changes in stocks and from supplies for exports. Sixth, value added in the third quadrant is not disaggregated with only one separate row for wages (including remuneration of collective farmers). Seventh,

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4. See Österreichisches Statistisches Zentralamt (1973).

5. See United Nations (1971).

6. See *Statistika* (1966), Appendix.

7. The definition of quadrants is provided below.

the prices used in the *Statistika* version refer to producers' and purchasers' prices calculated on the basis of the industry method as opposed to the enterprise method used in this study.[8] Hence, the purchasers' prices in the *Statistika* version and producers' prices in the version used here differ on account of trade, transport and distribution mark-ups which are included in the former but excluded in the latter .[9] Finally, whether due to differences in pricing methodology or in the classification or definition of industries, the total resources in the *Statistika* version amount to 392,388.6 mn. Kčs valued in purchasers' prices and 324,239.9 mn. Kčs valued in producers' prices, while in the UN version they amount to 353,900.3 mn. Kčs.

Since the appearance of the 1962 tables Czechoslovakia has published three further I-O tables for later years, 1967, 1973 and 1977. When the tables first appeared in the Statistical Yearbooks they were incomplete and, with the exception of the 1967 table provided to the UN they have remained so.[10] Moreover, a great deal of information concerning, primarily, methodology used in the compilation of all these tables remains

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8. In the *Statistika* publication, purchasers prices are defined as follows: 'Prices accounted by the consumers for their own use. In the case of intermediate consumption of industrial products the prices are basically represented by wholesale prices of enterprises including trade, distribution and transport margins as well as turnover tax where applicable. In the case of private and social consumption, the prices are represented mostly by retail prices. Finally, in the case of investment, wholesale prices include trade, distribution and transport margins. Producers' prices are defined as prices used by the actual producers to account for the value of their production. They include basically wholesale prices at enterprise level excluding turnover tax in the case of industrial production, and procurement prices net of price interventions in the case of agricultural products'.

9. The inclusion of trade, transport and distribution mark-ups in producers' prices would be highly undesirable for our purposes. On the shortcomings arising from the application of purchasers' prices see Treml, *et al*. (1972), pp. 69-79.

10. The table can be found in United Nations (1977).

secret today.[11] However, it is known from a report of Korda and Smilková (1977) that the methodology used in the compilation of tables for the later years has changed and would render the tables incomparable with the 1962 table. It was, therefore, also for these reasons that it was not possible to incorporate the later tables into this study.

2. Aggregation

The degree of aggregation of the tables was dictated partly by availability of data and partly by requirements for consistency between both tables. The latter aspect was particularly pressing in view of differences in the system of national income accounting used by these countries, as we shall see later.

Our basic sources (referred to in the previous section) are 18x18 I-O tables of Czechoslovakia and Austria for 1962 and 1964 respectively. The Austrian I-O table was obtained by consolidating the original 54 sectors into 18 sectors. The I-O table for Czechoslovakia is known to have been consolidated for the purpose of the UN study from the original version which consisted of 96 sectors.[12]

In correspondence with the standardized ECE rules, the I-O tables were constructed in such a way as to distinguish between three separate parts, i.e. each table consists of three quadrants. The quadrants reflect three different classification criteria: the first quadrant represents inter-industry deliveries; the second quadrant provides information on commodity flows to individual components of final demand; and the third quadrant includes data on individual components of value added. The sum of each quadrant is, therefore, dependent on the degree

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11. The description of methodology in the Statistical Yearbooks covers barely half a page and the amount of information provided in official publications has been declining generally.

12. See Korda and Spilková (1977), p. 3.

of aggregation of each of the three corresponding systems of classification (classification of industrial sectors, components of final demand, components of value added).

According to the ECE industrial classification, the production sectors were disaggregated into 22 producing sectors and these are specified in Table I.1. Since the classification differs from those used more frequently in the literature, the table also provides a link between the I-O classification and International Standard Industrial Classification (ISIC). In the present study, sectors 120, 121 and 122 were excluded and separate adjustments had to be made for section 119 (to be described below) so that the I-O tables were eventually disaggregated into 18 industrial sectors.

The original Czechoslovak I-O table was compiled according to the ECE classification below and, with one exception, no further modifications were reported. The only exception was sector 119 (restaurants, hotels, cafes, laundries) which was excluded from the table and only the trade margin of restaurants was taken into consideration.[13] More specifically, the trade margin was included in sector 117 (trade).

The same adjustment with regard to sector 119 was made in the Austrian table. In addition, oil extraction in the Austrian table had to be estimated but the estimates proved to be satisfactory.[14] The estimation of value added of the oil extraction sector was subject to some difficulties which will be described below. The estimation was necessary since it was accounted incorrectly in 1964. Minor inconsistencies with the ECE rules

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13. Sector 119 was excluded because data were not available for Czechoslovakia since activities of restaurants, hotels, cafes and laundries are considered, according to Marxian terminology, as 'non-productive activities' and thus excluded from national income accounting.

14. This information was provided informally to the author by the compilers of the table at the Institut für Wirtschaftsforschung.

Table I.1 ECE classification by industry groups

	Industry group	Former ISIC group
101.	Agriculture,[a] forestry, hunting and fishing	Division 0, 212
102.	Coal mining, crude petroleum and natural gas	11, 13
103.	Mining and quarrying, excluding coal, petroleum and gas extraction	12, 14, 19
104.	Food, beverages[b] and tobacco manufacturing industries	20, 211, 213, 214
105.	Manufacture of textiles	23
106.	Manufacture of footwear, other wearing apparel and made-up textile goods; manufacture of leather and leather and fur products	24, 29
107.	Manufacture of wood and cork; manufacture of furniture and fixtures; manufacture of paper and paper products; printing, publishing and allied industries	25, 26, 27, 28
108.	Manufacture of rubber products	30
109.	Manufacture of chemicals and chemical products	31
110.	Manufacture of products of petroleum and coal	32
111.	Manufacture of non-metallic mineral products, except products of petroleum and coal	33
112.	Basic metal industries	34
113.	Manufacture of transport equipment	38
114.	Manufacture of electrical machinery, apparatus, appliances and supplies; manufacture of machinery, except electrical machinery; manufacture of metal goods, except machinery and transport equipment; manufacture of professional, scientific, measuring and controlling instruments; manufacture of photographic and optical goods; manufacture of watches and clocks; manufacture of jewellery and related articles; manufacture of musical instruments; manufacturing industries not elsewhere specified	35, 36, 37, 39
115.	Electricity, gas, water and sanitary services	Division 5
116.	Construction	Division 4
117.	Wholesale and retail trade, storage and warehousing	61, 72
118.	Transport and communications	71, 73
119.	Restaurants, cafes, hotels and laundries	852, 853, 854
120.	Ownership of dwellings	
121.	Banking, insurance and real estate, medical and health services, recreation and personal services (except restaurants, cafes, hotels and laundries)	62, 63, 64, 822, 84, 851, 855, 856
122.	Government services, community and business services (except where medical and health services	81, 82 less 822

Notes: (a) including wine industries (b) excluding wine industries

Source: Standardized input-output tables of ECE countries for years around 1959, United Nations (1971), p. 22.

concern production of cement which is included in sector 3 (mining and quarrying) and not in sector 11 (non-metallic mineral products). In addition, production of locomotives, ships and wagons which is included in the ISIC classification in sector 13 (transport equipment) is included in sector 14 (various engineering).

The second quadrant includes the following components of final demand: private consumption, public consumption, investment, exports and change of stocks. The third quadrant of value added includes depreciation, wages, indirect taxes minus subsidies and other components of value added.

3. Definitions

The main reason for the exclusion of some of the sectors from the ECE classification of industries is the difference in the systems of national income accounting in Czechoslovakia and Austria. The national income accounts in Czechoslovakia and in other CPEs are constructed according to the Material Product System (MPS) concept while national income accounting in the West corresponds to the Standard National Accounting (SNA) concept. The difference between these concepts lies in the treatment of the so-called non-material services which in the ECE classification include ownership of dwellings (120), banking, insurance, etc. (121), government services and business services (both 122), a major part of recreation services and an important part of personal services (both 121). All these sectors are excluded from the MPS concept of national income accounting. The exclusion of sector 119 (restaurants, cafes, hotels and laundries), with the exception of trade margins of restaurants, was for the same reason.

Thus, productive activities are defined in both tables according to the MPS concept which required a corresponding adjustment in the Austrian table. Unfortunately, this adjustment led to a loss of valuable information; the alternative would have been to try to obtain additional information on intermediate consumption and deliveries and value added in non-productive services in Czechoslovakia which, however, was not available. The adjustment took the form of treating value added of non-productive services in Austria as nil and their intermediate purchases were identified as purchases of final consumers (public consumption). In addition, deliveries of the service sectors to other sectors were included in 'other value added'.[15]

According to the estimates of Fay and Fink, the adjustment of the Austrian I-O table to the MPS concept had the consequences shown in Tables I.2 and I.3.

Table I.2 Share of individual components of final demand in total final demand

(percentages)

	Standard National Accounting	Material Product Accounting
Private consumption	51.50	51.10
Public consumption	10.66	7.08
Investment	21.34	23.61
Change of stocks	2.08	2.33
Exports	14.42	15.88
Total final demand	100.00	100.00

15. Fay and Fink (1976), pp. 11-12.

Table I.3 <u>Share of individual components of value added in total value added</u>

(percentages)

	Standard National Accounting	Material Product System
Depreciation	11.49	9.67
Wages	48.98	41.54
Other value added	39.53	48.79
Gross value added	100.00	100.00

Source: Fay and Fink (1976), pp. 11-12.

As far as the relative weights of individual components of final demand and value added are concerned (which are of direct relevance to this study), the effect of the adjustment is negligible. The only exception is the relatively significant reduction in the share of wages and the increase in the share of other value added in total value added.

The purpose of all the above adjustments was to make the national accounting systems conceptually identical. However, as a result of differences between domestic and so-called foreign exchange prices, there is also a difference in the definition of national income due to the presence of accounting profits generated by foreign trade enterprises. The profits are known as 'Special Earnings of Foreign Trade' (SEFT). This is a rather important issue which is specific to CPEs and since it is not well known it may be useful to elaborate.

Foreign trade in CPEs is conducted by specialized foreign trade agencies whose principal role is to separate the domestic economy from external influences. The Foreign Trade Enterprises (FTE) purchase commodities for export from producing enterprises at enterprise prices (i.e. excluding turnover tax) and sell imported commodities to domestic consumers at wholesale or retail prices (i.e. including turnover tax).

Their foreign exchange proceeds from exports and their foreign exchange payments for imports - converted at the official exchange rate - are recorded on a foreign trade account in foreign exchange prices. On the other hand, their settlement with domestic producers and consumers is recorded on a separate foreign trade account at domestic prices. Since the domestic prices may differ from foreign prices and, also, because FTEs purchase exports net of turnover tax and sell imports including turnover tax, they will usually realize an income which is often called Special Earnings of Foreign Trade (SEFT) or gross income of foreign trade.[16]

The existence of two external accounts has important implications in the inter-country comparability of I-O tables. First, national income accounting practice differs in CPEs from that in most other countries.[17] Second, national income aggregates as recorded in national income accounts in Czechoslovakia differ from those which can be derived from the second and third quadrant of the I-O table.

Thus, differences in national accounting in the CPEs arise additionally from the variant treatment of foreign trade.[18] In this respect, the Czechoslovak methodology is similar to that existing in the Soviet Union which has been described in Kostinsky and Treml (1976).[19] National income produced in Czechoslovakia, therefore, consists of national income generated

16. A detailed description of the general features of foreign trade pricing with reference to the Soviet Union can be found in Kostinsky and Treml (1976).

17. Reference has been made only to differences arising from the pricing methodology of foreign trade. In other words, both concepts are different even adjusting for differences in the treatment of the so-called non-material services and depreciation, i.e. the difference between SNA and MPS concepts which were discussed above.

18. On conceptual differences between national income accounts in the West and in Czechoslovakia see Krejčí (1968), pp. 309-25.

19. Kostinsky and Treml (1976), pp. 4-7.

in individual sectors of the domestic economy plus SEFT.[20] In addition, while a negative trade balance (imports > exports) is regarded in Western practice as net foreign disinvestment, the Soviet-type concept treats this balance as net foreign investment.[21] On the other hand, national income as it can be derived from the Czechoslovak I-O table differs from the national income aggregate as shown in national income accounts. The difference lies in the exclusion of SEFT in the I-O table so that value added in the trade sector where SEFT is actually realized includes only remuneration to domestic factors of production.[22] The exclusion of SEFT means therefore than the I-O aggregate disregards the portion of national income produced which is generated as a result of differences between domestic and world prices and as a result of the fact that FTEs purchase export commodities from domestic producers at prices excluding turnover tax and sell imports to domestic consumers at prices which include turnover tax.[23]

To return to the definitions, in general, the classification of industries can be defined by means of either products produced by individual I-O sectors ('commodity' definition) or main products (or production programmes) of the producing units ('industry' definition).

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20. The treatment of SEFT in national income accounts in CPEs has been compared by Holzman to the treatment of tariff revenues including other indirect taxes and subsidies in GNP accounts of capitalist countries; Holzman (1974b), pp. 317-30.

21. The rationale for reversing signs for exports and imports can be found in Holzman (1974a), Chapter 14, especially pp. 335-6. More detailed discussion of the difference is included in Kostinsky and Treml (1976), pp. 6-7. On the treatment of external transactions in East European national accounting, see Kaser (1961), pp. 161-2.

22. Kostinsky and Treml (1976), p. 7. Some aspects of Czechoslovak methodology concerning treatment of SEFT in the I-O tables are discussed in the Appendix.

23. The question of actual import valuation in the Czechoslovak I-O tables is discussed separately in Section 6.

The difference between the two definitions lies in the treatment of subsidiary production or production for use by the producing units themselves. The advantage of the 'commodity' definition is that it implies more homogeneous classification of I-O sectors but its problem is that the necessary data are only rarely available, and it is also not suitable in some specialized I-O applications as we shall see in Chapter V. In the present study, the classification used in the Austrian I-O table corresponds to the 'industry' concept with the exception of agriculture and forestry which were defined according to the commodity concept.[24] No official explanation was provided as to the classification used in the Czechoslovak I-O table. However, one Czechoslovak source indicated that the standard methodology in the construction of the 1962 I-O table was based on the commodity definition.[25] It is also known that in preparing the methodology, Czechoslovak economists decided to adopt the Soviet definition of industrial classification which is known to be derived from the commodity concept.[26]

We can now turn to definition of imports. The accounting of imports both in the Czechoslovak and in the Austrian I-O tables also closely followed ECE rules. This meant that imports were 'classified according to the kind of commodities produced in each industry group', rather than according to importing industries.[27] This, in turn, enabled construction of two versions of each I-O table.

Version A does not make a distinction between domestically produced and imported commodities since both are merged in each cell of the first

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24. Österreichisches Statistisches Zentralamt (1973), p. 23.

25. See Stratil, Dürer and Mokrášová (1970), p. 12.

26. This also implies that the classification is not uniform. See also Korda and Splíková (1977), p. 3.

27. United Nations (1971), p. 3.

and second quadrant. The sum of imported inputs of each industry and the imported components of final demand was not represented by a separate row in the third quadrant but introduced as a separate column in the second quadrant. In contrast to the treatment of domestic flows, imports are included in the main diagonal.

Version B, on the other hand, makes the explicit distinction between domestically produced commodities and imports. Thus, the first and second quadrants of the I-O tables show distribution of domestically produced commodities to individual industries and components of final demand and distribution of imports in a similar fashion. The sum of imported material inputs by respective industries and the sum of imports of each component of final demand are provided in an additional row. The third quadrant remains unchanged.[28]

The classification of imports by the kind of commodities produced in each industry was chosen in line with the aim of this study. The classification enables us to show total resources for each commodity group in the third quadrant and it is, therefore, more suitable for structural comparisons.[29] While the Czechoslovak I-O table was supplied to the ECE according to the above rules, the original Austrian table had to be adjusted.[30] No distinction between competitive and non-competitive imports was possible.

We have suggested in the Introduction that inter-industry flows can be affected not only by technological relations but also, inter alia, by (the pattern of) factor endowments and by foreign trade

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28. Since production structures can be affected by imports it is more useful to analyse total (i.e. domestic plus imported) supplies. For that purpose we shall use Version A. On the other hand, whenever we are interested in the role of imports in domestic production structure we use Version B.

29. United Nations (1971), p. 4.

30. Skolka (1974), p. 27.

interventions which, in turn, would affect international comparisons of inter-industry flows. This is due to the fact that inter-industry flows may include commodities which can only be imported (i.e. 'non-competitive imports'), or, on the other hand, the flows may include (only) output of domestic sectors operating behind protective barriers. In I-O analysis, an attempt is often made to allow for the impact of factor endowments and trade interventions by distinguishing between 'competitive' and 'non-competitive' imports.[31]

In a strict sense, the distinction between 'competitive' and 'non-competitive' imports is meaningless in the context of centrally-planned foreign trade, since commodity markets and competition have been virtually eliminated.[32] Nevertheless, it would still be useful to distinguish between commodities which we may call 'substitutable' and others which are 'complementary'. Such a distinction would be sensible for the purpose of our analysis which, as will become clear in the next chapter, assumes that all imports are 'substitutable'. Unfortunately, the distinction was not possible in the present study since data were not available.[33] Hence, in order to allow for the possibility that the inter-industry flows may be distorted by the presence of 'complementary' imports we shall undertake a 'sensitivity

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31. Whenever the separation of 'competitive' and 'non-competitive' imports is possible, the 'non-competitive' imports are then taken out of the first quadrant and accounted for elsewhere in the I-O system. The first quadrant then retains only domestic deliveries and 'competitive' imports.

32. Some degree of competition still exists in the consumer goods markets in which consumers are free to choose between domestically produced commodities and imports. Nevertheless, even in this case the function of the market is limited since the volume of imports is subject to direct controls.

33. A separation of competitive and non-competitive imports was attempted in an internal study of the Research Institute of Macroeconomic Planning in Prague. See Bernovský, Šoborová, Vilímková, Sehnal (1966), pp. 119-21. However, their study requires a much greater degree of disaggregation than the one used here. Furthermore, the authors do not provide any description of their methodology.

analysis' where the issue arises. This will entail a test of the impact of imports on the outcome of the relevant comparisons.

The basic statistical unit used for the purpose of output calculation in the case of Austria was establishment.[34] No special arrangement in comparison to the ECE rules was reported in the Czechoslovak practice, and, consequently, enterprise as the basic statistical unit in Czechoslovakia was assumed.[35] This assumption was later confirmed in a Czechoslovak study.[36] On the other hand, the methodology has been clarified recently and minor modifications were suggested. The output in various industrial sectors was obtained by means of the so-called enterprise method (method of gross output); output of agriculture, forestry and construction was obtained by means of the 'branch method' (method of gross turnover); and in the distribution sector output was calculated by means of the value added concept.[37]

Thus, there are two minor inconsistencies involved in the comparison of the Austrian and Czechoslovak I-O tables. First, within each I-O table, the methodology applied in the construction of the tables was not uniform for all sectors although a uniform methodology was applied in the majority of cases. Second, the basic statistical units differ between Czechoslovakia and Austria.

Various difficulties often arise in I-O analysis in the context of international comparisons of production structures from differences in vertical integration which, in turn, affect intra-industry deliveries (i.e. elements lying on the main diagonal in the first quadrant of

34. Österreichisches Statistisches Zentralamt (1973), p. 18; Skolka (1974), p. 23; Fay and Fink (1976), p. 23.

35. United Nations (1971), p. 3.

36. Stratil, Dürer, Mokrášová (1970), p. 12.

37. Korda and Spilková (1977), p. 3.

I-O tables). Thus, in order to minimize ambiguities resulting from different degrees of vertical integration of production units in individual sectors, domestic intra-industry deliveries were not included so that the main diagonal of domestic intra-industry flows consists of zeros. However, imports in the main diagonal were considered as intermediate inputs and as part of total resources.[38]

4. Valuation of costs

The Austrian I-O table is valued in terms of market prices.[39] Since the use of market prices further enables a choice between 'producers' prices and 'purchasers' prices,[40] a decision had to be made and 'producers' prices were chosen.[41] This means that the prices include ex-factory prices plus indirect taxes minus subsidies, and they exclude trade and transport costs.

The prices used in the Czechoslovak I-O table are the so-called production prices which correspond conceptually to the prices in the Austrian table. The same methodology of valuation was applied in the study already quoted,[42] while another Czechoslovak study used purchasers' prices as the basis.[43]

However, conceptual consistency in the method of valuation does not guarantee that prices in different countries are identical. The price structure may differ between countries due to three main distorting factors: general economic organization, fiscal system and income distribution. We shall discuss the fiscal issue in some detail in the next section and here we shall confine ourselves to the remaining

38. See United Nations (1971), p. 3.

39. Österreichisches Statistiches Zentralamt (1973), p. 12.

40. Skolka (1974), p. 20.

41. Fay and Fink (1976), p. 23.

42. Korda and Spilková (1977), Special Appendix, pp. 6, 7.

43. Berka and Žváček (1969), p. 22.

two factors.[44]

In general, differences in general economic organization and income distribution are reflected in differences in the methods of price formation and cost accounting. In the case of Czechoslovakia before the economic reform of the mid-1960s, the price formation and cost accounting practices were modelled on the principles of Soviet price policy.[45] This meant that, in the absence of a price-generating market mechanism, (accounting) prices were broadly determined by average direct-plus-indirect labour costs prevailing in a particular branch of production. Indirect labour costs reflected essentially one element: embodied labour content in material input and capital employed in each branch of production. The contribution of other production factors was omitted; thus, in contrast to normal principles of cost accounting in MTEs, prices excluded interest and rent charges. The only element of capital costs included as part of the price formation was depreciation charges.

Moreover, while the allocative function of product prices was limited mainly to the consumer goods market,[46] other functions of prices have been retained if not strengthened. In particular, it is known that in some cases prices have been used as instruments of income distribution. As a result, some prices have been set artificially low even to the extent that certain enterprises had an exceptionally low operating surplus

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44. A general discussion of all these issues is also provided in United Nations (1971), pp. 6-8.

45. For a detailed assessment of Soviet price theory and policy in that period see Bornstein (1970).

46. There is a dispute in the literature as to the role of producers' prices. Briefly, the argument is about whether producers' prices perform any allocative function. On the one hand, it has usually been argued that markets have been virtually eliminated in the CPEs with the exception of markets for consumer goods and the labour market. See, for example, Portes (1974), p. 5. On the other hand, Wiles (1962), Bornstein (1970), Holzman (1955), Berliner (1976) suggest that producers' prices have retained some degree of allocative function.

which, in turn, distorts both gross value of output and value added. Clearly, all these factors make the method of price formation in Czechoslovakia different from that of Austria. Unfortunately, we have no information about the specific adjustments required to make both price structures comparable. Therefore, the method suggested in the text below is an attempt to compare internationally demand for intermediate inputs without adjustments of the actual I-O tables for any price differences.

5. Taxes

The system of indirect taxes in Austria was based in 1964 on the so-called 'Ausgleichsteuer' which was replaced in 1973 by Value Added Tax. In addition, prices of imports of oil products include an additional indirect tax ('Mineralölsteuer') and prices of alcoholic beverages and tobacco include a separate indirect tax.

In Czechoslovakia, the indirect tax used has been known as turnover tax. This is usually compared with the sales tax in market economies; it represents a budgetary charge against sales income based on the volume of sales rather than on the volume of employment of any particular factor. The method by means of which the tax is levied may be quite different in comparison to MTEs. In addition, it differs from a sales tax in another important respect: it is not the price determining factor to the same extent as it is in MTEs since prices are on the whole fixed by the state.

The inclusion of indirect taxes has the two following effects on the flows recorded in the I-O table. First, the relative prices imputable to the I-O table will differ from those calculated on the basis of the factor cost method. Consequently, the distribution of supplies across the rows and the cost and expenditure structure in columns will be disproportional.

Second, observed sales values across the rows and production costs in columns are inflated directly by the values of indirect taxes. For these reasons, it may be desirable to reconstruct the I-O tables by means of factor cost prices, as was done for the Soviet I-O table.[47]

It should also be noted that, in addition to direct effects, the turnover taxes induce value inflation of I-O flows indirectly. This was clearly demonstrated by Rosefielde in reconstructing the same I-O table for the Soviet Union.[48]

The direct value-inflation effect can be shown as follows. Assuming a perfectly competitive and stable economy with individual producing sectors being subject to constant returns to scale, consider a three sector economy represented by a production matrix X and final demand vector y, where[49]

$$X = \begin{pmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{pmatrix} \quad \text{exclusive of final sales}$$

$$y = \begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} \qquad (1)$$

Now, a levy of single differentiated tax defined by the diagonal $(\hat{\Lambda})$ matrix, where $\hat{\Lambda} = \text{diag}\ (\lambda_1, \lambda_2, \lambda_3)$, will directly inflate the matrix of inter-industry flows (X) in proportion to the tax $(\hat{\Lambda})$. Defining further the diagonal $(I + \hat{\Lambda})$ matrix, where (I) is the identity matrix we have, therefore,

47. See Treml, *et al.* (1973).

48. See Rosefielde (1975) and (1974b). The indirect effect is known as the 'cascade' system. For details, see United Nations (1971), p. 7.

49. While we preserved Rosefielde's methodology, his notation is slightly altered in order to avoid confusion in the text below.

$$'X = (I + \hat{\Lambda}) \quad X = \begin{pmatrix} 1+\lambda_1 & & \\ & 1+\lambda_2 & \\ & & 1+\lambda_3 \end{pmatrix} \begin{pmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{pmatrix} \qquad (2)$$

$$= \begin{pmatrix} (1+\lambda_1)X_{11} & (1+\lambda_1)X_{12} & (1+\lambda_1)X_{13} \\ (1+\lambda_2)X_{21} & (1+\lambda_2)X_{22} & (1+\lambda_2)X_{23} \\ (1+\lambda_3)X_{31} & (1+\lambda_3)X_{32} & (1+\lambda_3)X_{33} \end{pmatrix}$$

As can be seen from equation (2), the (i,j)th element in the matrix of sectoral sales is increased by $\lambda_i X_{ij}$ (i,j = 1, 2, 3).

To this, we must add a 'separately' inflated portion of sales as a result of inflated inputs. While inflated sales by turnover taxes can be simultaneously considered as purchases by other industries it may seem unnecessary to include input-induced inflation of sales. However, since industries' inputs valued at prices inclusive of turnover tax (where applicable) are considered in the centrally planned practice as prime costs, they are passed on in the price of industries' final products.[50] The tax is not, therefore, deducted and, *pari passu*, the value – inflation through inflated inputs is 'double counted' together with inflated value of sales as it would not be if taxes were deductible. Thus, the cost inflation effect on the output of sector $j(\theta_j^1)$ attributed to direct turnover tax levied on each j-th sector's i-th input is defined as:

$$\theta_j^1 = \sum_{i=1}^{3} \lambda_i X_{ij} \qquad (3)$$

Using equation (3), let us define the diagonal $(\hat{\theta}^1)$ matrix

50. The wholesale price system can be conveniently divided between enterprise and industry price, where the former excludes and the latter includes turnover taxes. In most cases, prices applied to inter-industry transactions refer to industry prices. Foreign trade enterprises, on the other hand, purchase commodities from producing enterprises at prices which exclude turnover taxes. More discussion on foreign trade pricing can be found below.

$$\hat{\theta}^1 = \begin{bmatrix} \theta_1{}^1 & & \\ & \theta_2{}^1 & \\ & & \theta_3{}^1 \end{bmatrix} \qquad (4)$$

The matrix (4) can be useful to formulate the value-inflation of output induced by inflated inputs representing the indirect effects of turnover tax . The indirect effects of turnover tax are dependent on the size of value-inflation of inputs and on the level of pre-tax sales. The distribution of input-induced value-inflation of output across the rows is, therefore, dependent on the share of sales to individual components of inter-industry use and to final demand.

Let c_{ij} represent the proportion of the pretax sale of aggregate commodity i to activity j in total pretax sale of commodity i (defined as X_i) - that is, $c_{ij} = X_{ij}/X_i$. Then

$$^2X = (\hat{\theta}^1)C = \begin{bmatrix} \theta_1^1 & & \\ & \theta_2^1 & \\ & & \theta_3^1 \end{bmatrix} \begin{bmatrix} C_{11} & C_{12} & C_{13} & C_{14} \\ C_{21} & C_{22} & C_{23} & C_{24} \\ C_{31} & C_{32} & C_{33} & C_{34} \end{bmatrix} \qquad (5)$$

where C_{i4} is the i-th element in the column of final demand.[51]

or write that

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51. The distribution of input-induced value-inflation is also dependent on the distribution of tax costs. It must, therefore, be assumed that the tax costs are distributed proportionately to all purchasers.

$$C = ({}^{1}C \vdots c_4)$$

and

$$^{3}X = (\hat{\theta}^{1})\,{}^{1}C = \begin{pmatrix} \theta_1^1 c_{11} & \theta_1^1 c_{12} & \theta_1^1 c_{13} \\ \theta_2^1 c_{21} & \theta_2^1 c_{22} & \theta_2^1 c_{23} \\ \theta_3^1 c_{31} & \theta_3^1 c_{32} & \theta_3^1 c_{33} \end{pmatrix} = \begin{pmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \\ w_{31} & w_{32} & w_{33} \end{pmatrix} \qquad (5.1)$$

Also, let $(\hat{\theta}^{1})c_4 = \begin{pmatrix} w_{14} \\ w_{24} \\ w_{34} \end{pmatrix}$

The total value-inflation effect of turnover tax (direct plus indirect) on output equals ^{1}X in equation (2), including sales for final demand y plus ^{2}X given by equation (5).

Indirect tax effects may go even further. First, if the turnover tax rates are set not only on direct but also on indirect costs which themselves include turnover tax, as seems to be the case in the Soviet Union,[52] the indirect effects are cumulative. In Rosefielde's words, we obtain a tax-on-tax value-inflation effect. Second, the indirect value-inflation effect

52. Bornstein (1970), p. 109.

of turnover tax does not terminate in the stage characterized by equation (5). The effect is again cumulative and could be represented by a number of iterative steps. In general, the indirect effect of turnover tax leads to value-inflation pyramiding. Thus it is clear that an inter-country comparison would be greatly improved if the value-inflation effects and disproportionality effects of indirect taxes could be eliminated through a conversion of I-O tables to a factor-cost-base.[53]

6. Valuation of imports

The prices of imports in the Austrian I-O tables include import prices at cif values plus import duties plus indirect taxes. The advantage of using this method of import pricing is that import prices correspond conceptually to the method of pricing domestic deliveries. Transport and trade charges on deliveries of imports are, therefore, excluded and they were accounted in the following way. Gross output of the trade sector was represented only by trade margins in the relevant row of the I-O table and distributed as inputs to various users. A similar procedure was applied to transport charges.[54] The accounting of trade and transport charges to final users was done in a similar way[55] and the procedure, therefore, guaranteed a high degree of conformity with the ECE rules.[56]

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53. Unfortunately, a direct comparison of prices used in the construction of both I-O tables is not possible because the price vectors are not available. What we can do, however, is to analyze the effects of the pricing methodology applied in the construction of the Czechoslovak I-O table on the I-O coefficients. For this, we can utilize information on the alternative version of the Czechoslovak I-O table as it appeared in *Statistika* (1966) which enables us to estimate the broad structure of the turnover tax. The results of our estimation of the turnover tax structure are reported in the Appendix.

54. Fay and Fink (1976), p. 23.

55. Skolka (1974), p. 20.

56. United Nations (1971), p. 16.

The accounting of imports in the Czechoslovak I-O table is more problematic due to the presence of the distorted exchange rate. Because of this the application of the official exchange rate does not lead to the equalization of import values in official parity terms to those in terms of domestic prices. In practical terms, the authors of the I-O table had two options. (1) They could account the value of imports in corresponding domestic prices. (2) Alternatively, they could account imports in official parity terms but since this procedure would lead to the generation of artificial profits (or losses) resulting from differences between foreign and domestic prices, the residual would have to be accounted for. This is usually done by distributing foreign trade profits in the 'trade' row. It is known that both methods were attempted in the original construction.[57]

There are indications, however, that the first method was chosen in the version reported to the ECE, i.e. that competitive (i.e. 'substitutable') imports were valued at corresponding domestic prices while only non-competitive ('complementary') imports were valued at parity prices. First, this method was used in other studies which were based on the 1962 I-O table[58] and there is some evidence that it was also favoured by the authors of the original I-O table.[59] Second, foreign trade returns in Czechoslovakia are usually provided in terms of foreign exchange crowns and they can be used as a check on trade data in the I-O table. Thus, according to the official trade returns, the total imports and exports in Czechoslovakia in 1962 were (in mn. foreign exchange crowns) 14,904 and 15,793 respectively.[60] The corresponding totals in the I-O table were 31,499 and 33,776 respectively (in mn. kčs). Although some differences in coverage are possible, due to the various adjustments required for the

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57. Bernovský *et al.* (1966), Part I, pp. 38, 65.

58. Berka and Žváček (1969), p. 22; Bernovský and Plchová (1969), p. 14. This methodology was also confirmed by one of the Czechoslovak experts in an unofficial communication with the Secretariat of the Economic Commission for Europe of the United Nations.

59. Bernovský and Popelka (1962), p. 14

60. ~~Research Institute of~~ Social and Economic Information (1975), p. 45.

I-O table, the difference between the I-O version and the official data lies mainly in the overvalued exchange rate of Czechoslovak currency. According to one estimate, the degree of overvaluation of the official exchange rate in 1968 was 2.29 with respect to the Soviet rouble and 4.35 with respect to the US dollar.[61] Allowing for the time difference between 1962 and 1968 and considering that in 1962 the share of the USSR in Czechoslovak trade was about 38 per cent (the share of the socialist countries was about 74 per cent), the application of the more realistic rouble-kčs rate leads to a highly consistent finding, i.e. after the revaluation of imports the relevant total is 34,130 mn. kčs. Third, the first official indication of the value of trade aggregates expressed in terms of both foreign exchange and domestic crowns was published in 1968 in social product and national income statistics. For example, the value of imports in domestic prices in 1968 was reported as 59,021 mn. kčs.[62] In contrast, the value of imports in foreign exchange crowns was 22,155 mn. in the same year.[63] Again, the trade data in our I-O table are roughly consistent with the reported returns expressed in domestic prices after allowing for the increase in trade between 1962 and 1968. The growth of imports in that period expressed in foreign exchange crowns was 48.7 per cent and that expressed in domestic currency was 87.4 per cent. The resulting discrepancy is likely to be caused by the differences in coverage of trade and mainly by the increase in domestic prices.

The use of domestic prices for competitive imports in the Czechoslovak I-O table and the inclusion of tariffs and indirect taxes in import prices in the Austrian I-O table imply that both procedures are conceptually similar, i.e. both correspond to the concept of producers' prices. Had the

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61. Košnár (1970), p. 692.

62. Krejčí (1974), p. 599.

63. Research Institute of Social and Economic Information (1975), p. 45.

imports in the Czechoslovak I-O table been valued at parity prices, it would have been more suitable to adjust the import prices in Austria purely to the cif concept (i.e. excluding tariffs and indirect taxes) as was done in the I-O comparison of Austria and Hungary.[64] This would have required that tariff and indirect taxes be accounted in the same way as trade margins and increase simultaneously the 'other value added' component of the trade sector. As a result of this adjustment, the total amount of 'other value added' in Austria would have increased by 9.55 per cent, total value added by 4.55 per cent while the value of imports would have fallen by 14.75 per cent.[65]

Finally, other minor inconsistencies in the pricing methodology may arise from the selection of domestic prices and from the treatment of customs duties.[66] With respect to the selection of domestic prices, the central planners often provide incentives to enterprises producing for export to increase the competitiveness of their products (to improve quality, technical parameters, etc.) by offering higher domestic prices as compared to the existing wholesale prices. Domestic prices of imported goods may also be found to differ from those of comparable domestic products.

The role of customs duties under central planning differs from that in market economies and the planners rely on more direct measures to control export and import flows. Nevertheless; customs duties are applied in Czechoslovakia and both their rates and their coverage of commodities were more significant until 1964 when customs duties on imports of all primary commodities and some semi-manufactures were

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64. Fay and Fink (1976), p. 24.

65. ibid., p. 25.

66. Kostinsky and Treml (1976), pp. 3-4.

abolished or reduced bilaterally.[67] Their treatment in the I-O table is not clear but it is thought that, in contrast to Western practice, they are not passed on in the final price to domestic consumers.[68]

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67. Further reduction of tariffs followed in later years, for example, in 1968 as a result of the Kennedy Round negotiations. See Pravda, Nováček, Venera (1970), p. 42.

68. Kostinsky and Treml (1976), p. 4.

CHAPTER II METHODOLOGICAL ISSUES RELATING TO TECHNOLOGICAL COMPARISONS OF THE INPUT-OUTPUT SYSTEM

Introduction

The comparison of NRP absorption in production processes or, for that matter, absorption of any material input is done in the I-O model with the help of a matrix of inter-industrial deliveries known as the technological matrix (A).[1] As we shall see later in more detail, these matrices represent deliveries of material (i.e. intermediate) inputs to sectors which need these inputs in the production of commodities. Thus, by entering into the processes of these industries, the inputs become a part of the 'technology' of producing given commodities. However, various factors may affect the actual inter-industry flows and it would be quite naive to argue that the A-matrices reflect technological relations only and nothing else. Thus, the purpose of this chapter is to define the notion of 'technology' in the 'ideal' I-O system and to discuss the correspondence between the theoretical notion of technology and its representation in the I-O system.

As indicated in Chapter I, the deficiences of I-O tables may be due to (i) aggregation, (ii) definitions, (iii) valuation and (iv) treatment of imports. In order to reduce the real world into measurable proportions the I-O tables have to be aggregated. This involves grouping either individual commodities into commodity groups defined by a particular physical characteristic (the so-called 'commodity definition' of the productive system) or individual establishments or enterprises into

1. The matrix will be introduced in the next section and it will be identified with the symbol A. The comparison of NRP absorption by final consumers which will be explained in Chapter III can be done either directly by comparing the relevant segments of I-O tables or with the help of the A-matrix. Due to space limitations, the present discussion will concentrate on issues connected with the A-matrix but the discussion is also relevant for comparisons of final demand.

industries (the so-called 'industry definition' of the productive system). The comparability of the I-O system depends, therefore, on the definition and coverage of product groups or producing units. As we shall see later, further problems of definition may arise due to the 'coverage' of the productive system which may vary from country to country.

Clearly, an important factor affecting international comparisons of I-O tables is the price system used in the valuation of I-O flows. Yet product prices may differ among countries due to the existence of indirect taxes or subsidies to product prices (including various trade interventions), or due to differences in factor prices. The role of prices in the international comparison of NRP absorption will be dealt with later in this chapter.

Imports may affect interpretations of I-O analysis both through their impact on the quality of the data and, since imports can perform different functions in the economy, through limitations of I-O techniques. The latter aspect will be discussed below. As far as the impact of imports on the quality of data is concerned, the problems involved may include difficulties arising from valuation of imports in the presence of disequilibrium exchange rates, and the classification of imports (and, consequently, their treatment in the I-O accounting scheme) according to the kind of commodities produced in each industry or by importing industries.[2]

The chapter is divided into the following sections. We shall start with a description of the main elements of the I-O model in Section 2. The concept of technology will be defined in Section 3. In Section 4 we shall discuss various data problems which may affect international comparisons of this kind and introduce assumptions concerning the quality of the data in order to obtain 'unbiased' comparisons. The specific

2. For more details and an assessment of each method see United Nations (1971), pp. 3-4.

treatment of 'competitive' and 'complementary' commodities in the I-O system is discussed in Section 5 and the so-called aggregation problem is discussed in Section 6. Methodological issues dealing with the price circuit in the I-O model and the concept of 'similarity' are discussed in Section 7. But first we shall introduce our notation.

1. Notation (Variables, parameters, constants)

Throughout this study we shall use the following notation which corresponds as closely as possible to the notation used most frequently in the literature. For clarity, the symbols are arranged in alphabetical order.

${}_{d}a_{ij}$	input-output coefficient of domestic transactions in value terms
${}_{m}a_{ij}$	input-output coefficient of imported transactions in value terms
a_{ij}, $\bar{a}_{ij}$	input-output coefficient of total transactions in value terms and physical terms respectively
${}_{2}a_{ij}$	input requirement of the i-th commodity per unit of total intermediate inputs in industry j
ε_i	share of commodity i in total exports in value terms
E_i	total exports of the i-th commodity in value terms
EX	value of total exports
g_j	total value added requirements of final use j
IM	value of total imports
μ_i	share of commodity i in total imports in value terms
M_{ij}	imports of the i-th commodity delivered to the j-th sector in value terms
M_i	total imports of the i-th commodity in value terms
L_x	productive services of natural resources directly embodied in NRP exports
L_m	productive services of natural resources directly embodied in NRP impor[illegible]

p_i unit price of output of the i-th sector

w_i unit wage costs of sector i

W_i total wage bill of sector i

${}_dX_{ij}$ domestic output of the i-th sector supplied to the j-th sector in value terms

${}_dX_i$ total domestic output of the i-th sector in value terms

X_{ij}, $\bar{X}_{ij}$ total output of the i-th sector supplied to the j-th sector in value terms and physical terms respectively

X_i, $\bar{X}_i$ total output of the i-th sector in value terms and physical terms respectively

$x_i^{e,m}$ value of direct and indirect gross output requirements of the i-th sector for exports (e) and import replacements (m) in absolute terms

${}_dY_i$ domestic output of the i-th sector to final demand in value terms

${}_mY_i$ imports of the i-th commodity purchased by final consumers

Y_i, $\bar{Y}_i$ total delivery of the i-th sector to final demand in value terms and physical terms respectively

Z_i total non-wage value added of sector i

z_i unit non-wage components of value added of sector i

α, β, γ 'proportionality' constants

σ Leontief statistic

Ω_1 ratio of direct Leontief statistics

Ω_2 ratio of indirect Leontief statistics

Ω_3 ratio of full Leontief statistics

<u>Notation</u> (Vectors)

${}_1a$, ${}_1\bar{a}$	vector of NRP input requirements per unit of output in value terms and in physical terms respectively
e	vector of exports in value terms; $e = (E_1, E_2, \ldots, E_n)$
${}_1e$	vector of final demand for outputs of industries
${}_f f$, ${}_f\bar{f}$	coefficient vector of final demand for products of industries in value an physical terms respectively
f	coefficient vector of final demand for products of industries in value terms
g^*, h^*	'weights' vectors
g	vector of primary inputs into industries
m	vector of imports in value terms; $m = (M_1, M_2, \ldots, M_n)$
${}_1m$	vector of outputs of industries in value terms
r	vector of "substitution" multipliers
s	vector of "fabrication" multipliers
p	vector of prices
q	vector of industry outputs
t	vector of primary inputs into commodities
t^t	coefficient vector of primary inputs into commodities
u	vector of total intermediate output
v	vector of total intermediate inputs
w	vector of wage bills
$\bar{w}$	vector of wage costs coefficients
${}_d x$	vector of domestic gross output in value terms
${}_d^a x$, ${}_d^{ar} x$	vectors of domestic gross output in value and relative terms respectively under hypothetical autarky

$x, \bar{x}$ vector of total output in value terms and in physical terms respectively ('commodity outputs')

$_{x}x$ coefficient vector of gross output

$y, \bar{y}$ vector of total supplies to final demand in value terms and in physical terms respectively ('commodity outputs')

$_{1}y$ vector of consumer expenditures of private consumers in value terms

$_{2}y$ vector of income

$_{y}y, _{y}\bar{y}$ coefficient vector of final demand for commodities in value and physical terms respectively

$_{d}y$ vector of domestic deliveries to final demand

$_{m}y$ vector of imports to final demand in value terms

z vector of non-wage value added

$\bar{z}$ vector of coefficients of non-wage value added

Notation (matrices)

$A, \bar{A}$ matrix of input-output coefficients in value terms and in physical terms respectively ('commodity × commodity' coefficient matrix)

$_{d}A$ matrix of input-output coefficients of domestic transactions in value terms

$_{m}A$ matrix of input-output coefficients of imported commodities in value terms

$B = (I - A)^{-1}$ inverse matrix

$C, \bar{C}$ matrix of distribution coefficients in value terms and physical terms respectively

D matrix of coefficients relating to purchases of commodities by industries in value terms

E industry × industry coefficient matrix

${}_{y}Y$ coefficient matrix of final demand (commodities), ${}_{y}Y = ({}_{y}y_{ij})$

G 'grouping' matrix

H 'weights' matrix

$I = I_{nn}$ n × n identity matrix

K, $\bar{K}$ matrix of capital stock in value terms and in physical terms respectively

M 'make' matrix

S 'absorption' matrix

U 'Product-mix' matrix

V 'market share' matrix

X, $\bar{X}$ input-output flow matrix in value terms and in physical terms respectively ('commodity × commodity' matrix)

${}_{d}X$ flow matrix of domestic intermediate deliveries

Y matrix of final demand in value terms

Z industry × industry flow matrix

2. Elements of the input-output model

The relevant part of the Leontief system[3] for commodities is as follows. Let us consider the typical i-th industry and assume input requirements are directly proportional to the amount of output produced

3. The general equilibrium framework of the Leontief system includes, of course, a treatment of primary factors and determination of prices and wages. What is included in the text here is only the one aspect of the system which is relevant for our inter-country comparison. For more details, see, for example, Balderson (1954).

by the industry which absorbs the input. Thus, we can first define the input-output (technological) coefficient a_{ij},

$$a_{ij} = X_{ij}/X_j \qquad (i, j = 1, 2, \ldots, n) \tag{1}$$

where a_{ij} is the coefficient of the i-th input required to produce one unit of the j-th commodity. The total amount of the i-th input required to produce the amount X_j of the j-th commodity is, therefore, $a_{ij}X_j (=X_{ij})$. Summing over all industries j and final demand y, we can write for the i-th indust

$$X_i = X_{i1} + X_{i2} + \ldots + X_{in} + Y_i \tag{2}$$

or

$$X_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{in}X_n + Y_i \tag{3}$$

or

$$-a_{i1}X_1 - a_{i2}X_2 + \ldots + (1 - a_{ii})X_i - \ldots -a_{in}X_n = Y_i \tag{4}$$

where n stands for the number of commodities (industries). There will be, therefore, n equations of the type formulated in equation (4). Equation (4) can be rewritten using matrix form as

$$\begin{bmatrix} 1-a_{11} & -a_{12} & \ldots -a_{1n} \\ -a_{21} & 1-a_{22} & \ldots -a_{2n} \\ & & \\ -a_{n1} & \ldots & 1-a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \\ X_n \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ \\ Y_n \end{bmatrix} . \tag{5}$$

or

$$(I - A)\ x = y; \qquad A = (a_{ij}) \tag{6}$$

4. At the moment we are using the terms 'commodity' and 'industry' interchangably and assume, therefore, that there exists a one-to-one relationship between both. Strictly speaking, we should also adopt the assumptions of 'identity of product and industry' and 'product homogeneity' which are explained below.

or

$$x = Ax + y \qquad (7)$$

which is the well known Leontief equation. Once the technology matrix A is known and the vector of final demand (y) is given exogenously, it is possible to solve this system of equations for the unknown level of output (x), so that

$$x = (I - A)^{-1} y \qquad (7.1)$$

Expanding the inverse using the expression of $(I - A)^{-1}$ as a power series, we obtain

$$x = (I + A + A^2 + \ldots)\, y \qquad (7.2)$$

This can be written as

$$x = \left(\sum_{t=0}^{\infty} A^t\right) y \qquad (7.3)$$

In general, the solution will exist provided the matrix (I - A) (the so-called 'matrix multiplier') is non-singular. In economics, one considers only those technological matrices A which are non-negative, i.e. matrices with every element $a_{ij} \geq 0$. This restriction constrains further the solution of the Leontief systems and there will be a number of alternative necessary and sufficient conditions for the existence of a non-negative solution.[5] It is the above matrix A or, alternatively, the matrix $(I - A)^{-1}$

5. It would be beyond the scope of this study to discuss the mathematical properties of the Leontief model but it may be useful to summarize the conditions which are well known in the I-O literature. The conditions which are all equivalent are as follows:
   (i) The vector x will have a non-negative solution if, in the expression $x = \left(\sum_{t=0}^{\infty} A^t\right) y$, $\lim_{t \to \infty} A^t = 0$.
   (ii) The vector x will have a non- negative solution if the dominant eigenvalue of A is less than 1 in absolute value.
   (iii) A non-negative solution for any $y > 0$ exists if (I - A) has a positive dominant diagonal.
   (iv) A non-negative solution exists if all the principal minors of (I - A) are positive.

   For more details see, for example, Heal *et al.* (1974), Chapter 10.

which is used in cross-section comparisons (or in comparisons over time) of technological differences, and the question arises: to what extent the A-matrix is a true reflection of technology?

The elements of the I-O model described above refer to what is known as the supply-form quantity model (i.e. 'the primal'). The model also refers to I-O transactions without any distinction between domestic and imported commodities. Such a distinction is made in our Version B described in Chapter I. Following the above procedure we have

$$_{d}X_{i} = {_{d}X_{i1}} + {_{d}X_{i2}} + \ldots + {_{d}X_{in}} + {_{d}Y_{i}}. \quad (i = 1, 2, \ldots, n) \qquad (2.1)$$

$$M_{i} = M_{i1} + M_{i2} + \ldots + M_{in} + {_{m}Y_{i}}. \quad (i = 1, 2, \ldots, n) \qquad (2.2)$$

and defining coefficients in the same way as before

$$_{d}a_{ij} = {_{d}X_{ij}}/{_{d}X_{j}} \qquad (i, j = 1, 2, \ldots, n) \qquad (1.1)$$

$$_{m}a_{ij} = M_{ij}/{_{d}X_{j}} \qquad (i, j = 1, 2, \ldots, n) \qquad (1.2)$$

and combining (1.1) with (2.1) and (1.2) with (2.2) we obtain

$$_{d}X_{i} = {_{d}a_{i1}}\,{_{d}X_{1}} + {_{d}a_{i2}}\,{_{d}X_{2}} + \cdots + {_{d}a_{in}}\,{_{d}X_{n}} + {_{d}Y_{i}}. \quad (i = 1,2,\ldots,n) \quad (3.1)$$

$$M_{i} = {_{m}a_{i1}}\,{_{d}X_{1}} + {_{m}a_{i2}}\,{_{d}X_{2}} + \ldots + {_{m}a_{in}}\,{_{d}X_{n}} + {_{m}Y_{i}}. \quad (i = 1, 2, \ldots, n) \quad (3$$

which represent 2n equations with $_{d}Y_{i}$ (and $_{m}Y_{i}$) being the exogenous (independent) variables and $_{d}X_{i}$ (and M_{i}) being the endogenous (dependent) variables, the values of which can be found with the knowledge of (fixed) I-O coefficients.

Note that imports (M_{i}) can be estimated only when imports by final consumers ($_{m}Y_{i}$) are given exogenously. If the latter are unknown we can compute only indirect imports, i.e. imports demanded by individual I-O industries (and the sums thereof).

Using matrix notation we can re-write (3.1) and (3.2) to modify equation (6)

$$(I - {}_dA)\,{}_dx = {}_dy \qquad (6.1)$$

$$m - ({}_mA)\,{}_dx = {}_my \qquad (6.2)$$

We can now solve for x in (6.1) to obtain

$${}_dx = (I - {}_dA)^{-1}\,{}_dy \qquad (8.1)$$

and use x to solve for m in (6.2), i.e.

$$m - {}_mA(I - {}_dA)^{-1}\,{}_dy = {}_my \qquad (8.2)$$

or

$$m - ({}_mB)\,{}_dy = {}_my \qquad (8.3)$$

where

$${}_mB = {}_mA(I - {}_dA)^{-1}$$

which is the inverse matrix of total (i.e. direct-plus-indirect) coefficients for imports.

3. Definition of technology in international comparisons

For the purpose of this study we shall define technology as 'ranges of equipment, mechanism, and processes which transform raw materials into products and services which may or may not have existed before' (Amann et al. 197 p. 2). The definition, which is derived from the engineer's understanding of technical progress, has often been used in the literature even by economists in order to compare technological levels of different countries.[6]

In economic theory, technology is typically specified in the context of a production function which describes the productive process by specifying the greatest amount of a given product which can be produced by any combination of productive agents or inputs (Chenery (1949), p. 507). What we observe in practice, however, is the actual combination of such productive agents or inputs, and the implication of this dichotomy can be quite serious. The A-matrices, whether they are compared on a cross-section basis or over time, may be affected by virtue of the fact that in the base period some firms do not choose the most efficient technique among 'available' alternatives. In such a case, the structure of inter-industrial relations and, consequently, NRP absorption in production processes is not determined, strictly speaking, by technology but by a 'wrong' choice of technique.

Moreover, economic theory makes a distinction between substitution and technology as well as between effects of technology and those of economies of scale. To put it differently, 'substitution reflects choices within the context of the production function while technological change reflects changes in the production function itself' (Carter (1970), pp. 9-11). In the I-O framework, however, these distinctions are not usually made; the technical relationships take the form of a linear homogenous production function with fixed input coefficients. Thus, even in the 'pure' theoretical sense, i.e. under conditions of perfect competition, changes in I-O structures can be the results of substitution, scale economies or technical change.

The demand for (intermediate) inputs may also be dependent on

6. For a review of various approaches to assessing the comparative level of technology, see Amann, Cooper and Davies (1977), particularly Chapter 1, pp. 1-8, 23-6.

commercial policies. For example, commercial policies will often protect a factor of production to the extent that the factor will be 'overemployed' in comparison to the level of employment of this factor (or any other input) which would take place under conditions of free trade. Moreover, demand for inputs may also depend on the access in foreign markets to a particular input. This access may be affected by protective policies abroad and/or (excessive) transport costs.

It follows from the above that the dichotomy between 'potential' (i.e. the most efficient) and actual technology is present, *nota bene*, in the case of countries where firms' objectives are other than profit maximization.[7] Thus, it may appear to be useless to undertake the comparison of countries which involve a CPE where resource allocation is known to be subject to various forms of imperfections.[8] For this reason we shall constrain the planners' behaviour by stating that while technology will refer to all feasible combinations of inputs we shall assume that the elasticity of substitution between NRP and other material inputs is zero even though possibilities of substitution may exist among primary factors of production. Thus, in the short run at least, there will be only one technique of production which a firm will be able to use, i.e. the one which the firm is actually using.[9] With regard to 'substitution' and 'technology' as two possible sources

7. As discussed extensively by Carter (1970), Chapter 1, the dichotomy can arise even in the case of profit maximizing firms.

8. It may be convenient to distinguish between 'distorting policies' and 'distorting signals'. The latter will be discussed later when we deal with the role of domestic prices.

9. It is assumed here, of course, that the choice of technique which is normally made by firms in MTEs is made in CPEs by the planners. This assumption has already been adopted by Simpson and Tsukui (1965), and it will be relaxed later in the analysis.

of differences in NRP absorption and, under *ceteris paribus* conditions, any differences in A-matrices will be defined as differences in technology.[10]

There are clearly some possibilities of substitution between a NRP and a non-NRP if one considers a particular micro-production process (e.g. natural and synthetic fertilizers, wood and plastics), yet these possibilities are more likely to be of a long-term rather than a short-term natur Moreover, there is no empirical evidence which would contradict the above assumption in economy-wide studies (Sato and Ramachadran (1980)). However, perhaps the most vulnerable aspect of the assumption is that it incorporates all substitutions, i.e. including those substitutions which distinguish among different origins of supply. Thus, in view of the possible distortions arising through foreign trade interventions of CPEs, the assumption would be realistic only if imports of NRP are complementary in the countries concerned, i.e. there are no possibilities of substitution between domestic and imported supplies.[11]

Note also that the assumption is a simple restatement of the 'fixed input proportion' assumption mentioned earlier. Also, the assumption refers to planners' behaviour in time, i.e. as relative prices of inputs change, the planners cannot alter the relative use of these inputs since their employment will be dictated only by technology. In contrast, the planners must still be sensitive about the absolute level of employment of each input, in other words, they must minimize

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10. Using Samuelson's words: 'all desirable substitutions have already been made by competitive markets' (or by the planners as the proxy for the competitive markets) and, therefore, all remaining differences will be attributed to technology. See Samuelson (1951), p. 7.

11. The issue of complementary imports will be discussed in more detail in a separate section of this chapter but a comment on this question may be in order. If we assume for the moment that the planners are insensitive to foreign prices, which we would argue is not a realistic assumption, the assumption of zero elasticity of substitution would be perfectly viable if all Austrian imports were complementary. The latter is clearly not the case but, as the data in Appendix 2 show, the proportion of complementary imports in total NRP imports was extremely high, particularly that of imported inputs.

costs at each point of time.

Since technology will be examined in the empirical part as one of several determinants of NRP absorption let us discuss the concept of technology in some further detail and consider the relationship between technology as defined in our I-O framework on the one hand and the foreign trade sector on the other. One of the implications of what has been said above is that firms operating in a closed economy will, under certain conditions, have identical ratios of inputs and outputs. Thus, following Samuelson (1951), his (non)-substitution theorem guarantees that there will be only one production process which is always optimal for the production of each commodity. The well-known conditions which will then ensure that each firm's ratios of inputs and outputs are the same include (1) all firms having the same production functions, i.e. having the same technical knowledge and identical fixed factors; (2) all firms facing the same factor and product prices (subject to the 'non-substitutability restriction' mentioned above) and (3) all firms being profit maximizers. All these rules which describe the behaviour of firms and their production functions apply also to 'countries' provided, of course, that firms, production factors and technologies can be non-ambiguously aggregated, an issue which we shall outline further below.

The Samuelson theorem is also valid for open economies which trade internationally those commodities which are final consumption goods assuming, of course, that the above conditions are fulfilled. However, as shown by McKenzie (1954) the theorem is no longer true once foreign trade in intermediate products is allowed. Thus, when a country can import intermediate products, the optimum production processes need no longer coincide with those processes which minimize domestic (labour) inputs. Clearly, under such circumstances, the ratios of inputs and outputs (and consequently, NRP I-O coefficients) will be affected by commercial policies or any autarkic tendencies of the importing country. This point can be made also with the help of our I-O model and equation (2b) above where imports are seen to be generated not only by final consumers (y) but also by intermediate demand (A). However, defining the coefficient matrix A as

$$A = {}_dA + {}_mA$$

we see that the composition of the technological matrix (coefficient) A will be dependent not only on the true technological relationships but <u>also</u> on the determination of the composition of matrices ${}_dA$ (for domestic deliveries) and ${}_mA$ (for imports).

In the absence of trade with intermediate products the intermediate coefficient matrix ${}_mA$ will include only zeros and the technology coefficient matrix A will be equal to the transaction coefficient matrix ${}_dA$. In other words, the coefficients of production included in the matrix A will be technically fixed, *ceteris paribus*. At the other extreme when imports of intermediate products face no domestic competition, which means that domestic firms supply only to final demand, the outcome will be different to some extent. The domestic coefficient matrix ${}_dA$ will have only zero entries and the technology coefficient matrix A will be equal to the import coefficient matrix ${}_mA$. This means that, under *ceteris paribus* conditions, the coefficients of production in matrix A will be technically fixed <u>once</u> the structure of (final) output is given. In practice, imports of intermediate products may or may not compete with domestic output, i.e. imports are 'competitive' or 'complementary'. Clearly, a high degree of complementarity reflects a small role for protectionist or autarkic policies in countries which are dependent on foreign trade and thus a correspondingly important role for technology in determining the I-O coefficients in matrix A. More detailed theoretical discussion of the relationship between the comparative advantage theory and the I-O model can be found in Chacholiades (1978) and we shall return to the methodological side of the issue further below.

What is the relevance of the argument that the transaction matrix A for a country such as Czechoslovakia reflects 'pure' technological relations rather than autarkic tendencies? The distorting effects of commercial policies of CPEs has been often suggested in the literature and the sentiment is perhaps best summarized in Wilczynski (1965). Even though it may be unrealistic to argue that CPEs follow strictly the principle of comparative advantage in domestic allocative processes it would seem unreasonable to accept the view that CPEs disregard comparative advantage entirely. In fact, there are reasons to believe that the comparative advantage principle is likely to have played a considerably more important role in the CPEs than was traditionally acknowledged. First, it is now widely accepted that the 'traditional' theory of international trade has made serious mistakes in explaining the foreign trade behaviour of the CPEs. This mistake was acknowledged by Holzman (1976, p. 33), who has been perhaps the most prolific and prominent writer on theory and policy issues of centrally-planned foreign trade: 'In the early days of CMEA, many scholars believed that each Soviet bloc nation attempted to industrialize as rapidly as possible and, in the process, exported any surpluses which happened to develop, using these to pay for the imports necessary to eliminate unforeseen bottlenecks. This is basically an error of theory of international trade since, presumably, if the method of material balances had assured perfect balance for all commodities neither exports nor imports would be necessary nor would they serve a useful function'. Further theoretical work which incorporates systematic planners' behaviour and their acceptance of the comparative advantage principle include, for example, Hewett (1974), Rosefielde (1981), Drabek (1980a).

Secondly, and more importantly, there is now a considerable volume of empirical evidence to support the view that the planners have been sensitive to price differentials in different markets and that they were not immune to gains from trade due to comparative cost differentials in their allocative decisions. Such evidence can be found in Brada and Wipf (1974), (1975), Wolf (1976), Wipf and Brada (1975), Vanous (1980) and Rosefielde (1974a). The fact that the foreign trade decisions have been indeed based on the so-called efficiency indices, which in theory and under certain conditions are consistent with the opportunity-cost version of the comparative advantage theory (Boltho 1971, p. 80), has been suggested by Zauberman (1964, p. 7) and Wilczynski (1965, p. 33). Of course this is not to argue that centrally-planned foreign trade leads to Pareto optimal solutions, a theoretical issue which I have discussed elsewhere (Drabek (1980c)). Nevertheless, the question of the relevance of the comparative advantage theory to foreign trade under central planning has become an empirical problem which has to be tested further and cannot be rejected on *a priori* grounds.

Finally, let us return for the last time to the general concept of 'technology'. There has been a considerable controversy in the literature with regard to the proportionality assumption concerning inputs used in production processes and it would be beyond the scope of this study to enter into the discussion.[12] However, it may be relevant to mention that there have been numerous attempts in the I-O literature to estimate changes in I-O coefficients, as reviewed in Sato and Ramachadran (1980). One of these methods, the RAS technique, will be used here to relax the assumption of zero elasticity of substitution between NRP and and non-NRP. In other words, an attempt will be made to measure the

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12. For the sake of completeness in our general discussion of the I-O model, it may be useful to refer to studies which suggest the empirical validity of the assumption. See, for example, Cameron (1952), Carter (Grosse) (1953), Carter (1970), Ozaki (1976).

'substitution' effect. In view of the foregoing discussion, it should be clear that measurement of the 'pure' substitution effect depends on the absence of effects of scale economies, commercial policies, and transport costs. The actual measurement will also be affected by imperfect data. If any of these effects is present we shall eventually find ourselves measuring a 'hybrid' rather than a 'pure' substitution effect. We shall return to this issue later.

4. Technology assumptions

The technology matrix of intermediate transactions (A) should be of a particular form. Assuming for the moment that we are using the matrix expressed in flow terms, such a matrix will show the flows of commodities used in the production of given commodities. Thus, using I-O terminology, the matrix of intermediate transactions will be a square $n \times n$ matrix where the n is the number of commodities. Formally, the accounting framework of I-O matrices can be represented schematically as in Tables II.1 and II.2,[13] which use the notation introduced in section 1 above.

Table II.1. Accounting scheme of I-O flows

	Commodities	Industries	Final demand	Total
Commodities		S	y	x
Industries	M			q
Primary inputs		g'		
Total	x'	q'		

13. For more details of the following accounting scheme, see United Nations (1968).

Table II.2. Accounting scheme of coefficients and derived matrices in the I-O table

	Commodities	Industries	Final demand
Commodities	A $X = A\hat{x}$	$D = S\,\hat{q}^{-1}$	
Industries	$U = M'\hat{q}^{-1}$ $V = M\hat{x}^{-1}$	E $Z = E\hat{q}$	f
Primary inputs	t'		

where A commodity × commodity coefficient matrix

D matrix of coefficients relating to purchases of commodities of industries

U 'Product-mix' matrix in which each column shows the proportions of commodities produced by a given industry

V 'Market-share' matrix in which each column shows the proportions of total output of a given commodity produced by various industries

E Industry × industry coefficient matrix

M 'Make-matrix' showing the values of commodities produced by industries

S 'Absorption-matrix' showing the purchases of commodities by industries

X the values of purchases of commodities (commodity × commodity flow matrix)

Z the value of purchases of industrial outputs by industries (industry × industry flow matrix)

f final demand for the output of industries

y final demand for commodities

q industry outputs

x commodity outputs

g primary inputs into industries

t primary inputs into commodities

Matrices are represented by capital letters; a prime (') superscript represents a transpose. Vectors are written as column vectors and in small letters; row vectors are shown as transposed column vectors; the symbol "^" identifies a diagonal matrix.

The actual technological comparison based on cross-section data (or time-series) can then be derived from comparisons of the matrices A or X. It might also be possible to use other matrices such as E or Z. The difference between the technology matrices X and Z (and the derived matrices A and E respectively) lies in different definitions of the rows and columns of I-O tables in the compilation of the data. The former refers to industries which are identified with actual commodities produced, while the latter refers to industries represented by a collection of establishments which are defined in terms of their principal products. Thus, there will be no difference between the matrices X and Z (and A and E) if and only if the establishments produce their principal products and nothing else, i.e. there is no subsidiary production.

However, under usual circumstances, the output of establishments involves some subsidiary production and a one-to-one relationship between commodities and industries is not possible. For example, both Czechoslovak and Austrian tables are defined in the industry x industry form which makes them comparable in one sense but may involve distortions due to the presence of subsidiary output. Before we proceed any further let us pause briefly to see what implications the presence of subsidiary output might have on our technological comparisons.

Consider, for example, the absorption matrix S and its coefficient matrix D which relates the purchases of commodities to industries. Each cell in the matrix of intermediate flows and, consequently, each coefficient is dependent on the distribution of principal and subsidiary products in each column of the table and on the technology of producing the principal and subsidiary commodities. Assuming that the technologies are different and disregarding for the moment the distinction between 'technology' and 'substitution' each cell in those matrices fails to represent the 'pure' technology of the principal product. In other words, such an entry represents the output of the intermediate commodities which is constrained not only by intermediate demand (i.e. technology in this case) generated in the production of the principal commodity but also by technology of the subsidiary production.

Solutions have been suggested in the literature to convert commodity x industry tables into a commodity × commodity version by Stone *et al.* (1963), United Nations (1968), Gigantes (1970) and Almon (1970). The methods involve a selection of an assumption concerning the technology of subsidiary production. We can assume, for example, that 'inputs are determined not by the industry which absorbs them but by the commodity into which they enter' (Stone *et al.* (1963), p. 14). This means that a commodity is assumed to have the same input structure irrespective of the industry in which it is produced. This is known as the assumption of commodity technology. Alternatively, we can assume that all commodities, whether principal or subsidiary, are produced with the same technology employed in the given industry which means that a particular commodity may be produced with different input structure depending on the industry in which it is produced. This is known as the assumption of industry technology. Finally, it is possible to assume that some subsidiary production involves the same technology of the principal products (e.g. in the case of joint products) while other subsidiary production requires technology characteristic for the (subsidiary) product itself. In such a case both technology assumptions are required and we shall refer to the so-called hybrid technologies assumption.

Using the above concepts, we can obtain three different solutions for the matrix of I-O coefficients.[14] In the case of commodity technology, we can write

$$D = A_c U \tag{9}$$

so that

$$A_c = D\, U^{-1} \tag{10}$$

where A_c is the matrix of I-O coefficients obtained on the basis of commodity technology. In this case, inputs into industry j are represented by the weighted average of the inputs into each of the commodities produced by the j-th industry.

Alternatively, using the industry technology assumption, the inputs into commodity j are represented by the weighted average of the inputs into each industry producing commodity j. This means that the weights will be represented by the market shares of each industry which is producing commodity j, namely,

$$A_I = D\, V \tag{11}$$

where A_I is the matrix of I-O coefficients obtained on the assumption of industry technology.

Using the hybrid technology assumption, let us define first sub-matrices M_1 and M_2 generated from the matrix M. The sub-matrix M_1 represents elements of commodity output of industries for which the commodity technology

14. The following presentation summarizes the results from United Nations (1968), Stone, Bates and Bacharach (1963) and Gigantes (1970). Moreover, Armstrong (1975) shows in the appendix practical examples of the applications of commodity and industry technology respectively.

is appropriate and similarly in the case of M_2 for which the industry technology is assumed to be more relevant so that $M = M_1 + M_2$.. As shown, for example Armstrong (1977), the solution obtained under these circumstances is more complex.[15]

Let us consider in more detail the case where hybrid technology is allowed. Referring to equation (7) above, we shall highlight the assumption by writing

$$x = A_H x + y \qquad (7.5)$$

Armstrong also writes

$$x = A_1 x_1 + A_2 x_2 + y \qquad (12)$$

where x_1 and x_2 are commodity outputs produced on the commodity and industry technology assumptions respectively.

In order to obtain A_1 and A_2 from D he defines two weighting matrices U_1 and $\tilde{V}_2$ as follows:

$$U_1 = M_1 \hat{q}_1^{-1} \qquad (13)$$

$$\tilde{V}_2 = M_2 \hat{x}_2^{-1} \quad . \qquad (14)$$

where matrix M_1 includes elements of production for which a commodity technology assumption is considered to be more appropriate while matrix M_2 includes those elements for which the industry technology assumption is assumed to be relevant. Both matrices U_1 and $\tilde{V}_2$ represent sets of weights and the interpretation of U_1 is similar to the one above, while

15. A different solution is obtained if we assume, for example, that the output of by-products in M is linked to output of the producing industries. See Armstrong (1975), pp. 74-5.

each column k in matrix $\tilde{V}_2$ represents the market share of each industry's by-products in total production of commodity k. The production of by-products is assumed to follow a fixed market shares pattern[16] as indicated by equation (15)

$$q_2 = M_2 i = V_2 x \quad (15)$$

where column i in V_2 specifies the market share of each industry's by-products in the total production of commodity i.

Armstrong then obtains the equation

$$x = DU_1^{-1}x_1 + D\tilde{V}_2 x_2 + y \quad (12.1)$$

which is equation (12) with $A_1 = DU_1^{-1}$ and $A_2 = D\tilde{V}_2$.
Using equation (15), he finds that

$$x_2 = M_2' i = \hat{x}V_2' i = \widehat{(V_2' i)}x \quad (15.1)$$

where i = (1, 1, ..., 1)'. Combining eq. (14) and (15) yields, after simple manipulation, the equation

$$\tilde{V}_2 x_2 = V_2 x_2 \quad (15.2)$$

Finally, substituting (15.1) and (15.2) into (12.1) and comparing the result with (7) he obtains the following expression for A_H:

$$A_H = D[U_1^{-1}(I - \widehat{V_2 i}) + V_2] \quad (15.3)$$

where A_H is the matrix of I-O coefficients obtained on the basis of the hybrid technology assumption and i = (1, 1, ..., 1)'.
Thus, in order to make (meaningful) conversions of I-O tables into the commodity x commodity form, the absorption matrix S and the make-matrix M must be available. Unfortunately, neither Czechoslovakia nor Austria made these matrices available. In the absence of the necessary data all

16. For more details see Armstrong (1975), p. 73.

we can do is constrain our analysis by several assumptions concerning the quality of our data. Before we state our technology assumptions more general assumptions are called for.

In the 'pure' I-O model one assumes that each 'industry' produces its own principal product and nothing else. This assumption is known as the assumption of identity of industry and product.[17] The assumption guarantees that I-O flows are not distorted by the presence of subsidiary output of non-principal commodities. The second assumption is that each product is uniform and is known as the assumption of product homogeneity.

In practice it is very unlikely that the assumption of identity of industry and product will be fulfilled[18] and since we have to rely on the industry × industry table it is necessary to adopt a technology assumption concerning the subsidiary output of industries. Clearly, each commodity should be treated normally on its own merit and it is quite possible that some form of the hybrid technology assumption would be preferable. However, since we have no practical solution to offer for ordering the data into the matrices M_1 and M_2 (particularly since the make matrices are not available), the 'second best' solution would seem to assume that all subsidiary products are characterized by industry technology.[19] This assumption guarantees that the intermediate flows in the I-O table are not distorted by differences in technology of production or subsidiary output.

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17. This and the following assumption is adopted from Stone, Bates and Bacharach (1963) where the assumptions are discussed in more detail.

18. We shall discuss the implications of this assumption later.

19. The choice made on purely mechanical grounds would seem to favour the industry technology assumption. This is given by the fact that, for the purpose of data conversion, the assumption may involve the least complex computations in terms of matrix inversion and, consequently, in terms of computing time. See Stone, Bates and Bacharach (1963), p. 22.

Intuitively it would appear that the sectors for which the assumptions of product identity and homogeneity are more likely to be realistic are NRP sectors, i.e. those with which we are concerned in this study. On the other hand, the output of non-NRP sectors is quite likely to involve some subsidiary products and the intermediate demand for NRP will be affected correspondingly. In such a case, the technology assumption becomes crucial. For reasons discussed in Stone, Bates and Bacharach (1963), the commodity technology assumption is more appropriate than the industry technology assumption. As a result, the commodity technology assumption has been used quite frequently whenever the hybrid technology assumption could not be used.

The industry technology assumption was dictated here entirely by the requirements of comparative analysis rather than by general technological plausibility. Fortunately, not all subsidiary products are produced on the basis of a specific commodity (rather than industry) technology (e.g. gas obtained as a by-product in the production of coke from coal, animal feedstuff obtained in some branches of the food processing industry, etc.). Moreover, experimental work undertaken by Armstrong (1975) for the UK suggests that the differences among the matrices A_C, A_I, A_H and D are rather small and do not always justify the costs of recalculations. In addition, the aggregation of I-O tables to a size similar to ours seems to affect the above differences only slightly, a point which will be useful in the analysis below.

5. Competitive and complementary commodities

In I-O analysis it is customary to make a distinction between competitive and complementary commodities. Competitive commodities are defined as products of industries which exist domestically. In contrast, complementary commodities are products for which there are 'no' domestic industries, and must, therefore, be imported (United Nations (1968), p. 35). Once the definition of competitive and complementary commodities is made it is possible to distinguish between competitive and complementary imports. The actual accounting of competitive and complementary imports may be done according to the scheme outlined below in Table II.3. Even though the majority of I-O tables do not include a separate treatment of these two groups of commodities, quite a number of countries have already done so. A review of the accounting practices adopted in the construction of various I-O tables can be found in Lecomber (1970).

Table II.3. <u>A scheme of accounting of industrial outputs and costs</u>

	Industries ⟶		
	Agriculture	Fuels	Mining ...
Commodities:			
A. Competitive intermediate inputs: ↓			
Agricultural products			
Fuels			
Products of mining			
.			
.			
.			
B. Complementary intermediate inputs: ↓			
Agricultural products			
Fuels			
Products of mining			
.			
.			
.			
PRIMARY INPUTS:			

Failure to distinguish between competitive and complementary imports could be quite serious. Consider the following example of an aggregate group 'Fuels' which consists of domestically (d) produced coal and imported (m) oil.

... User industries (j) ... final demand

Electricity producing branch

Intermediate inputs (i)

.

.

.

Fuels — coal (d), oil (m) $\Big\}$ ${}_d a_{ij} + {}_m a_{ij}$ ... ${}_y y_{i(d)} + {}_y y_{i(m)}$

.

.

.

Electricity

where ${}_d a_{ij}$ and ${}_m a_{ij}$ are the proportions in which the domestically produced coal and imported oil respectively are combined to produce one unit of electricity output and ${}_y y_{i(d)}$ and ${}_y y_{i(m)}$ refer to the proportions of coal and oil respectively per unit of final demand expenditures. It is clear that if the output of electricity is to be increased by one unit in the next time period, the resulting change in the intermediate demand for 'fuels' will depend, *inter alia*, on the combination of domestically produced coal and imported oil. In general, it is typically assumed that not only the total input of fuels but also imports are proportional to the output of user industries.

In reality, of course, there may be severe limitations on the expansion of imports given the presence of a balance of payments constraint. Moreover, the proportions of imports in the output of the user industries may also change due to changes in relative prices.[20] Consequently, the proportionality assumption with regard to imports is not suitable for forecasting purposes, particularly in the case of small countries which are likely to be heavily dependent on foreign trade.[21]

Failure to distinguish between competitive and complementary imports may also be vital in inter-country comparisons even though what matters in such cases is the use of total intermediate inputs, i.e. the combined use of domestic and foreign supplies. On the one hand, since the comparisons refer to ex-post situations, the balance of payments constraint is of no consequence. On the other hand, a different assumption is still needed in order to make the comparisons of technological matrices analytically meaningful.

Consider again the previous example of fuel-based technology which is shown in Table II.4. The scheme describes the technological structure in two countries which are assumed to be exactly the same except that country I produces electricity entirely from burning coal while country II produces electricity from burning oil which has to be imported. The notation is the same as before.

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20. Another aspect of the foreign trade sector not considered here concerns exports and these are assumed to change in fixed proportions so that the commodity structure remains constant.

21. Different solutions to endogenize imports in the I-O forecasting model have been suggested, for example, by Lecomber (1970) with reference to the UK.

Table II.4. <u>An alternative scheme of technological structure</u>

$$
\left.
\begin{array}{l}
\text{Coal} \\
\\
\text{Oil}
\end{array}
\begin{array}{c}
\begin{pmatrix}
d^{a}_{11} & \cdots\cdots & d^{a}_{1n} \\
\vdots & & \\
d^{a}_{i1} & \cdots \; \underline{d^{0.6}} \; \cdots & d^{a}_{in} \\
\vdots & & \\
d^{a}_{n1} & \cdots\cdots & d^{a}_{nn}
\end{pmatrix} \\
\begin{pmatrix}
m^{a}_{11} & \cdots\cdots & m^{a}_{1n} \\
\vdots & & \\
m^{a}_{i1} & \cdots \; \underline{m^{0.0}} \; \cdots & m^{a}_{in} \\
\vdots & & \\
m^{a}_{n1} & \cdots\cdots & m^{a}_{nn}
\end{pmatrix}
\end{array}
\right\} = A \text{ (Country I)}
$$

$$
\left.
\begin{array}{l}
\text{Coal} \\
\\
\text{Oil}
\end{array}
\begin{array}{c}
\begin{pmatrix}
d^{a}_{11} & \cdots\cdots & d^{a}_{1n} \\
\vdots & & \\
d^{a}_{i1} & \cdots \; \underline{d^{0.0}} \; \cdots & d^{a}_{in} \\
\vdots & & \\
d^{a}_{nn} & \cdots\cdots & d^{a}_{nn}
\end{pmatrix} \\
\begin{pmatrix}
m^{a}_{11} & \cdots\cdots & m^{a}_{1n} \\
\vdots & & \cdot \\
m^{a}_{i1} & \cdots \; \underline{m^{0.4}} \; \cdots & m^{a}_{in} \\
\vdots & & \\
m^{a}_{n1} & \cdots\cdots & m^{a}_{nn}
\end{pmatrix}
\end{array}
\right\} = A \text{ (Country II)}
$$

Here, for illustration, the underlined numerical entry in each matrix, is in row i and column j.

Also, ${}_{d}a_{ij}$ and ${}_{m}a_{ij}$ are the (i, j)th entries of the matrices ${}_{d}A$ and ${}_{m}A$ respectively.

Let $A \equiv {}_{d}A + {}_{m}A$, so that $A = (a_{ij})$

where $a_{ij} \equiv {}_{d}a_{ij} + {}_{m}a_{ij}$

Now, in our example $a_{ij} = 0.6$ (country I)

$a_{ij} = 0.4$ (country II)

If the comparison is made only on the basis of aggregated a's (i.e. combined competitive and complementary inputs) we conclude that, under *ceteris paribus* conditions, both countries use different technologies (even though both are 'fuels'-based) and country II appears to be more efficient in the use of fuels than country I. However, if we distinguish between competitive and complementary inputs we see that

$${}_{d}a_{ij}(I) > {}_{d}a_{ij}(II)$$

$${}_{m}a_{ij}(I) < {}_{m}a_{ij}(II)$$

which points to determinants other than technology. The most sensible procedure to follow under the circumstances would seem to be to distinguish in the table at least between domestically produced commodities and imports in general, the latter taking the same form of accounting as the former. As described in Chapter I, this procedure was adopted in this study.

6. Aggregation

6.1 Aggregation problems in economic analysis

In general, problems of aggregation can be divided into several groups. The first type of aggregation problem has been formulated in the static production theory which sought to specify the conditions for optimal rate of output of an industry consisting of single firms. Bliss (1975) found that any set of technologies of individual firms can be aggregated into a single aggregate technology only if all production factors are freely variable and purchased in competitive markets. Under the less restrictive assumption of fixed capital stock combined with freely variable factors, the necessary and sufficient restrictions imposed on firms' technologies were derived by Gorman (1968). Similarly, the conditions for aggregating inputs, outputs and technology sets under the assumption of imperfect factor (input) markets were obtained by Nataf (1948). Finally, Blackorby and Schworm (1980) derived the conditions for the existence of aggregate technology and aggregate extraction rate by natural resource industries.

The second type of aggregation problem arises in I-O analysis where two further issues can be distinguished. Consider, for example, a detailed I-O table which we may call for convenience a micro-table. The actual micro-table consists, of course, of sectors (or commodity groups) which represent groupings of sub-sectors or firms or working groups on the shop floor (or individual commodities respectively) which had to be aggregated by the statisticians into micro-sectors (micro-commodity groups) for statistical purposes. The aggregation into micro-sectors may have involved an error which we may call Type•1 error.

Now, suppose that the micro-table is to be consolidated into a more aggregated version which we may call for convenience a macro-table. As was observed by Leontief (1941, p. 210), the solution of the I-O system may be quite different in the macro- compared with the micro-version. The aggregation from micro- into macro-table may also involve an aggregation error, which we may call Type 2 error. In contrast to Type 1 error, Type 2 error is generated by economists who consolidate the micro-table while there is obviously nothing the economist can do about the Type 1 error. In the following analysis we shall, therefore, refer to the Type 2 error and assume that the Type 1 error is absent.

In the rest of this chapter we shall assume that the natural resources which firms in Austria and Czechoslovakia are extracting are homogeneous both across the border and within the country itself. In other words, we shall assume that various deposits of a single type of resource do not differ in the location of the deposit, its quality, the capital equipment associated with it, and in addition, that ownership makes no difference on the extraction paths. This is an approach adopted, for example, in the recent work of Dasgupta and Heal (1979). The actual aggregation problem involved will not be discussed in this study; a general review is provided, for example, in Green (1964) or Fisher (1969).

6.2 Statement of the aggregation problem

Consider the following set of I-O equations where each equation refers to an organizational micro-unit such as a firm.[22]

$$y = (I - A)x \tag{16}$$

where $y = (y_1, y_2, \ldots, y_n)'$ is a vector of final demand, so that n is the total number of firms in the economy. The vector $x = (x_1, x_2, \ldots, x_n)$ is a vector of gross output and $A = (a_{ij})$ is a $n \times n$ matrix of current I-O coefficients and $I = I_{nn}$ is the square identity matrix of order n. The set of equations (16) can be identified as a micro-system.[23]

22. It is obviously possible to consider individual products as the basic micro-units and the present choice was made entirely for convenience.

23. It will be recalled that the actual problems of aggregation may go beyond the level of firms. Each firm consists of different work units which can also be disaggregated. This issue is not considered and it will be assumed that firms are the basic micro-units provided to compilors of I-O tables.

In order to aggregate x and y, let us introduce a grouping matrix G ('aggregation operator') of order $M \times n$,

$$G = \begin{bmatrix} 1 \dots 1 & 0 \dots & 0 \dots 0 \\ 0 \dots 0 & 1 \dots 1 & 0 \dots 0 \\ \vdots \; \vdots & \vdots \; \vdots & \vdots \; \vdots \\ 0 \dots & 0 \dots 0 & 1 \dots 1 \end{bmatrix} = \begin{bmatrix} e_1'^{*} \dots & 0 \\ \cdot \quad e_J'^{*} & \cdot \\ 0 \quad \dots & e_M'^{*} \end{bmatrix} \tag{17}$$

Here $e_J'^{*}$ is a (row) vector with every element equal to 1, and the order of $e_J'^{*}$ is $g(J)$ ($J = 1, 2, \dots, M$)[24]. Note that $\sum_{J=1}^{M} g(J) = n$, and M represents the number of industries.

The aggregated macro vectors of final demand (y^*) and gross output (x^*) can then be obtained as

$$y^* = G\,y \tag{18}$$

and

$$x^* = G\,x \tag{19}$$

Alternatively, it is possible to obtain the macro-vector of final demand by aggregating matrix A and vector x in (16) so that

$$y^* = (I^* - A^*)\,x^* \tag{20}$$

Similarly, by aggregating A and y it is possible to obtain the macro-vector of gross output x^*

$$x^* = (I^* - A^*)^{-1} y^* \tag{21}$$

24. The number of 1's on any row is the number of firms to be aggregated into one industry. In general, aggregated sectors are identified in this chapter with an asterisk. Following the usual practice subscript small "j" will identify micro-sectors and subscript capital "J" will identify macro-sectors.

where, following Morimoto (1970, p. 120) and letting X and X* be the micro and macro-flow I-O matrices of intermediate transactions respectively, we can define the macro A* matrix as

$$A^* = X^* \hat{x}^{*-1} \qquad (22)$$

where $$X^* = G\ X\ G' \qquad (23.1)$$

and $$\hat{x}^* = G\ \hat{x}\ G' \qquad (23.2)$$

As shown by Malinvaud (1954), p. 198, there is no reason to expect that the vector x* obtained from (21) will be necessarily the same as the vector x* obtained from (19) since there is no simple relationship between y* and x* in (18) and (19) respectively. Namely, using (16), (18) and (19)

$$\begin{cases} y^* = G(I - A)\ x \\ x^* = G\ x \end{cases} \tag{24}$$

Thus, a bias may arise as a result of aggregating the micro-system into a macro one. Using (19) and (21), this bias can be defined as

$$x^* - G\ x = [(I^* - A^*)^{-1}G - G(I-A)^{-1}]y = V\ y \tag{25}$$

Thus,

$$Vy = [(I + A^* + A^{*2} + \dots)G - G(I + A + A^2 + \dots)]y$$

$$= [(A^*G - GA) + (A^{*2}G - GA^2) + \dots]y \tag{26}$$

Note that it is possible to identify two sources of the aggregation bias: (i) bias arising from the aggregation of the coefficient matrix A; and (ii) bias arising from the aggregation of final demands y. Moreover, the aggregation bias can be 'segmented' into biases of different order. Thus, according to Theil (1957, p. 117), the first order bias is defined as

$$(A^*G - GA)y = V^{(1)}y \tag{27}$$

where

$$V^{(1)} = A^*G - GA$$

6.3 Conditions for zero aggregation bias

Various conditions have been specified in the literature to ensure zero aggregation bias.

I. The aggregation bias vanishes for any final demands if and only if the coefficient matrix satisfies the following condition

$$GA = A^*G \tag{28}$$

This is a standard aggregation condition originally due to Hatanaka (1952). The condition constrains the aggregation of the micro coefficient matrix in the following way:

$$A^* = GAH \tag{29}$$

where H is a weight matrix of order $(n \times M)$ and of the form

$$H = \begin{bmatrix} h_1 & & & & & \\ h_2 & & & & & \\ h_3 & & & & & \\ & h_4 & & & & \\ & h_5 & & & & \\ & & h_6 & & & \\ & & h_7 & & & \\ & & & h_8 & & \\ & & & h_9 & & \\ & & & & \ddots & \\ & & & & & h_M \end{bmatrix} = \begin{bmatrix} h_1^* & & & & & \\ & h_2^* & & & & \\ & & h_3^* & & & \\ & & & \ddots & & \\ & & & & h_J^* & \\ & & & & & h_M^* \end{bmatrix} \tag{30}$$

where h_J^* is the column vector of order $g(J)$ with individual elements, the h_j, representing the output proportions in the Jth hybrid sector in the base period 0 and they add up to unity.

It is convenient at that stage to introduce an abuse of notation which greatly simplifies some of the expressions used below. We shall write

$$j \in J$$

to indicate that j represents a micro-industry in the macro-industry represented by J. With this convention we see that

$$h_j = x_j/x_j^* \qquad (j \in J;\ J = 1, \ldots, M) \tag{31}$$

The meaning of such expressions as $\sum_{j \in J} x_j$ should now be clear.

The matrix H has the property that $GH = I_n$ (I_n is the identity matrix of order $n \times n$) since only then is the aggregation condition (28) satisfied. The condition was interpreted by Malinvaud (1954, pp. 198-9) in terms of homogeneous input-output structure. In other words, each firm in industry J must have the same cost structure defined in micro units. In practical terms, however, this is a very severe requirement. Theil (1957, p. 118) reiterated the condition in a slightly less severe manner in terms of homogeneous input structure whereby each j-th firm in industry J must have the same cost structure defined in macro units (i.e. in terms of the aggregated industrial classification).

II. If the final demands are proportional to those of the base period then the aggregation bias is zero. This condition was discussed first in Balderson and Whitin (1954, pp. 159-260) and formalized in Malinvaud (1954, p. 220) and Theil (1957, p. 120).

III. If $y_j = h_j y_J^*$ for all $j \in J$, i.e. $Y_J = h_J^* y_J^*$ for each $J = 1, \ldots, M$ (where $h_j = x_j / \sum_{j \in J} x_j$ and Y_J and h_J^* are the column vectors whose elements are the y's and h's respectively in the J-th hybrid sector), then the first order aggregation bias vanishes. In other words, first order aggregation bias vanishes if the structure of final demand within each sector is the same as that of the corresponding outputs in the base period. This condition was formulated and the proof provided in Morimoto (1970, p. 121).

IV. The aggregation bias is zero if the following M^2 covariances all vanish

$$\sum_{j \in J} h_j (a^*_{IJ} - \sum_{i \in I} a_{ij}) \frac{y_j}{h_j} \qquad (I, J = 1, \ldots, M) \qquad (32)$$

The condition is due to Theil (1957, p. 120).

V. The aggregation bias is zero if the final demands are proportional to those within each hybrid (macro) sector and condition IV is satisfied in the base period (Theil (1957, p. 120)).

VI. If some sectors are not aggregated and the change in final demands occurs only in the unaggregated sectors, then the first order aggregation bias always vanishes regardless of the way of aggregating the rest of the sectors (Morimoto (1970), p. 122).

VII. The aggregation bias in the lagged Leontief system vanishes for any final demand and for any initial conditions if and only if GA = A*G. (Morimoto (1970), p. 124). This is the first of a number of conditions which have to be satisfied in a dynamic I-O model. The model can be derived from a static system either through introduction of time lags or through stock-flow relationships or both, as discussed by Leontief (1953b, pp. 82-3). The conditions are not included here because they lie outside the static intercountry comparison undertaken in this study. However, for details the reader may refer to Morimoto [1970, p. 125].

All previous theorems refer to simple aggregation whereby unit weights are applied to each original sector (firm), viz. the matrix G. The simple aggregation is a special case of weighted aggregation but, as shown by Morimoto (1971, p. 138) all theorems hold once we change the weights from unity to other positive numbers. Nevertheless, there are some specific features of weighted aggregation given by the fact that we may now choose different weights and thus eliminate the bias. The conditions obtained are rather extreme but, once again, they are included here for the sake of completeness.

VIII. If the coefficient matrix $A > 0$ is indecomposable, there exists a unique set of positive weights, $g_1^*, \ldots, g_n^*$ such that consistent aggregation into one all-inclusive sector is possible. The theorem was first formulated by McManus (1956) and the proof is provided in Morimoto (1971), p. 140 .

IX. If the coefficient matrix $A \geq 0$ is completely decomposable, there exists a unique set of positive weights such that consistent aggregation into the completely decomposable groups of sectors is possible (McManus (1956) and Morimoto (1971), p. 140).

X. Suppose that the coefficient matrix $A \geqslant 0$ is cyclic, i.e. A can be partitioned into a form $[A_{IJ}]$, $(I, J = 1, \ldots, M)$ where

$$\sum_{i \in J} a_{ij} \begin{cases} \neq 0 \text{ for } j \in J+1 \\ = 0 \text{ otherwise,} \end{cases} \qquad (J = 1, \ldots, M)$$

(Here we adopt the convention that $M + 1$ is taken as 1.)
Suppose also that the product of the partitioned matrices $[A_{K,K+1} \ldots A_{K-1,K}]$ $(K = 1, \ldots, M)$ is indecomposable. Then there exists a unique set of positive weights, $g_1^*, \ldots, g_n^*$ such that consistent aggregation is possible (Morimoto (1971), p. 141).

In the above cases VIII, IX and X the aggregation bias disappears in the very specific case when we choose the particular vector of weights, such as $g_1^*, \ldots, g_n^*$.

Note that it is possible to interpret the weights in the above system as prices in the matrix of physical flows. Thus, following Morimoto, we see that if weighted aggregation is consistent (for any final demands) in the open static Leontief system, then the ratio of the value of the labour input to the output price is common within each hybrid (macro) sector. Conversely, in the special cases of VIII, IX and X this condition is sufficient for consistent aggregation. In general it is not. (Morimoto (1971), p. 142).

In other words, prices cannot be used as weights in the process of aggregation except in the very special case of

$$p' = p'A + l' \qquad (33)$$

$$p' = l'(I - A)^{-1} \qquad (34)$$

where p' is the row vector of the output prices p_i $(i = 1, \ldots, n)$ and $l' = \beta a_0'$, β being the wage rate and a_0' the row vector of the labour input coefficients.

The above list gives a set of conditions which must be satisfied so that the aggregation bias is generally equal to zero.

We shall next turn to the question of relevance of the conditions.

6.4 The aggregation problem in the comparison of natural resource product absorption in Czechoslovakia and Austria

As mentioned in the previous section, the aggregation conditions for zero bias are extremely restrictive, and they are unlikely to be fulfilled in practice. This conclusion has been supported by the results of some experimental work, e.g. Balderson and Whitin (1954) and Kymn (19 In particular, the conditions are not likely to be met in the case of the required properties of the coefficient matrix A.[26] At the same time, it may seem intuitively more hopeful to rely on the restrictions imposed on the structure of final demand, but even the extent to which one can regard these conditions as realistic is questionable. Moreover, we are constrained in the inter-country comparison by the static nature of the analysis which makes the aggregation conditions in the dynamic Leontief model irrelevant for present purposes. Last but not least, condition VI (concerning the way of aggregating components of final demand which are not assumed constant) which might seem most promising is unfortunately not applicable in the present case either. Namely, to the extent that our task will be to compute the direct and indirect requirements of output of section j, this will always be done on the assumption that all, not only some, components of final demand will change.

It seems, therefore, that we have to resign ourselves to the fact that there is most likely to be a bias introduced into our analysis as

26. For example, the 'input-homogeneous' structure implied in (standard) condition I as well as the specific matrix structures defined in terms of (i) complete decomposability, (ii) indecomposability, and (iii) cyclicity should be regarded as excessively severe.

a result of aggregation. The question arises, therefore, what the implications are for the analysis. In general, the aggregation problem arising from aggregating a matrix of I-O flows of one country is obviously equally valid for aggregation of I-O matrix of another country.

Nevertheless, the difficulties arising from aggregation may not be as severe in inter-country comparisons as they are likely to be, for example, in forecasting. Thus, as long as the aggregation leads to the same bias in both countries, the inter-country comparison is not affected. Naturally, what will be affected is the interpretation of findings based on aggregated I-O tables. It may seem sensible, therefore, to ensure that the aggregation bias is kept to a minimum. Once again, the issue can be discussed on both the theoretical and practical level.

Theoretically, we should introduce a 'measure of closeness of linear transformations' represented by the micro and macro A-matrices for which we can use a matrix norm [Charness and Cooper (1961)]. For example, following Fisher (1958) we can minimize the aggregation bias (R) by minimizing the trace of the expected value of the second moment around zero of the aggregation bias[27] for different grouping matrices G, i.e.

$$\text{Minimize } R = \text{tr}E\left[(x^* - Gx)(x^* - Gx)'\right] \tag{35}$$

Fisher further makes the assumption that final demand y is a random variable with a mean value equal to its base year value (y_0) and variance proportional to the mean ($v\hat{y}_0$), v being a scalar and $\hat{y}_0$ being written in diagonal matrix form. Using equations (25) and (35) we can write

$$\text{Minimize } R = \text{tr}E\left(\{[(I^* - A^*)^{-1}G - G(I - A)^{-1}]y\}\{[(I^* - A^*)^{-1}G - G(I - A)^{-1}]y\}'\right) \tag{36}$$

27. The advantage of using the second rather than the first moment around zero as the criterion is that we can take into account the deviations irrespective of their sign. More importantly, it can be easily shown that, on average and under assumptions specified further in the text, the aggregation bias vanishes. See Neudecker (1970), p. 922.

and using the above assumptions[28] we obtain for the second moment around zero of the aggregation bias

$$R = v\ \mathrm{tr}[(I^* - A^*)^{-1}G - G(I - A)^{-1}]\hat{y}_0[(I^* - A^*)^{-1}G - G(I - A)^{-1}]' \qquad (37)$$

where the symbol '^' refers to diagonal matrix and the symbol ''' the transpose. Expression (37) is operational in the sense that it can be minimized for different grouping matrices G. Alternatively, we may wish to find directly the coefficient matrix A corresponding to a given grouping matrix by minimizing

$$\mathrm{tr}[(I^* - A^*)^{-1}G - G(I - A)^{-1}]\hat{y}_{00}[(I^* - A^*)^{-1}G - G(I - A)^{-1}]' \qquad (38)$$

where $\hat{y}_{00} = v\hat{y}_0 + y_0y_0'$ is the second moment around zero of final demand y which yields [Neudecker (1970), p. 923]

$$(I^* - A^*)^{-1} = G(I - A)^{-1}\hat{y}_{00}G'(G\hat{y}_{00}G')^{-1} \qquad (39)$$

So expression (39) gives A* which brings (38) to minimum minimorum.

There have been further attempts to find a method of aggregation which minimizes the aggregation bias in other ways. Among the best known is the method based on 'cluster analysis'.[29] The clustering problem is to find M-clusters from n-objects defined by q attributes in such a way that members of a cluster are similar to each other but are different from objects outside the cluster. As before, the M-clusters refer to a number of macro-sectors of the aggregated table and the 'n' objects are the column vectors $(a_1, a_2, \ldots, a_n)$ of the micro-table. The 'q' attributes for the j-th object are the j-th column's I-O elements $(a_{1j}, a_{2j}, \ldots, a_{ij})$. The members of a cluster have

28. Without the special assumptions, equation (36) would refer to the trace of the variance of the aggregation bias. See Neudecker (1970), p. 922.

29. For more details, see Blin and Cohen (1977), pp. 82-4. Leontief (1967), too, suggests an alternative to common aggregation which is based on 'double-inversion'.

been typically identified as similar on the basis of two well-established methods.[30] One measure of similarity is provided by the square of the Euclidean distance [Ward (1963)] :

$$E_p = \sum_{j=1}^{n_p} \sum_{i=1}^{q} (a_{ij(p)} - \bar{a}_{i(p)})^2 \qquad (40)$$

where E_p defines the error sum of squares for cluster p (i.e. within-group-squared deviations about the mean $\bar{a}_{i(p)} = (1/n_p)\sum_j a_{ij_{(p)}}$ and $a_{ij(p)}$ is the I-O coefficient in the p-th cluster and there are $n_p q$ in the p-th cluster The total error sum of squares is

$$E = \sum_{p=1}^{M} E_p \qquad (41)$$

which enables one to decide on that fusion of micro-sectors into clusters which yields the smallest increase in E. Alternatively, we may use correlation coefficients instead of Euclidean distance to merge at each stage those two micro-sectors with the most similar mean vectors or centroids (Sokal and Michener (1958)).

The choice among the various methods of aggregation is not straightforward. Fisher's method is awkward since it involves the inversion of as many matrices (I* - A*) as there are aggregation patterns G. Alternatively, we could choose only a set of G's but may not be able to reach the optimal solution. In addition, an inversion of (I - A) is also required. Neudecker's alternative based on the specification of the second moment around zero of the final demand vector y has considerable mathematical advantages. On the other hand, if we were to relax the assumption, we would obtain too stringent conditions for non-negativity of the Leontief matrix (Neudecker (1970), p. 926).

The 'cluster analysis' approach also has some disadvantages. To use the method, we first decide on the basis of a statistic (such

30. Both of the following methods will be used in the analysis later in this study.

as correlation coefficient or Euclidean distance) which micro-sector should be merged and then, in the actual analysis, we would measure the similarity among macro-sectors. The characteristic feature of this method is that we do not have so much control over the aggregation scheme and the question arises, therefore, whether the macro-sectors obtained from the fusion are economically (rather than statistically) meaningful.

In the present study, the Czechoslovak I-O table was published in the form in which it is used here and the only aggregation undertaken was a consolidation of the Austrian table down to the size of 18 sectors. Nevertheless, no attempt was made to apply any of the aggregation schemes. While the theory does not provide an unambiguous guide for aggregation there are also some reasons to believe our failure to seek an optimal pattern of aggregation of the Austrian table is not serious and that our heuristic approach is at least acceptable on some grounds for the purpose at hand, if not preferable on others. First, our aggregation scheme was adopted in such a way as to correspond as closely as possible to the UN classification of standardized I-O tables. Thus, our aggregation aims at making our data directly comparable with the UN tables, and provides a basis for comparing our findings with similar findings elsewhere.

Second, while obviously not perfect, the NRP groups are relatively homogeneous compared to the remaining sectors of manufacturing industry.[31] Moreover, the share of food (one of our NRP sectors) in total private expenditure in both countries was high in the period under consideration.[32] This means that changes in final demand were to a large extent represented

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31. According to Kymn (1977), however, a significant aggregation of I-O tables is possible without seriously affecting the power of the aggregated table to forecast energy (i.e. an element of NRP) sector output level.

32. See Chapter III.

by changes in food consumption which is one sector which remained unaggregated. Thus, according to aggregation condition VI above, this should mitigate the size of the bias.

Third, the bias which we would like to avoid most is the one which affects the size of direct as well as direct-plus-indirect NRP coefficients (i.e. the coefficients in the Leontief inverse matrix). To the extent that the NRP sectors produce homogeneous products in both countries, these sectors may also be more likely to employ similar technologies.

Fourth, by following the UN classification of standardized tables, we are assuming that the individual sectors which form a 'cluster' (an 'industry') in the I-O tables of Czechoslovakia and Austria are most likely to be 'economically related' in the same way as those which form a cluster in the UN methodology. Fortunately, experiments based on 'cluster analysis' have revealed that there is a considerable degree of similarity between clusters generated by minimizing the aggregation bias and those generated heuristically [Blin and Cohen (1977), p. 87].

Finally, further studies of the 'cluster analysis' type suggest that countries with similar economic structures also have a similar number of 'attributes'. This suggests, in turn, that we may be allowed to use an aggregation scheme based on these cluster tests. The UN methodology is an attempt to unify the methodology for all ECE countries including those for which the 'cluster analysis' has been carried out.

7. The price circuits and measures of matrix space

There are two final issues which have to be dealt with in international comparisons of production and use of commodities in the I-O model.[33]

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33. The following issues are more general and they are not restricted to I-O analysis.

First, the comparisons may be subject to price differences among countries, so there would be a need to distinguish between true differences in technology (or final demand or output) and 'optical' differences due to differences in prices. Second, in order to measure the degree of similarity or difference, a measure of 'matrix space' is needed. Let us begin with the price issue.

The Leontief system can be re-written in the following form disregarding, for simplicity's sake, the primary inputs.

$$
\begin{aligned}
p_{11}\bar{X}_{11} + p_{12}\bar{X}_{12} + \dots + p_{1n}\bar{X}_{1n} + p_{1n+1}\bar{Y}_1 &= \sum_{j=1}^{n+1} p_{1j}\bar{X}_{1j} \\
p_{21}\bar{X}_{21} + p_{22}\bar{X}_{22} + \dots + p_{2n}\bar{X}_{2n} + p_{2n+1}\bar{Y}_2 &= \sum_{j=1}^{n+1} p_{2j}\bar{X}_{2j} \\
\vdots \qquad\qquad & \qquad \vdots \\
p_{n1}\bar{X}_{n1} + p_{n2}\bar{X}_{n2} + \dots + p_{nn}\bar{X}_{nn} + p_{nn+1}\bar{Y}_n &= \sum_{j=1}^{n+1} p_{nj}\bar{X}_{nj}
\end{aligned}
\qquad (42)
$$

where p_{ij} refers to the price of the i-th commodity supplied to the j-th sector, $\bar{X}_{ij}$ is the delivery of the i-th product used in the production of the j-th commodity (i.e. j-th sector by assumption) and $\bar{Y}_i$ is the delivery of the i-th commodity to final demand. Both $\bar{X}_{ij}$ and $\bar{Y}_i$ are expressed in physical units. In other words, we are considering the commodity x commodity flow matrix and making a distinction between price and volume circuits.[34]

Using matrix notation and definition (1) from above let us define first the coefficient matrices in value and physical terms (A and $\bar{A}$ respectively) and the coefficient vectors of final demand in value and physical terms ($_f f$ and $_f \bar{f}$).

$$A = X\,\hat{x}^{-1} \qquad (43)$$

34. The implied assumption of the distinction between price and volume circuits is that we are able to measure all physical flows but this is not usually possible in practice (e.g. output of 'services'). The practical solution is, of course, to compile I-O tables in value terms and the distinction is made here only for presentational purposes.

$$\bar{A} = \bar{X}\,\hat{\bar{x}}^{-1} \tag{44}$$

$$_y y' = \nu_1 y' \text{ where } \nu_1 = (i'y)^{-1} \tag{45}$$

$$_y \bar{y} = \nu_2 \bar{y}' \text{ where } \nu_2 = (i'\bar{y})^{-1} \tag{46}$$

where $i = (1, 1, \ldots, 1)$ and y is the flow vector of final demand, x is the flow vector of output and X is the flow transaction matrix (all in value terms). As before, the bar over the letter refers to physical as opposed to value terms.

The specific feature of the Leontief model as described above is that it allows for different prices to be charged to different users of the same commodity, i.e. $p_{ij} \neq p_{ik}$ for $j \neq k$. Under competitive conditions, it is assumed that $p_{ij} = p_{ik}$ and for the system (42) as a whole, we can write, using matrix notation,

$$x = \hat{p}\,\bar{x} \tag{47}$$

$$X = \hat{p}\,\bar{X} \tag{48}$$

$$y = \hat{p}\,\bar{y} \tag{49}$$

where the symbol '^' identifies a diagonal matrix.[35]

Thus, using (43) - (46) and (48) - (49) we can write

$$A = \hat{p}\,\bar{A}\,\hat{p}^{-1} \tag{50}$$

and

$$_y y = \nu_3(\hat{p}\bar{y}) \text{ where } \nu_3 = \left[i'(\hat{p}\bar{y})\right]^{-1} \tag{51}$$

35. The assumption of uniform pricing principle is represented, of course, only by equations (48) and (49). The interpretation of equation (47) is trivial; it simply states that total value of each commodity produced can be obtained as the product of price and quantity.

Given the assumption (48), equation (50) represents a similarity transformation and it is well known that certain characteristics of matrices are invariant under similarity transformation. For example, Augustinovics (1970, p. 259) discusses the case of ratios between two types of inputs used in two absorbing sectors. Kýn and Šimerda (1974) show that the trace and the dominant characteristic root of the technology matrix are also independent of the price and valuation systems. In general, however, the usefulness of these characteristics in empirical work is highly limited [Augustinovics (1970), p. 258].

Now, turning to our empirical case, we see that the assumption of a uniform pricing principle (i.e. $p_{ij} = p_{ik}$ for $j \neq k$) must be valid, not only for the MTE and, therefore, for (competition-oriented) Austria but also for the practices of the centrally-planned economy of Czechoslovakia. The principle is typically adopted in the compilation of all I-O tables and, to the best of my knowledge, there is no evidence which would contradict the assumption in the case of Czechoslovakia. Moreover, the actual role of the price system in our comparisons which are examined more comprehensively in Appendix 1 will be mitigated by the methods chosen for the analysis as we shall see later.

Comparison of technological matrices and vectors (or matrices) of final demand for different countries according to equation (50) and (51) requires further finding a measure of similarity or, to put it differently, a measure of 'matrix space'. In the literature, a number of different methods have been distinguished and used since there appears to be no unambiguous disaggregate measure of matrix space.[36] Following Ward, Blin and Cohen (1977), for example, we shall adopt Euclidean distances as a measure of

36. For more discussion of this point see Chapter IV below. See also the following footnote.

similarity. Repeating equation (40) above, this can be written as

$$E_p = \sum_{j=1}^{n_p} \sum_{i=1}^{q} (a_{ij(p)} - \bar{a}_{i(p)})^2 \qquad (40)$$

which is an expression for the within group-squared deviations about the mean $\bar{a}_{ij(p)}$ which in turn were used by Blin and Cohen in 'cluster analysis' discussed earlier. We shall use this and related measures of similarity in this study as well.

Referring to two technological matrices such as A_C and A_A, the problem is, therefore, to find a disaggregate[37] measure of matrix space $d(A_C, A_A)$. Another measure which we shall use in this study will be matrix distance which defines the matrix space in terms of a difference matrix

$$d(A_C, A_A) = D^\circ = A_C - A_A \qquad (52)$$

The actual measures of (dis)similarity are then the parameters of the underlying distribution of the 'difference coefficients', ${}_\circ d_{ij}$, the elements of D°. Perfect similarity implies, of course, distribution of ${}_\circ d_{ij}$ with zero mean and zero variance.

In view of the absence of an unambiguous disaggregate measure of matrix distance we shall use several tests of similarity. Another and the last technique which we shall use is the correlation model. This technique has some advantages in comparison to other techniques and it has been, therefore, widely used in the literature.[38]

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37. A measure which refers to disaggregate rather than aggregate properties of matrix space is needed in this study since we shall be referring to individual (i.e. NRP) I-O coefficients. Note further that A_C refers here to the I-O coefficient matrix of a country (i.e. Czechoslovakia), previously symbol A_C referred to I-O coefficient matrix derived from 'commodity technology From now on, subscript "c" will identify Czechoslovakia.

38. We shall return to this in Chapter III. For the particular advantages in the context of this study see discussion further below.

CHAPTER III PRODUCTION, TRADE AND THE USE OF NATURAL RESOURCE PRODUCTS IN CZECHOSLOVAKIA AND AUSTRIA

1. Introduction

In this chapter we shall start by analysing the structure of foreign trade and the demand for NRP in Czechoslovakia and Austria. In doing the latter we shall distinguish between intermediate and final demand. We shall assume throughout this and the following chapter that the relative prices are the same in both countries even though the price levels may differ. Thus, the comparisons will be made on the basis of price-unadjusted data, i.e. data which we actually observe. This assumption will be relaxed in Chapter V.

It is convenient to distinguish between two approaches to the study and measurement of production structures: the input approach and th output approach. The input approach specifies the values of outputs (or primary inputs) required per unit of output or of final use. The output approach, on the other hand, specifies output (primary input) requirements at successive stages of production. Even though there are some similarities between the approaches, it is the input approach which is consistent with the concept of production techniques and hence technology and we shall, therefore, concentrate on this approach. Both the methods and their properties are discussed in Augustinovics (1970).[1]

As we indicated in the Introduction it is also possible to identify in the literature two separate methods of assessing the impact of technical progress on the demand for intermediate inputs. Traditionally the most frequently used method involves an analysis of direct and full (i.e. direct-plus-indirect) I-O coefficients. For convenience we have called

1. A major advantage of the 'output-model' is that when expressed in value terms and under certain assumptions, it is independent of the price and valuation systems. Augustinovics (1970), pp. 256-60 discusses this point in more detail together with other indicators which are independent of the price system. Unfortunately, the usefulness of the price-indeoendent indicators is very limited for an analysis of intermediate demand but we shall employ some of these indicators particularly in this chapter and the next chapter.

these 'direct methods'. On the other hand, the 'indirect methods' of technological assessment in the I-O system involve an evaluation of changes in industrial interdependence over time which in turn is based on the hypothesis that the production structure is determined by technology. Clearly both approaches can be applied to static international comparisons. Various methods and techniques can be used in the study of industrial interdependence. A detailed survey of these techniques can be found in Watanabe (1969) and is, therefore, not included here. In general, all the techniques of both 'direct' and 'indirect' approaches distinguish essentially between several features of the production structure, which may be broadly categorised as: (i) intersectoral dependence, (ii) intermediate use, (iii) production techniques and (iv) overall comparisons of inter-industry flows.[2] Among the variety of techniques which can be identified in the literature on the comparison of production structures, the 'linkage indices' of the Chenery or Rasmussen type are perhaps best known even though rather simplistic.[3] In contrast, a rather different approach has been adopted by Simpson and Tsukui (1965) who innovated systems of 'fundamental properties of I-O relations'. Simpson and Tsukui start from the traditionally held belief that the structure of production as represented by the matrix of I-O coefficients is determined by technology. Using the logic of this argument, they suggest that the I-O matrices of different countries should exhibit some common properties which have a technological origin - if the technology used by those countries is indeed similar. Simpson and Tsukui refer to such common properties as the 'fundamental properties of I-O

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2. The distinction was made by Song (1977), pp. 147-62.

3. Chenery-Watanabe indices describe how each industry in the economy depends on other industries for its inputs (a 'backward' linkage) and upon them as intermediate purchasers of its output (a 'forward' linkage). Rasmussen's 'total linkage indices' refer to similar I-O relatives but, unlike Chenery and Watanabe indices, they are derived from the Leontief inverse matrix. For more details, see Chenery and Clark (1959), p. 201 and Rasmussen (1956), pp. 13-140. See also Yotopoulos and Nugent (1976), p. 300 for further discussion and references concerning verification and measurement of linkages.

relations'. The properties can be defined as follows.

(i) Matrix decomposability. An I-O matrix is said to be decomposable if industries can be grouped according to their I-O physical characteristics such as metals, non-metals, energy and services.[4]

(ii) Block decomposability. Blocks created on the basis of physical qualities of products are to a large extent independent in that an industry is not related to other industries outside its own block.[5]

(iii) Triangularity. A matrix is said to be perfectly triangular if all entries lie either above or below the main diagonal.[6]

(iv) Physical homogeneity of blocks. The industries in each block have a common physical characteristic.

The methods used in this study will include the traditional method of comparing individual direct and full I-O coefficients. The analysis in this chapter will involve simple comparisons of the (direct) I-O coefficients and a more rigorous comparison of the I-O coefficients will follow in Chapter IV. As indicated above, the comparison of I-O coefficients is not unusual and the choice of this technique was determined on the basis of the following considerations. First, the decision to use these indicators was dictated by the standard methodology typically adopted in empirical tests of the same kind as that adopted here. The conformity of our methodology with the methodology adopted in other studies enables us, therefore, to compare our findings with those in similar studies in the foreign trade literature such as Vanek (1959) and Naya (1967).[7] Examples of this approach also include Chenery and Clark (1959) and, among more recent studies, Song (1977). Third, the choice can also be justified on the grounds that

4. At the same time, the blocks follow the order of sectors in the triangulated matrix. This property is sometimes called block triangularity.

5. This property is sometimes called 'block-diagonality'.

6. The property is discussed in more detail in Chapter IV.

7. The standard foreign trade literature usually relies on the comparison of I-O coefficients to measure the degree of technological similarity particularly with regard to the assumption known as 'factor reversals'. For details, see, for example, Baldwin (1971).

there are certain advantages in testing for similarity in I-O coefficients rather than using other techniques of technological comparison.[8]

However, the advantages of the direct approach are not unambiguous. Among the major elements of the generalized I-O model, the more complex forms appear to have been more stable and should be, therefore, more reliable. In this context, final structure matrices are considered more complex forms than the matrices of total coefficients which, in turn, are regarded as more complex than the matrix of direct coefficients (Augustinovics (1970), pp. 260-1). In contrast to intertemporal comparisons where the concept 'stability' refers to variability over time, the concept of 'stability' in international comparisons refers to variability among countries. We have decided, therefore, to apply the matrix triangulation technique as one of the alternative methods of comparing technological matrices among countries.

Under the assumptions of fixed coefficients of production with regard to the scale of output and the 'substitution effect', it seems particularly important to identify those parts of the I-O tables of Czechoslovakia and Austria which represent 'fundamental properties' of production (which, in turn, reflect common technology) and others which represent peculiarities of production. It is precisely with this objective in mind that the analysis based on matrix triangulation will be carried out in Chapter IV. Moreover, the use of matrix triangulation seems very suitable for the purpose at hand since, in comparison to, for example, 'linkage indices' it is possible to consider the spread of purchases among sectors (Simpson and Tsukui (1965), p. 443). In general, the matrix triangulation technique is a more general way of measuring structural interdependence but, in comparison to summary indicators of various structural characteristics, the triangulation technique can be used to study the fundamental properties of I-O matrices in qualitative terms. Moreover, and perhaps most importantly, triangulation as a more

8. See, for example, Yotopoulos and Nugent (1976), p. 302.

complex method of comparing production structures is likely to be less prone to statistical errors, which naturally leads to greater reliability (Augustinovics (1970),p.261). The techniques adopted to compare the various structural characteristics will be described as we proceed.

2. Natural resource product content of foreign trade in Czechoslovakia and Austria

2.1 Methodology of the Leontief statistics

The NRP content will be calculated here by means of Leontief statistics. These are a convenient means of calculating the proportion of factors (products) required directly and indirectly in the production of exportables and importables. The Leontief statistic (σ) represents the ratio of the NR requirements per unit of exports and those per unit of import replacements.

$$\sigma = \frac{L_X}{L_M} \qquad \text{(for notation, see below)} \qquad (1)$$

Under conditions specified in the Introduction, the ratio σ in equation (1) can be suitably estimated by the ratio of NRP requirements per unit of exports and those per unit of import replacements.

The inter-country comparison of Leontief statistics represented by Ω is the rate of σ's for the compared countries "c" and "A" under consideration

$$\Omega = \frac{[L_X/L_M]_C}{[L_X/L_M]_A} \qquad (2)$$

In this study, values of both σ and Ω will be considered; while σ identifies the NRP content of trade, the statistic Ω represents a measure for comparing trade structures on an inter-country basis.

The notation used is as follows:[9]

c Czechoslovakia

A Austria

Y_{ij} value of supplies of commodity output i to final demand component j

9. In general, the notation in the whole study is uniform and follows the standard notation in the literature. To assist the reader, the relevant notation glossary will be repeated in several parts of the study. In addition, we have seen in Chapter I that the Czechoslovak and Austrian I-O tables were compiled on a mixture of 'commodity' and 'industry' definitions of sectors. The notation adopted in the rest of the study treats both tables as if they were compiled on the basis of commodity definition only.

L_X	productive services of natural resources directly embodied in NRP exports
L_M	productive services of natural resources directly embodied in NRP imports
Y_j	value of total final demand j
X_{ij}	value of supplies of i to industry j
X_j	gross output of industry j
a_{ij}	technological coefficient
ε_i	share of commodity i in total exports
μ_i	share of commodity i in total imports
EX	value of total exports
IM	value of total imports
E_i	value of domestic supplies of commodity output i for exports
M_i	value of imports of commodity i
$x_i^{e,m}$	direct and indirect gross output requirements of i for exports (e), imports (m) in <u>absolute</u> terms
x; $_d\hat{x}$	vector of total output and domestic output respectively
^a_dx; $^{ar}_dx$	vectors of domestic gross output in value and relative terms respectively under hypothetical autarky
X	flow matrix of intermediate deliveries
$_dX$	flow matrix of domestic intermediate deliveries
w	vector of wage bills
z	vector of non-wage value added
t	vector of value added (net output, primary inputs) ('commodities')
t^t	coefficient vector of value added (net output, primary inputs, ('commodities')
x^x	coefficient vector of gross input
y^Y	coefficient matrix of final demand
A	transaction matrix of direct I-O coefficients
e	export vector
m	import vector
i	vector with all elements being 1, i = (1, 1, ..., 1)

Three types of calculations will be undertaken: <u>direct</u> NRP requirements of exports and imports in relative magnitudes, <u>full</u> (i.e. total whic means direct and indirect) NRP requirements of exports and imports in absolute magnitudes and in relative magnitudes. These calculations will then constitute the basis for the calculation of the Leontief statistics.

The calculation of direct NRP requirements of exports and imports is straightforward. Direct NRP requirements are simply given as the value of NRP exports and imports. The relative magnitudes are then calculated as the shares of individual NRP commodity groups in total exports and imports. In the I-O tables exports and imports are represented by two separate columns in the second quadrant (final demand) of Version 'A'.[10] The formulae for calculating the direct NRP content of exports and imports in relative magnitudes (ε_i and μ_i respectively) are as follows.

$$\varepsilon_{i(C)} = \left(\frac{E_i}{EX}\right)_C \tag{3}$$

$$\varepsilon_{i(A)} = \left(\frac{E_i}{EX}\right)_A \tag{3.1}$$

$$\mu_{i(C)} = \left(\frac{M_i}{IM}\right)_C \tag{4}$$

$$\mu_{i(A)} = \left(\frac{M_i}{IM}\right)_A \tag{4.1}$$

where i ranges over industries 101, 102, 103 and 104 of the input-output classification.

Full NRP requirements of exports and imports in absolute terms (X_i^e and X_i^m respectively) were calculated from Version 'A' according to the following formulae

$$(x^e)_C = (I - A)_C^{-1} \quad (e)_C \tag{5}$$

$$(x^e)_A = (I - A)_A^{-1} \quad (e)_A \tag{6}$$

$$(x^m)_C = (I - A)_C^{-1} \quad (m)_C \tag{7}$$

$$(x^m)_A = (I - A)_A^{-1} \quad (m)_A \tag{8}$$

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10. For a detailed description of Version 'A' and difference from Version 'B', see Chapter 1.

where i ranges over industries 101, ..., 118.

Finally, full NRP requirements of exports and imports in <u>relative</u> magnitudes were calculated by dividing x^e and x^m in equations (5) and (7) for Czechoslovakia (6 and 8 for Austria) by full (i.e. direct plus indirect) requirements of value added in total exports and total imports respectively. These are normalised magnitudes of gross output requirements of NRP in exports and imports.

The Leontief statistic (σ) for each of our countries is calculated as the ratio of e_i and m_i, X_i^e and X_i^m and x_i^e and x_i^m from formulae (3)-(8) and as the ratio of the normalised gross output requirements in total exports and total imports.

Strictly speaking, the Leontief statistic refers to the amounts of NRP which would have to be produced domestically in order to replace imports and which would be saved by eliminating all exports. In other words, the statistic does not refer to the foreign NRP requirements of their exports to Czechoslovakia (Austria) as one would require, for example, in testing the Heckscher-Ohlin model of foreign trade. However, this procedure is usually adopted in the empirical literature and we shall follow the established practice. Moreover, we are assuming that in principle it will be possible to replace all imports, i.e. even those which are complementary.

It may be useful to note that, strictly speaking, this does not correspond to the more traditional methodology adopted for calculations of factor proportions in the Hecksher-Ohlin framework. Starting with

Leontief himself,[11] the usual approach has been to calculate factor proportions directly and indirectly required per unit of exports and import replacements. Thus, in the actual calculations, the matrix of full NRP coefficients would have to be multiplied by the vectors of exports and of imports respectively per unit of total exports and total imports.[12] However, as long as we are not concerned with proving or disproving the theory we do not need to worry about possible overestimation of the NRP content either on the export or import side. On the contrary, in line with our aim to identify a structural bias in the foreign trade of Czechoslovakia, the methodology is more appropriate. This is because trade under central planning has, until recently, relied almost exclusively on the rule of trade balancing.[13] On the other hand, Austria's balance of payments has been dependent traditionally on capital inflow (which has been substantial), in addition to receipts from tourism.[14]

As a next step we shall compare the structure of gross aggregate output, net output, final demand and I-O coefficients where gross and net aggregate output are defined respectively as follows:

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11. Leontief (1969), pp. 101-25.

12. One of the crucial assumptions of the theory is that movement of production factors across frontiers is not allowed. Otherwise, cheaper and more mobile production factors may not be embodied in exported commodities but they could instead move across the frontiers and thus eliminate the differences between external and internal prices (the case of a small country which is a price taker). Since deficits on current account are usually balanced by surpluses on capital account the calculations of factor proportions are based on the comparison of unit-requirements, which relates the factor proportions to typical exports and typical imports. The methodology based on the hypothetical situation of complete export diversion and complete replacement of imports could, therefore, lead to distortions in the Leontief statistic by overestimating factor proportions on the export or import side.

13. In other words, imports should be paid for by exports. On recent changes, see Matejka (1975), pp. 443-79.

14. In 1964, the trade deficit of Austria was 12,515 million schillings representing 31.4 per cent of Austria's exports.

$$\left.\begin{aligned} x_A &= (X'i)_A + w_A + z_A \\ x_C &= (X'i)_C + w_C + z_C \end{aligned}\right\} \quad (6.1)$$

$$\left.\begin{aligned} t_A &= w_A + z_A \\ t_C &= w_C + z_C \end{aligned}\right\} \quad (6.2)$$

The coefficient vectors (matrices) of gross aggregate output, net output, final demand and the transaction matrices are then defined as:

$${}_x x' = \nu_4 x' \text{ where } \nu_4 = (i'x)^{-1} \quad (6.3)$$

$${}_t t' = \nu_5 t' \text{ where } \nu_5 = (i't)^{-1} \quad (6.4)$$

$${}_y Y = Y(\widehat{Y'i})^{-1} \quad (6.5)$$

$$A = X\hat{x}^{-1} \quad (6.6)$$

where the symbol '^' identifies a diagonal matrix, and the prime identifies a transpose.

2.2 Direct natural resource content of trade

The role of NRP in the trade of Czechoslovakia has a certain similarity to its role in that of Austria but there is also an important difference. With respect to NRP, the similarity lies in heavy dependence on imports. Both countries are net importers of NRP and each is relatively well endowed with some natural resources (coal in Czechoslovakia, minerals in Austria). The food component of NRP is, therefore, the dominant group of NRP (see Table III.1).

The characteristic difference between the two countries' structure of foreign trade is reflected in the different content of NRP entering directly into exports and imports (Definitions 1-2 above). The export-import ratio, although significantly below unity in both countries, is lower in the case of Czechoslovakia than it is in Austria (Table 2, columns 5 and 6). In contrast to Czechoslovakia, Austria is a net exporter of one major NRP group - minerals (103). A glance at columns 1, 2, 7 and 8 will quickly reveal why the overall ratio is smaller. First, Czechoslovakia had become by 1962 extremely import-dependent with respect to her domestic requirements of NRP. Based on our definition of NRP, imports of NRP accounted for almost 45 per cent of total imports (compared with only 25 per cent for Austria). Seventy-seven per cent of overall NRP imports were represented by imports of food. In terms of our comparison with Austria, the commodity group which exercised the largest influence on import dependence was processed food (104). Nevertheless, even the import shares of 101 (agriculture, etc.) and 103 (minerals) were more than 60 per cent above the import shares of Austria.

Second, as shown in Table III.2, both Czechoslovakia and Austria exported approximately the same proportion of their exports in the form of NRP. Therefore, the difference in the overall NRP export-import ratio must be attributed to the different shares of NRP imports.

In order to complete the picture of direct NRP trade requirements in both countries, data in absolute terms are provided in Table III.3. The data on the Leontief statistics shown in column 3 are not comparable with those shown in Table III.2, column 5 for reasons which will be explained later. However, they represent a supplementary source of information on the Leontief statistics, and, as far as the absolute amount of direct requirements is concerned, they are used below for the calculation of indirect NRP requirements.

2.3 Direct and indirect requirements of natural resource products of exports and import replacements

The results of our calculations of direct and indirect NRP requirements of exports and of import replacements both for Czechoslovakia and Austria are summarized in Table III.4 below which is based on equations (5)-(8) above. They show gross output requirements

Table III.1: Structure of trade: Czechoslovakia (1962) and Austria (1964)

(total = 100)[a]

(percentages)

	EXPORTS		IMPORTS	
Sectors[b]	Czechoslovakia	Austria	Czechoslovakia	Austria
Agriculture	3.05	2.51	19.24	11.82
Coal,oil,gas	1.63	0.01	4.20	4.49
Mining	0.30	4.57	5.38	3.34
Food processing	5.32	2.35	15.87	5.34
Textiles	6.01	7.13	1.39	8.17
Shoes, etc.	4.60	5.34	0.68	3.02
Wood processing	5.23	15.92	1.89	3.86
Rubber	0.60	1.62	0.17	0.83
Chemicals	3.30	6.27	8.37	10.44
Oil,coal proc	2.60	0.50	1.23	2.93
Non-ferrous metallurgy	4.82	1.71	1.41	0.59
Basic metals	6.15	16.52	12.30	8.16
Transport, vehicles	16.65	2.17	4.35	9.62
Engineering	29.92	25.22	19.64	23.10
Electricity	0.24	2.40	0.14	0.41
Construction	-	0.25	-	0.14
Trade	6.80	2.73	-	3.67
Transport	2.79	2.77	3.76	0.07

Notes: (a) Not adjusted for rounding
(b) For detailed sectoral classification, see Chapter I.

Source: The data in this table and in all following tables of this chapter are based on the author's computations from standardised I-O tables of Czechoslovakia (1962) and Austria (1964).

Table III.2: Direct natural resource product requirements of exports and imports in Czechoslovakia (1962) and Austria (1964); relative magnitudes

	Czechoslovakia (C)		Austria (A)		Czechoslovakia	Austria	Exports	Imports
	Exports	Imports	Exports	Imports	Export:Import (Column 1:2)	Export:Import (Column 3:4)	C :A (1:3)	C :A (2:4)
Sectors	1	2	3	4	5	6	7	8
Agriculture (101)	3.05	19.24	2.51	11.82	0.1585	0.2124	1.2151	1.6277
Coal,oil,gas (102)	1.63	4.20	0.01	4.49	0.3881	0.0022	163.0000	0.9354
Other mining (103)	0.30	5.38	4.57	3.34	0.0558	1.3683	0.0656	1.6108
Food processing (104)	5.32	15.87	2.35	5.34	0.3352	0.4401	2.2638	2.9719
101+102	4.68	23.44	2.52	16.31	0.1997	0.1545	1.8571	1.4372
101+103	3.35	24.62	7.08	15.16	0.1361	0.4670	0.4732	1.6240
101+104	8.37	35.11	4.86	17.16	0.2384	0.2832	1.7222	2.0460
102+103	1.93	9.58	4.58	7.83	0.2015	0.5849	0.4214	1.2235
102+104	6.95	20.07	2.36	9.83	0.3463	0.2401	2.9449	2.0417
103+104	5.62	31.25	6.92	8.68	0.1798	0.7972	0.8121	3.6002
101+102+103	4.98	28.82	7.08	19.65	0.1728	0.3603	0.7034	1.4667
102+103+104	7.25	25.45	6.93	13.20	0.2849	0.5250	1.0462	1.9280
101+103+104	8.67	40.49	9.43	20.50	0.2142	0.4600	0.9194	1.9751
101+102+104	10.00	39.31	4.87	21.65	0.2544	0.2249	2.0534	1.8157
101+102+103+104	10.30	44.69	9.44	24.99	0.2305	0.3778	1.0911	1.7883

Source: As for Table III.1.

Table III.3: Direct natural resource product requirements of exports and imports in Czechoslovakia (1962) and Austria (1964): absolute magnitu

VERSION 'A'[a]

Czechoslovakia Sectors	Exports 1	Imports 2	Exports/Imports 3
Agriculture (101)	1028.80	6060.80	0.1697
Coal,oil,gas (102)	549.60	1321.80	0.4158
Other mining (103)	99.70	1694.60	0.0588
Food processing (104)	1795.20	4998.40	0.3597
All NRP (101-104)	3473.30	14075.60	0.2468

Austria Sectors			
Agriculture (101)	999.0	6069.0	0.1646
Coal,oil,gas (102)	3.0	2307.0	0.0013
Other mining (103)	1822.0	1715.0	1.0623
Food processing (104)	936.0	2744.0	0.3411
All NRP (101-104)	3760.0	12835.0	0.2929

Note: (a) For definition of Version 'A' see Chapter I.

Source: As for Table III.1.

of exports and of import replacements of individual NR industries and various combinations thereof for Czechoslovakia in 1962 and Austria in 1964 (columns 1 and 2). Column 3 gives the respective indices of NRP requirements of exports relative to those of import replacements. The results from Table III.4 provided in column 3 are summarized in columns 1 and 2 of Table III.5. Column 3 of Table III.5 compares the Leontief statistics in Czechoslovakia and Austria. Column 4 of the same table indicates the degree of difference between the Leontief statistics for the two countries.

Our computations indicate that the Leontief statistics both for Czechoslovakia and Austria were very low and below unity. As shown in Table III.5, columns 1 and 2 respectively, the statistic for Czechoslovakia was 0.39463 and for Austria 0.50373. Out of the four NRP groups the export embodiment exceeds that of import replacement in only one case: viz., minerals (sector 103) in Austria.

The most interesting aspect of the comparison of the Leontief statistics is that the statistic for Czechoslovakia is smaller than for Austria. It is lower in spite of the fact that the disaggregated value of 102 is more than twice as large as that of Austria. Comparison of the aggregated values of the Leontief statistics remains virtually unchanged if 101 (agriculture, etc.) or 104 (food processing) respectively are excluded from the computations.

2.4 Leontief statistics: relative magnitudes

The alternative way of computing the Leontief statistics is by means of the share of NRP requirements of exports and of import replacements in the total value added required per unit of exports and import replacements. The computations are summarized in Table III.6, column 7 and could be compared with Table III.5, column 3.

An interesting difference can be observed from a comparison of the

Table III.4: Direct and indirect natural resource product requirements of exports and import replacements: Czechoslovakia (1962) and Austri (1964)

VERSION 'A'

(in terms of kčs (Schilling) per 1 mn. kčs (Schilling) of exports and import replacements)

Czechoslovakia (1962) Sectors[a]	Exports 1	Import replacements 2	Exports: Imports replacements 3
Agriculture (101)	2586.61	8796.36	0.29405
Coal,oil,gas (102)	2403.08	3211.70	0.74823
101+102	4989.69	12008.06	0.41553
Other mining (103)	928.38	2611.83	0.35545
101+102+103	5918.07	14619.89	0.40480
Food processing (104)	2329.98	6280.69	0.37098
All NRP (101+102+103+104)	8348.05	20900.58	0.39463
102+103+104	5661.44	12104.22	0.46772
102+103	3331.46	5823.53	0.57190
103+104	3258.36	8892.52	0.36642
101+102+104	7319.67	18288.75	0.40023
101+103+104	5844.97	17688.88	0.33043
101+103	3514.99	11408.19	0.30811
102+104	4733.06	9492.39	0.49862
Austria (1964) Sectors[a]			
Agriculture (101)	4029.70	9742.52	0.41362
Coal,oil,gas (102)	1554.71	4442.41	0.34997
101+102	5584.41	14184.93	0.39369
Other mining (103)	3528.89	3345.43	1.05484
101+102+103	9113.30	17530.36	0.51986
Food processing (104)	1763.04	4061.13	0.43413
All NRP (101+102+103+104)	10876.34	21591.49	0.50373
102+103+104	6846.64	11848.97	0.57783
102+103	5083.60	7787.84	0.65276
103+104	5291.93	7406.56	0.71449
101+102+104	7347.45	18246.06	0.40269
101+103+104	9321.63	17149.08	0.54356
101+103	7558.59	13087.95	0.57752
102+104	3317.75	8503.54	0.39016

Note: (a) For sectoral codes, see Appendix.

Source: As for Table III.1.

Table III.5 Direct and indirect natural resource product requirements of exports and import replacements: Czechoslovakia (1962) and Austria (1964)

Sectors[a]	Czechoslovakia Export:Import[b] 1	Austria Export:Import[b] 2	Column 1: Column 2 3	Sign of column 1 (column 2=1)[c] 4
Agriculture (101)	0.29405	0.41362	0.71092	$<$
Coal,oil,gas (102)	0.74823	0.34997	2.13798	$\geqq$
101+102	0.41553	0.39369	1.05548	$\geq$
Other mining (103)	0.35545	1.05484	0.33697	$\leqq$
101+102+103	0.40480	0.51986	0.77867	$<$
Food processing(104)	0.37098	0.43413	0.85454	$\leq$
All NRP (101+102+103+104)	0.39463	0.50373	0.78342	$<$
102+103+104	0.46772	0.57783	0.80944	$<$
102+103	0.57190	0.65276	0.87613	$\leq$
103+104	0.36642	0.71449	0.51284	$\leqq$
101+102+104	0.40023	0.40269	0.99389	$\leq$
101+103+104	0.33043	0.54356	0.60790	$\leqq$
101+103	0.30811	0.57752	0.53351	$\leqq$
102+104	0.49862	0.39016	1.27799	$>$

Notes: (a) For sectoral codes, see Appendix.

(b) Import replacements .

(c) (1) Sign '$<$' indicates smaller export requirements of NRP of exports than those of import replacements in Czechoslovakia as compared to the same in Austria.

(2) Sign '$\leqq$' indicates the same as (1) above but the inequality is stronger.

(3) Sign '$>$' indicates the opposite of (1) above.

Source: As for Table III.1.

Table III.6: Leontief statistics - relative magnitudes

Sectors[a]	Austria		Czechoslovakia		Austria	Czecho-slovakia	Column 6: Column 5	Column 3: Column 1	Column 4: Column 2
	Exports	Import[b]	Export	Import[b]	Export: Import[b]	Export: Import[b]		$(EX_C : EX_A)$	$(IM^b_C : IM^b_A)$
	1	2	3	4	5	6	7	8	9
Agriculture (101)	0.101160	0.189728	0.076580	0.279261	0.53318	0.27414	0.51416	0.75702	1.47190
Coal,oil,gas (102)	0.039029	0.086512	0.071147	0.101963	0.45114	0.69777	1.54668	1.82293	1.17860
Other mining (103)	0.088588	0.065150	0.027486	0.082919	1.35975	0.33148	0.24378	0.31027	1.27274
Food processing (104)	0.044259	0.079087	0.068983	0.199395	0.55962	0.34596	0.61821	1.55862	2.52121
All NRP (101+102+103+104)	0.273036	0.420477	0.244196	0.663538	0.64935	0.36802	0.56675	0.89437	1.57806
(101+102+104)	0.184448	0.355327	0.216688	0.580619	0.51909	0.37320	0.71895	1.17491	1.63404

Notes: (a) For sectoral codes, see Appendix.

(b) Import replacements.

Source: As for Table III.1.

alternative values of Leontief statistics. The statistics for Czechoslovakia as compared to those of Austria are even lower as shown in Table III.5. After excluding sector 103 the statistics are still not identical. Because of the methodology applied in the computation, the difference must be due, apart from the different gross output requirement per unit of exports and of import replacements, to higher requirements of value added in import replacements in Austria compared with Czechoslovakia. An interpretation and further discussion of this point is provided in the final chapter.

The advantage of this method is that it enables a comparison of the direct and indirect NRP requirements of exports (and import replacements) of Czechoslovakia and Austria. We have seen above that the Leontief statistic for Czechoslovakia was lower than that for Austria but it was not possible to specify whether this was due to lower NRP requirements per unit of exports or due to higher NRP requirements per unit of import replacements. In fact, as Table III.6, columns 8 and 9 have shown, it was the combination of lower NRP requirements of exports as well as higher NRP requirements of import replacements which resulted in the lower values of the Leontief statistic. The higher NRP requirements per unit of import replacements produced, nevertheless, the dominant influence.

2.5 Influence of indirect requirements on the value of Leontief statistics

A closer inspection of Tables III.2 and III.3, on the one hand, and III.5 and III.6, on the other, will reveal differences between the values of the Leontief statistics. Since the first pair of tables concentrates on the direct NRP requirements of foreign trade while the second concentrates on the full requirements (i.e. direct and indirect), the residual of the differences would lie in different indirect NRP requirements. In order to estimate the indirect NRP requirements, we shall employ the 'absolute' rather than the 'relative' method.[15]

Before comparing indirect requirements, let us summarize the relevant conclusions of the previous sections.

	Czechoslovakia : Austria
Direct NRP requirements - Exports	1.0911
Full[a] NRP requirements - Exports	0.8944
Direct NRP requirements - Imports	1.7883
Full[a] NRP requirements - Imports	1.5781

Note: (a) Direct and indirect

Our data show the following:

(i) Direct NRP content of exports of Czechoslovakia was similar to that of Austria (or slightly higher);

(ii) Full NRP content of exports of Czechoslovakia was smaller than that of Austria implying smaller indirect NRP content of Czechoslovak exports;

(iii) Direct NRP content of Czechoslovak imports was much higher than that of Austria;

(iv) Full NRP content of Czechoslovak import replacements was also much higher than that of Austria but not to the same extent as in the direct case (iii

15. Each method serves a definite purpose and has, therefore, its own validity. For this reason, let us recall first what each type of calculation identifies. The direct requirements calculated by the relative method specify the NRP content per unit of expenditures of total exports and import replacements. The direct requirements calculated by the absolute method specify the NRP content of total exports and import replacements. With respect to the Leontief-type of calculations, the difference between the methods lies in different hypothetical situations. In the former case, we would assume that only one unit of exports was to be diverted for domestic use and one unit of imports was to be replaced. In the latter case, we would refer to the complete export diversion and import replacements.

The full requirements calculated by the absolute method specify the value of gross NRP output which would be required directly and indirectly for complete diversion of exports and for complete replacement of imports. The full requirements calculated by the relative method specify the same hypothetical situation but the value of gross NRP output is taken as a proportion of total value added required directly and indirectly to divert exports and replace imports completely. The advantage of the former case is that it enables us to calculate indirect requirements in each country. The advantage of the latter is that it will give a broader base for inter-country comparison.

Although the nature of the influence of the indirect requirements can be derived from the above data, we can estimate them more precisely (see Table III.7). The comparison of indirect NRP requirements is shown in Table III.8

The comparison of indirect NRP content of trade in both countries shows certain similarities. First, the direct NRP content of exports was lower than the indirect in both countries (columns 7, 8). Second, the direct NRP content of imports was larger than the indirect.

However, there were also significant dissimilarities. Table III.8 shows that direct requirements relative to indirect requirements of NRP for exports were larger in Czechoslovakia than in Austria. A similar result was obtained for import replacements. Again, the direct requirements of NRP for import replacements as compared to indirect ones were substantially larger in Czechoslovakia than in Austria. As a result, the ratio of the two Leontief statistics (Ω) calculated in terms of indirect requirements was smaller in Czechoslovakia than in Austria but substantially smaller than in the case of direct requirements.

Ratio of direct Leontief statistics $\Omega_1 = \frac{0.2305}{0.3778} = 0.6101$

Ratio of indirect Leontief statistics $\Omega_2 = \frac{0.6996}{0.8127} = 0.8608$

Ratio of full Leontief statistics $\Omega_3 = \frac{0.3680}{0.6494} = 0.5668$

The influence of indirect requirements was, therefore, to increase further the dissimilarity between the countries with respect to NRP content of foreign trade. However, due to the difference in Ω_1 and Ω_2, the differences in Ω_3 were mainly due to differences in direct NRP requirements.

Since direct NRP requirements for exports were very similar (as shown in Table III.2), we may conclude that the differences in Ω_3 were primarily due to differences in direct NRP requirements of imports. For the purpose of our discussion we will identify these differences as the main source of the foreign trade bias in Czechoslovakia.

Table III.7: **Indirect natural resource product requirements of exports and import replacements:** Czechoslovakia (1962) and Austria (1964)

VERSION 'A'

(in millions of national currencies)

Czechoslovakia

Sectors[a]	Exports Direct 1	Exports Full 2	Imports Direct 3	Imports Full 4	Exports Indirect 5 (column 2-1)	Imports Indirect 6 (column 4-3)
Agric. (101)	1028.80	2586.61	6060.80	8796.36	1557.81	2235.56
Coal,oil,gas (102)	549.60	2403.08	1321.80	3211.70	1853.48	1889.90
Other mining (103)	99.70	928.38	1694.60	2611.83	828.68	917.23
Food proc. (104)	1795.20	2329.98	4998.40	6280.69	534.78	1282.29
All NRP (101-104)	3473.30	8248.05	14075.60	20900.58	4774.75	6824.98

Austria

Sectors[a]	Exports Direct 1	Exports Full 2	Imports Direct 3	Imports Full 4	Exports Indirect 5 (column 2-1)	Imports Indirect 6 (column 4-3)
Agric. (101)	999.00	4029.70	6069.00	9742.52	3030.70	3673.52
Coal,oil,gas (102)	3.00	1554.71	2307.00	4442.41	1551.71	2135.41
Other mining (103)	1822.00	3528.89	1715.00	3345.43	1706.89	1630.43
Food proc. (104)	936.00	1763.04	2744.00	4061.13	827.04	1317.13
All NRP (101-104)	3760.00	10876.34	12835.00	21591.49	7116.34	8756.49

Note: (a) For sectoral codes, see Appendix.

Source: As for Table III.1.

Table III.8 Comparison of indirect natural resource product requirements of exports and import replacements: Czechoslovakia (1962) and Austria (1964)

VERSION 'A'

Sectors[a]	Direct : Indirect Czechoslovakia Exports (columns 1:5)[b] 7	 Austria Exports (columns 1:5)[b] 8	Direct : Indirect Czechoslovakia Imports (columns 3:6)[b] 9	 Austria Imports (columns 3:6)[b] 10
Agric. (101)	0.6604	0.3296	2.2156	1.6521
Coal,oil,gas (102)	0.2965	0.0019	0.6994	1.0804
Other mining (103)	0.1203	1.0674	1.8475	1.0519
Food proc. (104)	3.3569	1.1317	3.8980	2.0833
All NRP (101-104)	0.7274	0.5284	2.0624	1.4658

Sectors[a]	Indirect Czechoslovakia Export/Import (columns 5:6)[a] 11	 Austria Export/Import (columns 5:6)[a] 12
Agric. (101)	0.5695	0.8250
Coal,oil,gas (102)	0.9807	0.7266
Other mining (103)	0.9035	1.0469
Food proc. (104)	0.4171	0.6279
All NRP (101-104)	0.6996	0.8127

Notes: (a) For sectoral codes, see Appendix.

(b) For columns 1-6 refer to Table III.7.

Source: As for Table III.1.

2.6 Effect of hypothetical autarky on the value of Leontief statistics

We have seen in the previous section that our methodology for calculating NRP content implied a hypothetical situation of complete diversion of exports for domestic uses and complete replacement of imports. This follows from equations (3) and (4) above. In other words, in order to calculate the NRP content of trade we have assumed a hypothetical case of complete autarky.[16]

The interpretation of such calculations will, therefore, have to be formulated as follows. Assume that all imports and exports are eliminated while domestic production remains unchanged. The calculated NRP content of imports will then indicate the total amount of NRP required directly and indirectly to replace total imports. The calculated NRP content of exports will indicate the total amount of NRP which will be released directly as a result of the 'disappearance' of NRP exports and, indirectly, as a result of the 'disappearance' of non-NRP exports.

Although the calculations are interesting it is clear that their use is restricted to the extreme case of autarky. Since neither exports nor imports were actually discontinued the calculations do not reflect the actual NRP content. We will, therefore, now identify the sources of error as they entered into our calculations.

Let us recall that Version 'A' which was used in our calculations does not distinguish between domestic supplies and imports. Under the hypothetical case of autarky there would be various pressures put on domestic NR industries to increase output. Let us assume, for example, that domestic production was to remain unchanged while exports and imports are cut off. On the one hand, the elimination of imports would then represent additional requirements imposed on domestic NR production. On the other hand, exports could be redirected to domestic uses and thereby reduce the additional NRP

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16. The use of I-O technique under the assumption of complete autarky was discussed in some detail in Skolka (1974), pp. 120-4.

requirements. The ultimate effect could be that both the structure of final demand as well as the structure of intermediate demand might change.

However, among the various pressures on the domestic NR base there are two of particular relevance to our calculations.

(1) Version 'A' does not tell us anything about the content of exports and imports in terms of domestic and imported NRP. The calculated NRP content of exports and import replacements included NRP supplies which were produced domestically and imported. For one thing, some NRP imports could have been directly re-exported.[17] More importantly, NRP imports were used as inputs in domestic production and some were also allocated to other uses of final demand. If we add direct and indirect requirements of domestic and imported NRP for total final use and compare them with actual domestic production, we obtain a residual representing the additional value of NRP required in the case of autarky. Similarly, the ratio between direct and indirect NRP requirements for total final use and the actual domestic output of NRP would give us the degree of overestimation of actual NRP requirements.

Using Version 'A' and the solution to the I-O model shown in Chapter II, we can compute for each country the direct and indirect requirements of domestic and imported NRP as

$$x = (I - A)^{-1} y \qquad (9)$$

and compare these requirements with actual domestic gross output $({}_{d}x)$

$$(x) - ({}_{d}x) = ({}^{a}_{d}x) \qquad (10)$$

where $({}^{a}_{d}x)$ stands for a vector of additional domestic gross output required in case of autarky in absolute terms

or

$$({}^{a}_{d}x)' \, ({}_{d}\hat{X})^{-1} = ({}^{ar}_{d}x)'_{1} \qquad (11)$$

17. This is not shown in our I-O table.

and

$$(x)' \, (\widehat{_d x + m})^{-1} = (^{ar}_{d}x)'_2 \qquad (12)$$

where $(_d X)$ and $(_d x+m)$ are diagonal matrices generated from vector $(_d x)$ and from the sum of vectors $(_d x)$ and (m) respectively. The symbol $(^{ar}_{d}x)_2$ stands for vectors of additional domestic gross output required in a case of autarky in relative terms.

(2) The direct-and-indirect NRP requirements for total final use calculated by means of Version 'A' will be larger than those which are derived from the sum of direct and indirect requirements of domestic and imported NRP. Direct and indirect requirements of domestic and imported NRP computed from Version 'B' are

$$\left.\begin{aligned} {}_d x &= (I - {}_d A)^{-1} \; {}_d y \\ m &= {}_m A (I - {}_d A)^{-1} \; {}_d y \end{aligned}\right\} \qquad (13)$$

where $(_d x) + (m) < (x)$. Equation (13) is clearly the solution of the I-O model based on our Version 'B' as shown in Chapter II.

The interpretation of the residual is as follows: under the hypothetical case of autarky, a country would have to produce more than what is actually provided by existing resources (actual domestic output plus actual imports). This is because the country's 'savings' in terms of domestic output include not only that portion of output which would have to be produced to replace imports but, also, additional output directly and indirectly required to supply such imports, given the structure of output, final demand and technology in the import replacing country.

We can see, therefore, that our calculations of the NRP content of trade in both countries overestimate the actual requirements in terms of domestic NRP. This is a shortcoming of Version 'A' since the autarkic treatment of exports, and, particularly, imports are unrealistic. Thus,

(i) Some imports cannot be replaced at all because they are not available domestically. The risk of the impossibility of replacing imports increases particularly with NR.[18]

(ii) Even if imports can be replaced physically this will be accompanied by price changes. Again, the probability of price increases as a result of import replacement will be very high in the case of NR, particularly those which are exhaustible.[19]

(iii) Autarky may also affect domestic structure and/or prices through exports. The smaller the country and the higher the share of industrial output in GNP, the more likely it is that such a country would require large export markets for an efficient allocation of domestic resources.[20]

Theoretically, we could overcome the shortcoming by following the traditional treatment of imports whereby they are divided between competitive and non-competitive imports, the former being included in the second and the latter in the third quadrant of the input-output table. However, this distinction was not possible in practice as we have seen earlier. Moreover, the product mix of small countries is likely to be narrower than that of larger countries at a comparable level of development.[21]

For these reasons, we had to rely on what has become a customary treatment of imports in the case of small countries by treating all imports as competitive.[22] We can, however, correct for the shortcoming by calculating

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18. The availability of NR is used as the basis of explaining international trade flows in Kravis' model. See Kravis (1956), pp. 143-55.

19. The point was discussed in the second Leontief article: see Leontief (1956), p. 395. On the theoretical treatment of equilibrium price formation of exhaustible NR see, for example, Solow (1974), pp. 1-14.

20. The determination of GNP growth by growth of exports, as one element in the causal process, was established, for example, by Maizels (1968), pp. 44-5.

21. Obviously, this is not to argue that the Czechoslovak structure of production was highly specialized.

22. Such treatment of imports was also undertaken in the UN study quoted: United Nations (1971).

the degree of overestimation with the help of Version 'B'. This has been done in Tables III.9 and III.10. Our data in Table III.9, columns 3 and 4, show how much the actual domestic NRP output would have to increase to accommodate complete replacement of imports assuming that domestic final demand remains constant. The results are based on computations using equations (10) and (11). The data in Table III.10, column 5, show, under the same assumptions as those applied in Table III.9, and based on equation (12), how much domestic output would have to increase over and above that actually produced (actual domestic output plus actual imports). This amount may be called NRP 'savings' which would have to be employed directly and indirectly if the imports were to be <u>produced</u> domestically.

The degree of overestimation resulting from the assumption of complete autarky is relatively high in both countries. It is about 23 per cent in terms of domestic NRP output in Czechoslovakia and 27 per cent in Austria, and about 6 and 10 per cent respectively in terms of actual resources. The additional requirements of hypothetical output under autarky are relatively small in the case of food processing (104) and the degree of overestimation is almost identical in both countries. However, in the case of other commodity groups the hypothetical output would have to increase substantially. At the extreme, domestic output of non-fuel mining industries (103) in Czechoslovakia would have to increase by as much as 352.3 per cent and domestic output of fuels (102) in Austria by 133.1 per cent to replace corresponding imports. Whether this would be feasible, given the actual NR endowment of each country, cannot be determined from our I-O calculations.

2.7 <u>Summary</u>

In this section, we have calculated the NRP content of trade in Czechoslovakia and compared it with that of trade in Austria. The calculated NRP content of trade was then applied to the calculation of

Table III.9: Effect of hypothetical autarky on domestic natural resource product requirements: Czechoslovakia (1962) and Austria (1964)

Sectors[c]	Direct and indirect NRP requirements for final use[a]	Gross output[b]	1-2	Column 3 as per cent of column 2
	1	2	3	4
	(in millions of national currencies)			
Czechoslovakia				
Agriculture (101)	36810.05	28013.20	8796.35	131.4
Coal,oil,gas (102)	12026.20	8814.50	3211.70	136.4
Other mining (103)	3353.03	741.20	2621.83	452.3
Food processing (104)	61327.08	55046.40	6280.68	111.4
All NRP (101-104)	113516.36	92615.80	20900.56	122.6
Austria				
Agriculture (101)	39679.51	29937.00	9742.51	132.5
Coal,oil,gas (102)	7780.41	3338.00	4442.41	233.1
Other mining (103)	13042.43	9697.00	3345.43	134.5
Food processing (104)	40016.12	35955.00	4061.12	111.3
All NRP (101-104)	100518.47	78927.00	21591.47	127.4

Notes:

(a) Direct and indirect NRP requirements were calculated from Version 'A', data for total final demand.

(b) Both Version 'A' and Version 'B' can be applied.

(c) For sectoral codes, see Appendix.

Source: As for Table III.1.

Table III.10: Natural resource product savings with trade: Czechoslovakia (1962) and Austria (1964)

Sectors[b]	Gross output 1.	Imports 2.	Total resources (column 1+2) 3.	Direct and indirect NRP requirement for final use[a] 4.	Column 4 as per cent of column 3 5.
		(in millions of national currencies)			
Czechoslovakia					
Agriculture (101)	28013.70	6060.80	34074.50	36810.05	108.0
Coal, oil, gas (102)	8814.50	1321.80	10136.30	12026.20	118.6
Other mining (103)	741.20	1694.60	2455.80	3353.03	137.7
Food proc. (104)	55046.40	4998.40	60044.80	61327.08	102.1
All NRP (101-104)	92615.80	14075.60	106691.40	113516.36	106.4
Austria					
Agriculture (101)	29937.00	6069.00	36006.00	39679.51	110.2
Coal, oil, gas (102)	3338.00	2307.00	5645.00	7780.41	137.8
Other mining (103)	9697.00	1715.00	11412.00	13042.43	114.3
Food proc. (104)	35955.00	2744.00	38699.00	40016.12	103.4
All NRP (101-104)	78927.00	12835.00	91762.00	100518.47	109.5

Notes:

(a) Version 'A'

(b) For sectoral codes, see Appendix.

Source: As for Table III.1.

the Leontief statistic (Ω) which is used in this study as a statistical measure for inter-country comparisons of trade structures.

The NRP import bias in both countries is not surprising, given their relatively poor natural resource endowment. However, there were also significant differences between their trade structures. While the NRP content of exports in Czechoslovakia was very similar to that of Austria, the amounts of NRP required directly and indirectly for import replacement in Czechoslovakia were substantially higher than those in Austria. In other words, Czechoslovak imports were characterized by what we call an NRP bias. This bias was created mainly by direct rather than indirect NRP requirements for import replacements.

Thus, the comparison of the foreign trade of Czechoslovakia (C) and Austria (A) is defined by the following properties:

(1) The NRP content of foreign trade of both countries is smaller for exports than for imports, where measured directly or indirectly.

$$\left(\frac{N_x}{N_m}\right) C,\ A \quad < \quad 1$$

(2) The above ratio is smaller for Czechoslovakia than for Austria.

$$\left(\frac{N_x}{N_m}\right) C < \left(\frac{N_x}{N_m}\right) A$$

(3) The NRP content of exports of Czechoslovakia is very similar to that of Austria.

$$\frac{(N_x)_C}{(N_x)_A} \simeq 1$$

(4) The NRP content of Czechoslovak imports is significantly higher than the NRP content of Austrian imports.

$$\frac{(N_m)_C}{(N_m)_A} \gg 1$$

Finally, our methodology implied a certain degree of overestimation of the actual domestic NRP requirements for exports and import replacements.

The calculated degree of overestimation amounted to 23 per cent in Czechoslovakia and 27 per cent in Austria in terms of gross output and 6 and 10 per cent respectively in terms of actual resources.

3. Production and final demand

It has been demonstrated above that Czechoslovak imports had a higher NRP content than Austrian. This may, in turn, indicate that domestic demand in Czechoslovakia was biased towards NRP in comparison with Austria unless the share of domestic production in total supply was relatively smaller. In this section, therefore, we shall compare the structure of domestic output and final consumption to see how the import bias defined under condition (4) above was reflected in the structure of domestic output and final demand.

3.1 (a) Structure of gross aggregate output

In the following discussion we shall analyse the degree of similarity of the aggregate structure of output in both countries, and the extent to which these structures differ. In addition, an attempt will be made to identify sectors which could be defined as leading sectors in the two economies. The weight of NRP industries in the aggregate output is analysed in the final part of this sub-section.

The structure of aggregate output is given in gross terms which include the value of intermediate inputs and value added and this, in turn, corresponds to the Western concept of gross aggregate output. Following the traditional approach we shall use the rank correlation technique to measure vector distance.[23] Obviously, the main reason for choosing the ranks rather than actual shares to compare the aggregate output is to minimize the effect of any differences in the price structure. The rank correlation coefficient was computed according to the following formula

23. More rigorous measures of vector and matrix distance will be applied in later chapters.

$$R_s = 1 - \frac{6\Sigma d^2}{N(N^2 - 1)} \qquad (14)$$

where d refers to rank differences and N to the size of the sample. The gross aggregate output is defined as

$$x_A = (X'i)_A + w_A + z_A$$
$$x_C = (X'i)_C + w_C + z_C \qquad (15)$$

where x vector of gross aggregate output

X flow matrix of intermediate deliveries

w vector of wage bills

z vector of non-wage value added

i vector with all entries being 1, i = (1, 1, ..., 1)

The basis of the present analysis is provided by data in Table III.11. The table shows the percentage shares of individual sectors and these weights are further ranked. It is quite apparent from the ranking of the sectors that the structure of gross aggregate output was quite similar to that of Austria. The Spearman rank correlation coefficient between the two sets is as high as 0.8122 which indicates a high degree of similarity.[24]

The differences in the structure of aggregate output are summarized in Table III.12 which includes sectors with significant differences in ranking. They are divided as between the leading sectors in each country taken separately.

24. The test does not show, however, that the two structures are similar in any statistically significant sense. This is one of the reasons why further tests, which will be carried out later, are necessary.

Table III.11: Structure of gross aggregate output: Czechoslovakia (1962) and Austria (1964)

Sectors	Czechoslovakia (in percentages)[a]	Austria	Czechoslovakia Ranks	Austria	Difference
Agriculture (101)	8.7	9.2	4	5	-1
Coal,oil,gas (102)	2.7	1.0	15	16	-1
Other mining (103)	0.2	3.0	18	12	+6
Food processing (104)	17.1	11.0	1	2	-1
Textiles (105)	4.3	3.0	10	11	-1
Shoes, clothing, leather, fur (106)	4.3	4.9	9	8	+1
Wood processing (107)	4.3	6.5	8	6	+2
Rubber (108)	1.0	0.8	17	17	0
Chemicals (109)	3.3	3.6	12	10	+2
Oil,coal processing (110)	2.9	1.3	13	15	-2
Non-ferrous metallurgy (111)	4.5	0.5	14	18	-4
Basic metals (112)	4.8	4.5	7	9	-2
Transport vehicles (113)	16.0	2.3	6	14	-8
Engineering (114)	2.1	9.9	2	4	-2
Electricity (115)	11.1	2.7	16	13	+3
Construction (116)	5.8	10.1	3	3	0
Trade (117)	3.8	20.0	5	1	+4
Transport (118)		5.9	11	7	+4

$R^2 = 0.8211$

Note:
(a) No allowance made for rounding and the total does not add up to 100. Ranks, on the other hand, were established on the basis of shares including two decimal points.

Source: As for Table III.1.

Table III.12 Large differences in industrial ranks: Czechoslovakia (1962) and Austria (1964)

Leading sectors in Czechoslovakia

Rank difference[a]	Sectors	
-8	Transport equipment	(113)
-4	Processing of non-metals	(111)
-2	Processing of oil, coal	(110)
-2	Basic metals	(112)
-2	Engineering	(114)

Leading sectors in Austria

Rank difference[a]	Sectors	
+6	Mining, excluding coal, oil, gas	(103)
+4	Trade, distribution	(117)
+4	Transport	(118)
+3	Electricity	(115)
+2	Chemicals	(109)
+2	Wood processing	(107)

Note: (a) Minus sign indicates lower rank in Czechoslovakia and plus sign indicates higher rank in Austria.

Source: As for Table III.1

The comparison of ranks reveals some of the differences in structure of the two aggregate outputs. First, Czechoslovak aggregate output was oriented relatively more towards processing activities. In fact, all sectors with significant rank differences are represented by one type of processing industry or another. The largest difference was accounted for by the sector of transport vehicles (113) which ranked sixth in Czechoslovakia but was well at the bottom of the list in Austria. In contrast, Austrian aggregate output included only two out of six important sectors which belong to the group of processing industries (chemicals and wood processing). By implication, Austrian aggregate output was generated relatively more by one primary industry group, two sectors of infrastructure and the electricity branch.

Second, the differences in structure of the two aggregate outputs were to some extent affected by the availability of domestic resources rather than differences in strategies. Thus, while processing activities can be developed through employment of two variable factors - capital and labour - or through some combination of both, the development of mining industries is additionally constrained by the fixed size of the NR. The extremely small share of the mining sector (103, which excludes fuels) in Czechoslovakia clearly documents this point.[25] Given our degree of disaggregation, non-fuel raw materials represent the only NR commodity to which the availability constraint can be applied. The NR factor in agriculture can be considered as reproducible and the expansion of agricultural output will be largely dependent on the quantities of inputs employed and on their efficiency. Nevertheless, the rent element enters into the picture through differences in the quality of land. Output of food processing cannot be considered as being in fixed supply since NR are used in this sector only indirectly. With respect to fuels, Czechoslovakia has large deposits of hard and brown coal while Austria has deposits of oil. However, similar reasoning would have to be applied if, for example, labour in Czechoslovakia were to be regarded as being in fixed supply given the currently low rate of population growth and an extremely high degree of labour participation.[26]

The bias towards processing activities in Czechoslovakia in comparison

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25. This point is elaborated in more detail in, for example, Pytel and Safar (1976) and further tests obtained in Berka and Zvacek (1970).

26. See Elias (1972), p. 43.

to the output structure in Austria can also be seen from the comparison of absolute shares. In this respect, it may be convenient to distinguish between producer and consumer goods within the processing industry group. Defining producer goods as sectors 108-114 and consumer goods as sectors 104-107, the former group accounted for 35 per cent of GNP in Czechoslovakia but for only 22.9 per cent in Austria. Consumer goods represented 30 per cent of GNP in Czechoslovakia (including food processing) and 25.4 per cent in Austria. However, these shares are considerably affected by differences in relative prices. In Czechoslovakia, as in any other CPE, consumer goods are subject to indirect taxation (turnover tax) while producer goods are usually not.[27] Hence, unless Austrian relative prices are changed through indirect taxation as are those in Czechoslovakia, it is clear that the latter are biased in favour of producer goods which are relatively cheaper in terms of consumer goods. Consequently, the higher share of producer goods in GNP in Czechoslovakia would be even higher if the relative prices were to be the same.

We have no simple way of demonstrating the Austrian bias towards non-processing activities, particularly the high share of wholesale, retail trade and distribution (117). Here, again, prices could substantially distort the picture. A significant distortion could also originate in this case, in different organization of trade and distribution. In particular, it is known that some of the activities of the trade and distribution sector were handled in Czechoslovakia by the productive sector itself. Nevertheless, the difference is again so large (5.8 per cent in Czechoslovakia compared to 20 per cent in Austria) that substantial differences in physical output are almost inevitable. What is perhaps even more significant is that output of this sector ranked first in Austria but only fifth in Czechoslovakia. Common sense makes this point quite obvious. The economic growth of Austria

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27. A detailed discussion of the structure of indirect taxation in Czechoslovakia can be found in the Appendix.

has been associated traditionally with the importance of tourism which, in turn, is dependent on a developed trade network. Unfortunately, the tourist industry will not be fully reflected in our comparison of output since non-productive services have been transferred from the third to the second quadrant of our I-O tables.[28]

The importance of the NR sector depends largely on the treatment of the food processing industry. If the output share of this sector is included in the aggregated NR sector, the Czechoslovak weight will be higher than the Austrian (28.7 per cent as compared to 24.2 per cent) and vice versa if the sector is excluded (11.6 per cent and 13.0 per cent). On the whole, however, there certainly was no simultaneous relative expansion of the NR sector in Czechoslovakia as might have been required by the bias towards producer goods.

3.2 Structure of net aggregate output

The structure of net aggregate output represents an alternative way of comparing the role of individual sectors in each economy. The merits and disadvantages of each concept were described elsewhere [29] and we do not need to enter into any detailed discussion concerning the methodology. It is enough to say that while the previous discussion referred to the concept approximating the structure of total domestic supplies, this section will concentrate on the concept which is commonly used in the West. The difference lies, therefore, in the inclusion or exclusion of intermediate supplies. The advantages and disadvantages obviously depend on the purpose for which they will be applied. Net aggregate output is defined as:

$$t_A = w_A + z_A \qquad t_C = w_C + z_C \qquad (16)$$

28. See Chapter I.

29. On the difference between 'gross' and 'net' output concepts and on advantages and shortcomings of each, see United Nations (1970), p. 13.

where t is the vector of total value added and w and z are the vectors of wage bills and non-wage value added respectively.

The net output concept was applied for the simple purpose of comparison with the results obtained in the previous section. We identified a relatively high degree of similarity in structure of output measured in gross terms in the previous section. If the structure of output in net terms is also similar in both countries, the import bias toward NR must be explained on the basis of domestic consumption. This, in turn, includes both the structure of final consumption and the structure of intermediate demand. Although the technology of production has a separate place in this study, some aspects of technology are included in the present comparison. Thus, similarity in a sectoral ratio of net to gross aggregate output is taken to imply a correspondingly similar sectoral ratio of material consumption per unit of gross output. There is obviously no reason why this should be the case. However, there is also no reason why the absorption of material inputs should be different for individual sectors in comparable economies. It is precisely for this reason that our discussion of output structure includes an analysis of aggregate output in net terms.

The actual structure of net output is shown in Table III.13 which also ranks individual sectors according to their shares in net aggregate output. The comparison of the ranks with those which were derived from the structure of gross aggregate output is provided in Table III.14. Table III.14 shows whether the ranks of individual industries in net aggregate output were lower, higher or the same as those obtained from the shares in gross aggregate output. In addition, significant changes in ranks are shown encircled.

It is apparent already from Table III.13 that the structure of net output in Czechoslovakia was substantially different from that of Austria. The value of the Spearman rank correlation declined from

Table III-13: Structure of net aggregate output: Czechoslovakia (1962) and Austria (1964)[a]

Sectors[b]	Czechoslovakia (in percentages)	Austria (in percentages)	Czechoslovakia Ranking	Austria Ranking	Difference
riculture (101)	8.7	11.5	4	2	+2
al, oil, gas (102)	3.4	1.6	11	16	-5
ner mining (103)	0.1	3.2	18	11	+7
od processing (104)	16.6	7.3	2	5	-3
xtiles (105)	5.1	2.1	6	14	-8
oes, clothing, ather, fur (106)	4.6	3.9	7	9	-2
od processing (107)	4.4	6.0	9	8	+1
bber (108)	0.9	6.2	17	7	+10
emicals (109)	3.1	3.0	12	13	-1
l and coal ocessing (110)	2.9	0.7	15	17	-2
n-ferrous tallurgy (111)	3.1	0.5	14	18	-4
sic metals (112)	3.1	3.3	13	10	+3
ansport hicles (113)	4.3	1.8	10	15	-5
gineering (114)	16.7	8.5	1	4	-3
lectricity (115)	2.4	3.2	16	12	+4
nstruction (116)	9.2	10.4	3	3	0
rade (117)	7.0	25.0	5	1	+4
ransport (118)	4.5	7.3	8	6	+2

$R_s^2 = 0.6429$

Notes:

(a) No allowance made for rounding. See also footnote (a), Table III.11.

(b) For sectoral codes, see Appendix.

Source: As for Table III.1.

0.8122 for the comparison of gross aggregate output to 0.6429 for the comparison of the two aggregate outputs in net terms. The structures of net and gross output were somewhat more similar in Czechoslovakia than in Austria if measured by the number of sectors retaining their ranks but not sufficiently enough to alter the argument.

This suggests, therefore, that of the two components of gross aggregate output - intermediate consumption and value added - it was the difference in structure of the latter which was primarily responsible for whatever differences existed in the structure of gross aggregate output. In contrast, the shares of intermediate consumption in gross aggregate output in individual sectors of the two countries were considerably more similar. A similar point was made in Stratil et al. (1970) and Berka and Zvacek (1970) who found considerable differences in the shares and in the structure of value added between Czechoslovakia and France.[30] These findings are not entirely surprising in view of the fact that value added in different branches and different countries can be significantly affected by fiscal policies of individual governments such as incomes policies, indirect taxation, subsidies, etc., and by other forms of market imperfections, e.g. monopolistic pricing, in addition to differences in productivity. What is important, however, is that the relatively high degree of similarity in the structure of gross aggregate output was brought about primarily by similarities in the structure of the share of intermediate consumption in gross aggregate output of the countries under consideration.

In order to complete the picture, Table III.15 provides a comparison

30. Stratil et al. (1970), p. 164 who computed the shares of the structure of value added in the form of what they called 'difference indicators'.

Table III-14: Rank comparison,[a] net and gross aggregate output: Czechoslovakia (1962) and Austria (1964)

Sectors[b]	Ranks[a] Czechoslovakia Lower	Higher	Same	Ranks[a] Austria Lower	Higher	Same
Agriculture (101)			X	(X)		
Coal, oil, gas (102)	(X)					X
Other mining (103)			X	X		
Food processing	X				(X)	
Textiles (105)	(X)				(X)	
Shoes, clothing leather, fur (106)	X				X	
Wood proc. (107)	X				X	
Rubber (108)			X	(X)		
Chemicals (109)			X		(X)	
Oil and coal proc. (110)		X			X	
Non-ferrous metallurgy (111)			X			X
Basic metals (112)		(X)			X	
Transport vehicles (113)		(X)		(X)		
Engineering (114)	X					X
Electricity (115)			X	X		
Construction (116)			X			X
Trade (117)			X			X
Transport (118)	(X)			X		
TOTAL	7	3	8	6	7	5

Notes:

(a) Ranks of individual industries in net aggregate output as compared to the ranks in gross aggregate output. Changes in ranks by at least three places expressed as crosses with circles.

(b) For sectoral codes, see Appendix.

Source: As for Table III-1.

Table III-14: Rank comparison,[a] net and gross aggregate output: Czechoslovakia (1962) and Austria (1964)

Sectors[b]	Ranks[a] Czechoslovakia Lower	Higher	Same	Ranks[a] Austria Lower	Higher	Same
Agriculture (101)			X	(X)		
Coal, oil, gas (102)	(X)					X
Other mining (103)			X	X		
Food processing	X				(X)	
Textiles (105)	(X)				(X)	
Shoes, clothing leather, fur (106)	X				X	
Wood proc. (107)	X				X	
Rubber (108)			X	(X)		
Chemicals (109)			X		(X)	
Oil and coal proc. (110)		X			X	
Non-ferrous metallurgy (111)			X			X
Basic metals (112)		(X)			X	
Transport vehicles (113)		(X)		(X)		
Engineering (114)	X					X
Electricity (115)			X	X		
Construction (116)			X			X
Trade (117)			X			X
Transport (118)	(X)			X		
TOTAL	7	3	8	6	7	5

Notes:

(a) Ranks of individual industries in net aggregate output as compared to the ranks in gross aggregate output. Changes in ranks by at least three places expressed as crosses with circles.

(b) For sectoral codes, see Appendix.

Source: As for Table III-1.

foreign trade. The basic difference between MTEs and CPEs is obviously the fact that in MTEs import decisions are usually taken by independent agents while under central planning they are usually taken by state trading organizations. In CPEs, therefore, the state ultimately decides on imports to meet its own demand, the demand of the co-operative sector, and that of private final consumers. This has the following important complication. Let us at first divide import demand into demand for material inputs and final demand. Under state trading, any import bias of final demand for a particular product does not necessarily imply a similar bias of firms' demand for the same product. Thus, for example, potatoes can be used as final products of private consumers or, alternatively as inputs of the food processing or distilling industry. Whether the imported potatoes will be allocated to one use or the other will depend on many factors including domestic production and stocks of potatoes, planned output target of the food processing (distilling) industry and its relation to the set of planners' priorities, the priority given by planners to final consumption (individuals, public, investment, exports), etc. As a consequence, the relative import dependence (measured, for example, as the ratio of imports to total supplies to private consumers and enterprises) may be substantially different and, for this reason, our analysis refers again to a comparison of the two economies on the level of domestic final demand without attaching any explanatory interpretation to the results. Before we proceed to compare the structure of final consumption, a few methodological points should be clarified.

First, the analysis of the structure of final consumption will concentrate on two aggregated product groups, i.e. NRP and non-NRP with only the former being disaggregated according to our input-output industry classification. The aggregation of individual non-NRP industries into one non-NRP group is considered adequate for the purpose of our analysis as long as the direct requirements of final consumption are significantly different.

Second, as in previous cases, this structural comparison will be subject to several influences. Thus, the structural differences may be again affected by potential differences in the physical structure of supplies to final consumption and by differences in relative prices. One additional and specific factor will influence the column comparison of final consumption, i.e. the bigger weight of non-productive services in Austria compared to Czechoslovakia which is included in the second quadrant of our I-O tables.

Third, the relative consumption levels of NRP and non-NRP are calculated as the shares of each in individual components of final demand. They represent, in fact, direct requirements of NRP and non-NRP per unit of individual components of final demand and are formulated as input coefficients. They can be expressed by the following formulae:

$$({}_{y}y_{ij})_C = \left(\frac{Y_{ij}}{Y_j}\right)_C \qquad (17)$$

$$({}_{y}y_{ij})_A = \left(\frac{Y_{ij}}{Y_j}\right)_A \qquad (18)$$

where i rows of industrial sectors (i = 1, ..., 18)

j columns of final demand (j = 1, ..., 4)

${}_{y}y_{ij}$ coefficient relating supply of commodity i to final user j as proportion of total purchases by user j

Y_{ij} value of commodity group i supplied to final consumption j

Y_j final consumption j

c Czechoslovakia

A Austria

The final consumption of NRP and non-NRP is shown in Table III.16 which gives the shares of NRP and non-NRP in total final consumption and in three individual components of final demand, namely private and public consumption, and investment. Since the export content of NRP was approximately the same in both countries,[31] exports as another component

31. See Section 2.5 above.

Table III.16: Direct final requirements of natural resource and non-natural resource products: Czechoslovakia (1962) and Austria (1964)

(percentages)

Sectors[a]	Private consumption		Public consumption		Investment		Total final consumption	
	Czechoslovakia	Austria	Czechoslovakia	Austria	Czechoslovakia	Austria	Czechoslovakia	Austria
Agriculture	10.04	8.50	3.10	1.66	-0.75	0.91	5.34	5.48
Coal,oil,gas	0.70	0.49	3.13	0.73	-	0.39	0.95	0.41
Other mining	-	0.24	0.17	2.16	-	3.02	0.05	1.79
Food processing	45.65	22.58	12.86	3.96	-	0.12	23.76	12.26
Total NRP	56.39	31.81	19.26	8.51	0.00	4.44	30.10	19.94
Total non-NRP	43.61	68.19	80.74	91.49	100.00	95.56	69.90	80.06

Notes: For sectoral codes, see Appendix.

Source: As for Table III.1.

of total final demand were omitted.

The table shows clearly that the relative consumption of NRP was substantially higher in Czechoslovakia than in Austria. The direct requirements of NRP per unit of final demand amounted to 30 per cent but the share was only 20 per cent in Austria. This was primarily due to relatively high food consumption in Czechoslovakia, the share of which in total final demand was twice as high as in Austria.

The differences in structure of domestic final demand can be seen particularly if the structure of private consumption is compared. It can be ascertained, in fact, that Czechoslovak private consumption was definitely biased towards food consumption, while the differences in the case of other NRP were considerably smaller. The NRP accounted for more than half of total private demand. Again, the share of food in total private consumption in Austria was significantly lower, being much more oriented towards such non-NRP as industrial consumer goods and services.

It may be objected, however, that private consumption is not the most convenient indicator of the bias in domestic consumption particularly since some of the private demand is met through the public sector. But, the share of food in total public consumption in Czechoslovakia was also well above that in Austria. Moreover, the weight which we should attach to private and public food consumption only underlines the basic picture. The share of private consumption of all NRP in total final consumption of NRP was as high as 88.9 per cent in Czechoslovakia. Although the share was only slightly smaller in Austria (81.6 per cent), it cannot affect the actual bias.

4. Technology

4.1 Structure of domestic output and demand for natural resource products

The question to which this section is addressed is whether, in view of the fact that imports must meet requirements not only of final consumers but also of intermediate producers, the structure of final demand can explain the import bias in Czechoslovakia towards NRP. There are several reasons why this may not be the case.

(i) The NRP content of non-NRP supplies to final consumption may have been lower (direct requirements of NRP per unit of output of non-NRP);

(ii) The NRP content of NRP may have been lower (direct NRP requirements per unit of output of NRP);

(iii) The NRP content of intermediate supplies of NRP and/or of non-NRP may have been higher (share of intermediate purchases of NRP and non-NRP in total supplies);

(iv) The same products from imports may have been preferentially allocated to intermediate purchasers (import fractions).

This section is limited to a discussion of conditions (i) and (ii).[32] The analysis will be based on a comparison of input coefficients which were calculated according to the following formula:

$$(a_{ij})_C = \left(\frac{X_{ij}}{X_j}\right)_C \quad \text{and} \quad (a_{ij})_A = \left(\frac{X_{ij}}{X_j}\right)_A \qquad (19)$$

where i — rows of natural resource product industries (i = 101 + 102 + 103 + 104)

X_{ij} — domestic and imported supplies of natural resource products to industry j (column j)

X_j — gross output of industry j

C — Czechoslovakia

A — Austria

The results of our calculations are provided in Table III.17 which shows the direct NRP requirements per unit of gross output in each of our 18

32. This analysis constitutes only one attempt to compare technology by means of I-O coefficient comparisons and further tests will be carried out later in this study, particularly in Chapters IV and V. Thus, we are starting from more simple tests and will proceed to more complex ones, a procedure which, as we have seen earlier, is usually followed in international comparisons.

Table III.17: Direct natural resource product requirements per unit of gross output in individual sectors: Czechoslovakia (1962) and Austria (1964)

(input coefficients)

Sectors[a]	Czechoslovakia 1	Austria 2	Ranks Czechoslovakia 3	Ranks Austria 4	Ranks Difference 5	Sign[b] 6
Agriculture	0.158306	0.079133	6	9	-3	>
Coal,oil,gas	0.028442	0.011983	14	16	-2	>
Other mining	0.069751	0.045890	10	12	-2	>
Food processing	0.322604	0.435349	2	2	0	<
Textiles	0.105416	0.113732	8	6	+2	=
Shoes, clothing leather,fur	0.038729	0.025297	13	14	-1	>
Wood processing	0.166596	0.375586	5	3	+2	<
Rubber	0.089380	0.069217	9	10	-1	>
Chemicals	0.111126	0.045547	7	13	-6	>
Oil,coal proc.	0.380471	0.492567	1	1	0	<
Non-ferrous metallurgy	0.063572	0.066945	11	11	0	=
Basic metals	0.191961	0.181395	4	4	0	=
Transport vehicles	0.004434	0.006109	18	18	0	=
Engineering	0.008047	0.009110	16	17	-1	=
Electricity	0.214569	0.107327	3	7	-4	>
Construction	0.005713	0.122379	17	5	+12	<
Trade	0.008692	0.100227	15	8	+7	<
Transport	0.046082	0.015038	12	15	-3	>
All industry (101-118)	0.115057	0.128023				<

Notes:

(a) For sectoral codes, see Appendix. $R^2 = 0.709$

(b) Sign '>' indicates that the absolute level of input coefficients is higher by at least 10 per cent in Czechoslovakia than in Austria and vice versa for the sign '<'. Sign '=' indicates that the absolute level of input coefficients in Czechoslovakia is neither higher nor lower than the absolute level of the coefficients in Austria after allowing for ± 10 per cent.

Source: As for Table III.1.

sectors both in Czechoslovakia and in Austria (columns 1 and 2). Each pair of input coefficients for each industry was compared to indicate the absolute level of the direct requirements in order to identify the NRP content of NRP and non-NRP. The similarity of the Czechoslovak input coefficients in comparison to those of Austria was defined as the Austrian coefficients after allowing for ± 10 per cent. The a priori 'acceptable' margin of error was adopted in order to allow for various structural and institutional influences (column 6).[33] The input coefficients were ranked (columns 3 and 4) and compared again on an inter-country basis (column 5). The similarity in the technological conditions or, more specifically, the measurement of matrix space is defined here as similarity in ranking of sectors according to their direct requirements of NRP (input coefficients).

Our results indicate that the similarity was fairly high, represented by the Spearman rank correlation coefficient of 0.709. The number of non-zero coefficients was also the same in the corresponding sectors of the two economies. In addition, there were only three sectors which were considerably out of line from the general pattern. In other sectors, the difference was relatively small and may be allowed for in view of the very different institutions of each country. On the other hand, the degree of similarity was not as high as we might have wanted. In particular, the rank differences of the three sectors, which include chemicals (109), construction (116) and wholesale and retail trade and distribution (117), were too big to accept a hypothesis of technological similarity without further examination.

4.2 'Anomalous' coefficients

An interesting feature of the technological comparison above is that

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33. The 10 per cent margin used here as a margin of error of the distance between the matrices is obviously arbitrary. On this point, see also the next chapter.

two out of the three sectors namely construction (116) and domestic trade and distribution (117), represent, in fact, what are often called non-trading industries. Products of the construction industry cannot be transported across frontiers and neither sector 116 nor sector 117 even enters foreign trade statistics.[34] Also, the relevant Spearman rank correlation coefficient (R_S^2) which, as we have seen, was 0.709 was increased to 0.960, if construction and internal trade, two 'badly behaved' sectors are excluded. However, neither of these two sectors enters foreign trade. This means, however, that the deviations in the technological comparison can be explained alternatively on the basis of structural differences which may include price, policy and other institutional variations. We will now turn to this aspect.

Domestic trade and distribution (117). This sector, which showed the second largest difference in ranking in Table III.17, needs least additional evidence to support our point. It was by far the most important sector in Austria (20 per cent of total gross aggregate output) and it ranked only fifth in Czechoslovakia (5.8 per cent). Even on a net basis, the importance of this sector was much bigger (the share of value added was about twice as high as compared to Czechoslovakia).[35]

Additionally, since transport costs of supplies to sectors considered as non-productive are included as intermediate purchases of this sector, the

34. Inputs of both sectors, however, can fully comply with the definition of traded goods. Therefore, the level and structure of imports may be dependent on the size of the non-traded sector. Theoretically, both sectors can obviously become trading sectors by allowing for free movement of factors of production. Furthermore, some complications may also arise from differences in the size of the countries and, consequently, the role of the transport services. Thus, there was a considerable difference in the average distance of freight transported by rail in 1962, i.e.

	Size of the country	Average distance
Czechoslovakia	127,869	252
Austria	83,849	170

Source: Stratil, et al. (1970), pp. 31, 77.

35. See Tables III.11 and III.13 above.

coefficients for the NRP inputs are consequently inflated by virtue of the smaller share of the non-productive sector in the Czechoslovak economy. Furthermore, the different input coefficients of NRP of this sector were due to differences in purchases of agricultural products by this sector (4.4 per cent of total supplies in the case of Austria but zero in Czechoslovakia). It seems, therefore, that the differences also lay in the system of food marketing.

Construction (116). The extreme difference in the ranking of NRP intensity of this sector was brought about by the differences in input coefficients shown in Table III.18. Moreover, the structure of demand for construction services also differed as shown in Table III.19. The distribution coefficients were computed as

$$_1C = \hat{x}^{-1}X \qquad (20)$$

$$_2C = \hat{x}^{-1}Y \qquad (21)$$

where $_1C$ and $_2C$ are matrices of distribution coefficients, x is a vector of gross output, X and Y are matrices of intermediate deliveries and final demand respectively.

Table III.18 Main differences in input coefficients of the construction sector: Czechoslovakia (1962) and Austria (1964)

(percentages of gross aggregate output of construction)

Inputs from:		Czechoslovakia	Austria
103	(Non-fuels raw materials)	0.01	11.87
107	(Processed woods)	6.26	3.01
111	(Non-metal mineral manufacturing)	13.99	0.83
114	(Engineering)	11.14	6.14
901	(Material consumption)	49.02	36.97
501	Depreciation	3.93	3.05
502	Wages	30.63	32.99
503	Taxes - subsidies	0.27	6.22
504	Other incomes	16.14	10.75
904	Value added	50.98	63.03

Source: As for Table III.1.

Table III.19 Distribution coefficients of the construction industry: Czechoslovakia (1962) and Austria (1964)

(percentages of total supply of the construction sector)

	Supply to:	Total intermediate purchases	Private consumption	Public consumption	Investment
Supplies from construction	Czechoslovakia	7.42	1.94	6.39	90.19
	Austria	10.38	5.87	10.82	72.63

Sources: As for Table III.1.

The difference in input coefficients can be explained on the basis of differences in the structure of supplies. In line with the policy of attributing priority to the producer goods sectors, construction works to meet private and public demand were disproportionately lower in Czechoslovakia than in Austria. On the other hand, construction works for investment (mainly expansion of the capacity of buildings) accounted for more than 90 per cent of the value of total supplies in Czechoslovakia but only slightly more than 70 per cent of the value of total supplies in Austria. Hence, the technological differences were accompanied by a different product-mix of the construction sector in each country.

The differences in the direct requirements of NRP by the construction industry were additionally affected by relatively higher material consumption in Czechoslovakia than in Austria (49 per cent of gross output in Czechoslovakia as compared to 37 per cent in Austria). However, the structure of value added was relatively similar.

Perhaps the most important factor affecting the structure of input coefficients was the difference in the use of products of mining and of processed mineral products (103 and 111 respectively). While in Czechoslovakia the construction industry did not require directly 'any' raw materials produced by sector 103 (mining),[36] the construction industry in Austria required as much as 11.9 per cent in terms of its own gross output. The pattern was reversed with respect to the use of processed mineral products (see Table III.18).

Chemicals (109). It is impossible to make a precise statement concerning the technology employed in this sector without a detailed analysis of the product-mix and detailed cost structure (i.e. disaggregation of inputs), and the degree of vertical integration in the chemical industry. The range of commodities produced by the chemical industry may have been vastly different in one country compared to the other and consequently also the industry's demand for NRP. The structure of material inputs will be especially dependent on the stage of processing employed in this sector. As we see below, the different direct requirements of NRP per unit of gross output were not so much due to different technology employed as due to the lower degree of processing in Czechoslovakia (Table III.20).

Electricity (115). Although the actual rank difference was not as big as in the cases shown above, NRP intensity of the electricty sector was still substantially higher than that in Austria. The main difference lay in the utilization of hard fuels which, as far as coal was concerned, were relatively more abundant in Czechoslovakia. The production of electricity in Austria, on the othe hand, was based relatively more on the utilization of water power. This corresponds to the relatively higher prime costs under the heading of 504 in Austria as shown in Table III.21.

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36. This, on the other hand, must also reflect different organization of supplies of raw materials, the effect of which is hard to distinguish from structural effects. Thus, 67 per cent of the value of total supplies of non-raw materials (103) were allocated to the 'Basic metals sector' (112) and only 0.2 per cent to construction (116). In spite of the fact that the level of output was comparable for both sectors (Tables III.11, III.13 above), the Austrian supplies of non-fuel raw materials to construction represented 34.2 per cent of total, and supplies to basic metals 14.2 per cent. Although the structure of the supplies of non-fuel raw materials may have been different, it is not clear why only 0.2 per cent of total non-fuel raw materials (103) was charged to the construction industry as the purchasing sector.

Table III-20: Structure of material inputs in the chemical industry:

Czechoslovakia (1962) and Austria (1964)
(percentages)
(total material inputs = 100)

Inputs from:		Chemical industry Czechoslovakia	Austria
101	(Agriculture, forestry etc.)	2.63	0.60
102	(Fuels)	6.21	0.82
103	(Non-fuel raw materials)	3.97	5.00
104	(Food processing)	14.25	2.86
101-104	(Total NRP)	22.06	9.28
104-118	(Total non-NRP)	72.94	90.72

Source: As for Table III.1.

Table III-21: Selected input coefficients of the electricity industry:

Czechoslovakia (1962) and Austria (1964)

(percentages of gross aggregate output of electricity industry)

Inputs from:	Czechoslovakia	Austria
102 (Fuels)	21.37	10.23
901 (Total material consumption)	30.04	25.70
501 (Depreciation)	39.29	19.63
502 (Wages)	12.65	23.88
503 (Taxes - subsidies)	-1.15	1.29
504 (Other incomes)	19.17	29.51
904 (Total value added)	69.96	74.30

Source: As for Table III.1.

4.3 Natural resource content of output

Even if technology with respect to NRP use were similar in the above sense (i.e. relative NRP-intensity), inter-country differences in industries' demand for NRP may arise as a result of differences in the absolute level of NRP consumption of individual industries. Thus, although the ranking may be the same, NRP required directly per unit of output of each industry may be higher in one country than in the other. If the structure of output was identical in both countries, the higher material consumption of NRP could be reflected by (i) the lower share of value added per unit of gross aggregate output and (ii) the higher intermediate consumption of non-NRP.

According to our previous findings, the structure of output was more similar if measured in gross terms than in net terms.[37] The difference implies that the level of material consumption of individual industries was highly dissimilar and it remains, therefore, to examine the level of material consumptic of NRP in individual industries. For this, we shall return to Table III.17.

As Table III.17 shows, there appears to be a bias towards higher material consumption in Czechoslovakia. In total we can identify higher material consumption of NRP in eight out of 18 sectors in Czechoslovakia. However, total NRP use by the whole of industry is smaller in Czechoslovakia.

Moreover, the higher NRP content of supplies from individual industries in Czechoslovakia is considerably affected by higher intra-branch use which, in turn, is likely to be due to institutional rather than technological specifics. Thus, out of our four NRP sectors, the input coefficients are significantly higher in Czechoslovakia in three, even after allowing for +10 per cent in the level of input coefficients characteristic of the Austrian NRP sectors. In the remaining sector (food processing), NRP content was lower.

In addition, using the arbitrary 10 per cent cut-off point as a measure of distance between the coefficients, the Czechoslovak bias towards higher

37. See discussion related to Tables III.11 and III.13 above.

material consumption of NRP among non-NRP industries is much less pronounced. There were five non-NRP industries in Czechoslovakia with higher use of NRP and three in Austria. Thus, neither the similarity nor the level of aggregation allows us at this stage of the analysis to make a more precise statement about the level of individual NRP coefficients. It is for these reasons that we shall return to this issue in the next chapter.

4.4 Relative intermediate consumption of natural resource and non-natural resource products

Our findings based on the comparison of I-O coefficients and their interpretation could be considerably changed if domestic (incomes) policies were differentiated by sectors or if incomes were affected by other forms of market imperfections. In both cases, the value added recorded in the tables would be affected. In fact, as we have seen earlier, the sectoral variations in value added between both countries differed to a much larger extent than those in gross aggregate output. We cannot be confident, therefore, that the technological similarity discussed above was due to similarity in the NRP requirements rather than to differences in the sectoral shares in value added. If the technology was to be 'similar' only because of the variations in value added, we would have to observe significant variations in the relative intermediate consumption of NRP and non-NRP.

Because of the possibility of such distortions, technological similarity was tested on the basis of technological (as opposed to input) coefficients. The coefficients are ratios of NRP consumption to total intermediate consumption in each sector. These were calculated according to the following formulae:

$$({}_2a_{ij})_C = \left[\frac{X_{ij}}{\sum_{i=1}^{18} X_{ij}}\right]_C \qquad (22)$$

$$({}_2a_{ij})_A = \left[\frac{X_{ij}}{\sum_{i=1}^{18} X_{ij}}\right]_A \qquad (23)$$

where X_{ij} domestic and imported inputs of the i-th natural resource products to industry j

$_2a_{ij}$ technological coefficient of the i-th natural resource products in industry j

C Czechoslovakia

A Austria

Our data are shown in Table III.22 which otherwise incorporates the same approach as applied in Table III.17 including ranking and absolute differences between respective coefficients.

The basic features of relative intermediate consumption by sectors remain very similar to those which we observed in the case of input coefficients. The degree of similarity measured by the Spearman rank correlation coefficient is almost identical (0.695 compared to 0.705 for input coefficients). The main difference relates to the same three industries as before, i.e. chemicals (109), construction (116), domestic trade and distribution (117). This time we have nine industries in which input coefficients were higher by at least 10 per cent in Czechoslovakia than in Austria (as compared to eight industries in our previous case) and three in the case of Austria (four previously).

Nevertheless, small differences in the patterns of NRP intensity would still emerge should we examine the changes in more detail. Such variations would be, therefore, due to variations in the differences in the shares of value added to gross aggregate output. In order to establish the effects of variations in the shares of value added, we have compared the sectoral input and technological coefficients and this is summarized in Table III.23.

Table III.22: Direct natural resource product requirements per unit of material consumption by sectors: Czechoslovakia (1962) and Austria (1964)[a]

Sectors[b]	Czechoslovakia	Austria	Ranks Czechoslovakia	Ranks Austria	Differences	Signs[c]
Agriculture	0.417317	0.338139	5	6	-1	>
Coal,oil,gas	0.124801	0.134228	12	13	-1	=
Other mining	0.107978	0.140417	14	11	+3	<
Food processing	0.807301	0.734502	1	2	-1	>
Textiles	0.395411	0.201955	6	9	-3	>
Shoes, clothing leather, fur	0.115049	0.051733	13	16	-3	>
Wood processing	0.444821	0.452211	4	3	+1	=
Rubber	0.199721	0.135554	9	12	-3	>
Chemicals	0.269625	0.093137	8	14	-6	>
Oil,coal proc.	0.672809	0.741924	3	1	+2	=
Non-ferrous metallurgy	0.178956	0.192771	10	10	0	=
Basic metals	0.335967	0.326869	7	7	0	=
Trans. vehicles	0.009977	0.011771	18	18	0	=
Engineering	0.022730	0.019161	16	17	-1	>
Electricity	0.714314	0.415636	2	5	-3	>
Construction	0.011654	0.326062	17	8	+9	<
Trade	0.033954	0.427497	15	4	+11	<
Transport	0.173081	0.062487	11	15	-4	>
All industry (101-118)	0.302075	0.329532				=

Notes:

(a) Share of NRP inputs per unit of material consumption (technological coefficients).

(b) For sectoral codes, see Appendix.

(c) Sign '>' indicates that the absolute level of technological coefficients is higher by at least 10 per cent in Czechoslovakia than in Austria and vice versa for the sign '<'. Sign ' = ' indicates that the absolute level of the technological coefficients in Czechoslovakia is neither higher nor lower than the absolute level of the coefficients in Austria including an allowance for ± 10 per cent.

Source: As for Table III.1.

Table III.23: Comparison of ranks of input and technological coefficients by sectors: Czechoslovakia (1962) and Austria (1964)

	Czechoslovakia			Austria		
Sectors[a]	Input coefficients	Technological coefficients	Difference	Input coefficients	Technological coefficients	Difference
Agriculture	6	5	1	9	6	3
Coal,oil,gas	14	12	2	16	13	3
Other mining	10	14	-4	12	11	+1
Food proc.	2	1	1	2	2	0
Textiles	8	6	2	6	9	-3
Shoes,clothing leather,fur	13	13	0	14	16	-2
Wood proc.	5	4	1	3	3	0
Rubber	9	9	0	10	12	-2
Chemicals	7	8	-1	13	14	-1
Oil,coal processing	1	3	-2	1	1	0
Non-ferrous metallurgy	11	10	1	11	10	1
Basic metals	4	7	-3	4	7	-3
Trans. vehicles	18	18	0	18	18	0
Engineering	16	16	0	1	17	0
Electricity	3	2	1	7	5	-2
Construction	17	17	0	5	8	-3
Trade	15	15	0	8	4	4
Transport	12	11	1	15	15	0

Notes: (a) For sectoral codes, see Appendix.

Source: Based on Tables III.17 and III.22.

The table reproduces the ranks from Tables III.18 and III.19 and compares them for each country separately.

The effects of value added on differences in the technology indicator (input coefficients) were estimated by correlating the ranks of input and technological coefficients in individual industries for each country. We have obtained the following values for the Spearman rank correlation: Czechoslovakia = 0.955 and Austria = 0.922. We are, therefore, able to explain almost 96 per cent of the technological pattern of Czechoslovakia by means of the industries' relative consumption (absorption) of NRP and 92 per cent in the case of Austria. If we were to explain inter-country variation on the same basis we would obtain the correlation coefficient 0.901.[38]

5. Summary

There is very little evidence to suggest that the technology of domestic production with respect to NRP is subject to what is known as factor reversal. Industries which are most NRP intensive in Austria tended also to be NRP intensive in Czechoslovakia. The ranking of industries according to their NRP intensity was relatively highly correlated (R_S^2 = 0.709). There are strong indications that the residual of the correlation coefficient should be explained on the basis of structural differences rather than on the basis of differences in technology. Moreover, two sectors with considerable rank differences do not, in fact, represent trading sectors. By excluding the two sectors, the value of the Spearman rank correlation coefficient is raised to 0.871 which indicates an even higher degree of technological similarity in the two countries. On the other hand, even if technology was similar, there appear to be differences in the level of I-O coefficients. We shall return to this issue in the next chapter.

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38. The comparison of inter-country variations employs rank differences rather than the actual ranks used in comparison of the variations in each country separately.

But there is stronger evidence that the structure of domestic final demand was highly dissimilar in the two countries. Domestic final consumption in general and private consumption in particular were significantly biased in Czechoslovakia towards NRP consumption (particularly food). Consequently, the structure of final (domestic) consumption could go a long way in explaining the strong import bias of Czechoslovakia towards NRP as discussed in the previous section.

All these findings are subject to one major qualification. Since the computations reported in this chapter were based on the valuation of inter-industry flows in terms of domestic prices, it was necessary to assume that domestic prices in both countries were similar. The assumption will be relaxed later.

CHAPTER IV TESTS OF SIMILARITY OF INPUT-OUTPUT COEFFICIENTS AND THE TRIANGULAR PROPERTY OF THE CZECHOSLOVAK AND AUSTRIAN INPUT-OUTPUT TABLES

1. Introduction

The discussion in the previous chapter concentrated on a comparison of Czechoslovakia and Austria with regard to their structures of foreign trade, technology and domestic components of final demand. Using the I-O approach, it was suggested with respect to NRP that (i) the trade structure of Czechoslovakia differed from that of Austria (primarily on account of the greater dependence of Czechoslovakia on NRP imports) and this phenomenon can be explained to some extent by (ii) the structure of domestic final demand in Czechoslovakia being relatively more oriented towards NRP consumption.

While there is some evidence that Czechoslovak and Austrian industries appeared to use the same techniques of production as indicated by individual NRP input coefficients, nevertheless the question of technological similarity and efficiency of NRP remains open. Quite apart from the assumptions necessary for such a study, the comparison of I-O coefficients also depends on the method of identification of 'similar' and 'different' I-O coefficients. Thus, for the comparison of individual I-O coefficients, we have chosen an arbitrary cut-off point of 10 per cent around each I-O coefficient of one country and identified the corresponding I-O coefficients in the other country as 'different' whenever they exceeded the cut-off limit.

The above method is clearly not an ideal way of assessing the degree of similarity between corresponding I-O coefficients but it should be treated only as one of a number of alternative methods. As a result, we have been unable to establish 'objectively' what constitutes a pair of 'similar' or 'different' I-O coefficients. But, as pointed out by

Harrigan *et al*. (1980), there is no objective way of doing so. To use more technical language, there is no unambiguous measure of the distance between I-O matrices.[1] What we propose to do next, therefore, is to carry out further tests on the similarity of the matrices of I-O coefficients. The statistical methods and the actual procedure are similar to those adopted in a recent study of Harrigan *et al*. (1980). At the same time, it must be emphasized that, as before, these tests are not intended to infer the degree of similarity between I-O matrices from differences in specific individual coefficients. Rather, the tests are undertaken in order to see whether both of these matrices can be identified with features which are similar and, therefore, general.

One point which may be well worth repeating is relevant to the study of 'fundamental' properties in general and 'triangular' property in particular. The approach to the study of 'fundamental' properties of I-O matrices is derived from a specific definition of technology and an assumption concerning substitution among intermediate inputs. For example, Simpson and Tsukui (1965, p. 434) write: 'We mean by technology all feasible transformations of goods and factors. In this sense, the word should be carefully distinguished from the actual combinations of factors of production and intermediate goods used in production which are determined by the prevailing system of prices ... While the primary factors may possibly be substituted for each other as their relative prices change, inputs of intermediate goods are inelastic with respect to price changes for reasons dictated by technology'.

This chapter consists of two main sections. The following Section 2

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1. The argument of Harrigan and his colleagues is not generally true because there *are* some aggregate measures of the distances between normalized I-O matrices, e.g. mean square root. It is possible, for example, to define a matrix distance for matrices A_C and A_A as

$d(A_C A_A) = \sqrt{\sum_{ij} (a^C_{ij} - a^A_{ij})^2}$. However, these are *aggregate* measures and they are not suitable for detailed assessment of individual elements of the two matrices which is a task under investigation in this study. The remark of Harrigan and his colleagues can be found in Harrigan *et al*. (1980), p. 799.

includes further tests of similarity of individual I-O coefficients. Section 3 concentrates on the test of 'fundamental properties' of production in these two countries and the section itself is sub-divided into six sub-sections. The basic concepts of matrix triangulation are explained in sub-section 3.1. The method of analysis is part of sub-section 3.2. The main results of the matrix triangulation technique are reported in sub-section 3.3. Sub-section 3.4 discusses a concept known as 'circularity' in the case of the two countries being studied and sub-section 3.5 analyses the structure of production from the point of view of block decomposability. Finally, sub-section 3.6 provides an evaluation and assessment of the results.

2. Further tests of similarity of natural resource product input coefficients

It was noted above that there is no unambiguous measure of the distance between I-O matrices and that the choice among similarity tests is, therefore, arbitrary. The present comparison will be derived from a number of different tests in order to provide checks on the findings. In this respect, the procedure is similar to that adopted in Harrigan *et al*. (1980).[2] The tests undertaken in this study will not include a separate treatment of relative prices which may affect international comparisons.[3]

Our first test measures the similarity of I-O coefficients on the basis of difference matrices defined as

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2. Most of the tests employed here are based on Harrigan *et al*. (1980), pp. 795-810 and the following description of the tests also preserves their original notation. Other tests were also considered but they were not included because of their evident similarity with some of the tests already employed here. An example is a technique based on the analysis of variance (ANOVA) which was suggested recently by Van Ravenzwaaij (1979).

3. First experiments with price adjustments in these tests have been carried out but they are not reported here. The results are summarised in my Comparison of Technical Structures in Market and Centrally-Planned Economies; Mimeo, 1982.

$$D^1 = A_C - A_A \; ; \; D^1 = (d^1_{ij}) \tag{1}$$

$$D^2 = B_C - B_A \; ; \; D^2 = (d^2_{ij}) \tag{2}$$

where A is the matrix of direct I-O coefficients, B is the matrix of full (i.e. direct-plus-indirect) coefficients (or Leontief inverse matrix).[4] The symbols C and A stand for Czechoslovakia and Austria respectively. Finally, the elements of D^1 and D^2 have been formed into frequency distributions shown in Table IV.1.

The computation of D^1 and D^2 makes it possible to obtain the mean direct coefficient difference ($\bar{d}^1$) and the mean full coefficient difference ($\bar{d}^2$). In addition, in order to obtain a measure of absolute coefficient differences, two indicators have been computed. First, the measures of absolute differences are defined as

$$\bar{e}^1 = \sum_{ij}\sum |a^C_{ij} - a^A_{ij}|/n \quad (i=1,2,3,4;\; j=1,2,\ldots,18) \text{ where } A_C = (a^C_{ij}),\; A_A = (a^A_{ij}) \tag{3}$$

$$\bar{e}^2 = \sum_{ij}\sum |b^C_{ij} - b^A_{ij}|/n \quad (i=1,2,3,4;\; j=1,2,\ldots,18) \text{ where } B_C = (b^C_{ij}),\; B_A = (b^A_{ij}) \tag{4}$$

where $n = 4 \times 18 = 72$

The usefulness of the 'e'-type of indices used in conjuction with 'd'-type indices is that they may indicate the presence of large differences in individual coefficients for some cells. This feature of 'e'-type indices is obviously given by the fact that no account is taken of the self-cancelling effect of positive and negative numbers as in the case of 'd'-type indices.

The above feature is even more pronounced in the measure of absolute relative differences which are computed as follows:

4. The comparison of the corresponding elements in the Leontief inverse matrices should be understood in a broader sense in comparison to the corresponding elements in matrices A. This is because the individual elements of matrices B are 'generated' both by NRP input requirements and non-NRP input requirements.

$$\bar{r}^1 = (\sum_{ij}\sum|a^C_{ij} - a^A_{ij}|/a^C_{ij})/(n - k) \qquad (5)$$

$$\bar{r}^2 = (\sum_{ij}\sum|b^C_{ij} - b^A_{ij}|/b^C_{ij})/(n - \ell) \qquad (6)$$

where k is the number of corresponding cells for which either $\bar{a}^C_{ij}$ or $\bar{a}^A_{ij}$ is zero, ℓ is the number of corresponding cells for which either b^C_{ij} or b^A_{ij} is zero.

Let us start our comparison of individual coefficients by looking at the pattern of distribution of the coefficient differences. The actual distribution of differences of direct and full NRP coefficient differences, is reported in Table IV.1. The 'd', 'e' and 'r' (summary) measures are as follows:

$\bar{d}^1 = -0.003\ 018$ $\qquad \bar{e}^1 = 0.018\ 608$ $\qquad \bar{r}^1 = 81.592\ 791$

$\bar{d}^2 = -0.001\ 931$ $\qquad \bar{e}^2 = 0.026\ 484$ $\qquad \bar{r}^2 = 1.504\ 742$

As can be seen from the table, both direct and full coefficients are fairly similar in Czechoslovakia and Austria. This similarity is reflected in the fact that 76 per cent of direct coefficients and 69 per cent of full coefficient differences lie in the range of -0.019 to +0.020. The direct coefficient differences appear to be distributed around a mean of -0.003 018 indicating a somewhat higher level of intermediation for Austria. The mean of the full coefficient differences is also negative. It may be interesting to note that unlike the findings of Harrigan et al. the mean difference of full coefficients is smaller than the mean difference of direct coefficients, which suggests that the process of higher intermediation was not necessarily cumulative. This can be explained by lower intermediation of products other than NRP and/or lower relative prices of NRP.

TABLE IV.1 Distribution of actual, direct and full NRP coefficient differences

Class intervals		NRP direct coefficients: Number of observations	NRP direct coefficients: Relative frequency[b]	NRP full coefficients[a]: Number of observations	NRP full coefficients[a]: Relative frequency[b]
	≤0.340	0	-	1	0.0139
-0.220	-0.239	1	0.0139	0	-
-0.200	-0.219	0	-	0	-
-0.180	-0.199	0	-	0	-
-0.160	-0.179	0	-	0	-
-0.140	-0.159	0	-	0	-
-0.120	-0.139	0	-	0	-
-0.100	-0.199	2	0.0278	2	0.0278
-0.080	-0.099	0	-	0	-
-0.060	-0.079	2	0.0278	3	0.0417
-0.040	-0.059	1	0.0139	2	0.0278
-0.020	-0.039	2	0.0278	2	0.0278
0.0	-0.019	24	0.3333	30	0.4167
0.001	0.020	31	0.4306	20	0.2778
0.021	0.040	4	0.0556	6	0.0833
0.041	0.060	3	0.0417	2	0.0278
0.061	0.080	1	0.0139	3	0.0417
0.081	0.100	0	-	0	-
0.101	0.120	1	0.0139	1	0.0139
0.121	0.140	0	-	0	-
0.141	0.160	0	-	0	-
0.161	0.180	0	-	0	-
0.181	0.200	0	-	-	-
		Σ72	Σ1.0	Σ72	Σ1.0

Notes: (a) Direct and indirect coefficients obtained from the Leontief inverse matrix B.

(b) The sums do not add up exactly due to rounding.

The 'e' and 'r' measures tell essentially the same story as emerged from the study of Harrigan et al. The 'e' measures are larger than the corresponding arithmetic means ($\bar{d}$), indicating that there are some coefficients with substantial differences. Or, to put it differently, the 'd' indicators are smaller because of the cancelling effect of positive and negative coefficient differences. These findings are reflected in high values of the 'r' indicators which were computed to take into account the relative importance of coefficient differences - in comparison to the 'e' indicators.[5]

Another test suggested by Harrigan et al. is defined as follows:[6]

$$s_j^d = 100\left(\sum_{i=1}^{4} a_{ij}^C - \sum_{i=1}^{4} a_{ij}^A\right) / \sum_{i=1}^{4} a_{ij}^C \quad (j = 1, 2, \ldots, 18) \tag{7}$$

$$t_j^d = 100\left(\sum_{i=1}^{4} b_{ij}^C - \sum_{i=1}^{4} b_{ij}^A\right) / \sum_{i=1}^{4} b_{ij}^C \quad (j = 1, 2, \ldots, 18) \tag{8}$$

These two measures identify the percentage differences in the level of intermediation and percentage differences in the column sums of coefficients from the inverse matrix. It is clear that these two tests are very similar to the tests employed earlier in this study[7] and they need not be repeated here.

However, one comment is in order. The findings discussed in Chapter III indicate that there exists a high ordinal correspondence between the Czechoslovak and Austrian levels of intermediation of NRP. The Spearman rank correlation coefficient (R_s^2) was 0.705 and the value of the coefficient was increased to 0.960 if construction and internal trade, two 'badly

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5. Note that these values are affected by percentage differences rather than absolute differences. Consequently, high average values of these percentage differences may be due to the effect of differences arising in the case of coefficients with small values which could be a disadvantage. See Harrigan et al. (1980), p. 801.

6. The following equations in the text have been modified to take into account the slightly different problem at hand in this study.

7. See Chapter III.

behaved' sectors are excluded. The results of this test suggest, therefore, similarities of Czechoslovak and Austrian industries reflected in the fact that industries which are NRP intensive in one country are NRP intensive in the other as well.[8]

Another, even though rather crude, test is to hypothesize that input coefficients of Czechoslovakia (a_j^C) may be approximated by Austrian input coefficients (a_j^A) and that any difference between the coefficients can be attributed to random errors of observation. The test obviously amounts to estimating α and β in the following equation[9]

$$a_j^C = \alpha + \beta\, a_j^A + u_j \qquad (j = 1, 2, \ldots, 18) \qquad (9)$$

Setting the hypothesis $H_0 : \alpha = 0$ against $H_1 : \alpha \neq 0$ and $H_0 : \beta = 1$ against $\beta \neq 1$, we obtained the following estimates[10] : $\hat{\alpha} = 0.03$ and $\hat{\beta} = 0.622$.

These results, which were based on 18 highly aggregated NRP coefficients, also produced a reasonably good fit. Using the 99 per cent level of confidence, the ordinary least squares estimator of parameter β is statistically significant, while parameter $\hat{\alpha}$ turned out to be statistically insignificant in the regression.

Therefore, this leads to rejection of the null hypothesis for parameter $\hat{\beta}$ and acceptance of the null hypothesis for parameter $\hat{\alpha}$.

However, the values of parameter $\hat{\beta}$ are

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8. The exclusion of these two 'anomalous' sectors is not too serious in view of the fact that neither of them enters foreign trade.

9. On the one hand, the test has the major advantage that it is directed to inference of overall similarity or dissimilarity between the matrices rather than differences in individual I-O coefficients. See Harrigan et al. (1980), p. 802. On the other hand, it should be kept in mind that regression analysis is not a symmetrical test. This means that if $y = a + bx + u$ then $x \neq a + by + u$, where a and b are parameters, u is the disturbance term. In this respect, the correlation coefficient R^2 is more suitable.

10. The symbol '^' above the parameters α and β indicates estimates in the present case and not a symbol for diagonal matrix as used elsewhere in this study.

significantly below a level which would indicate perfect similarity of both countries' NRP coefficients. Once again, this can be explained by price differences implicit in the I-O coefficients.

On the whole, the main result is confirmed by running the regression at a more disaggregated level than the one used above. The regression with more disaggregated data involved 62 observations in Version A (including imports) and 58 observations in Version B (excluding imports)[11] and led to the following results:

	$\hat{\alpha}$	$\hat{\beta}$	R^2	$t_{\hat{\alpha}}$	$t_{\hat{\beta}}$	F
Version A	0.009	0.628	0.7485	2.099	13.362	178.53
Version B	0.008	0.589	0.6896	2.053	11.155	124.44

In sum, even though there is some degree of similarity between both sets of NRP coefficients, it appears that the Austrian NRP coefficients were consistently higher than those of Czechoslovakia - before price adjustment. The inclusion or exclusion of imports in the transaction matrix failed to produce any significantly different results.

Our final computations involve a simulation of the gross output of Czechoslovakia on the assumption that Czechoslovakia was able to use Austrian technology.[12] The simulated vector of gross output (net of imports) was obtained according to the following equation:

$$B_A y^C = (\tilde{x}^C - \tilde{m}^C) \qquad (10)$$

where $\tilde{x}^C - \tilde{m}^C$ is (hypothetical) Czechoslovak gross output net of imports, y is a vector of total final demand and B is the inverse of the Leontief

11. The separate treatment of imports was undertaken in order to check their effect on the transaction matrix particularly in view of pricing practices adopted in Czechoslovakia with respect to foreign trade flows. See Chapter I for further discussion.

12. This technique was developed and further explored in studies by Leontief (1966), pp. 41-67, Augustinovics (1968), Carter (1970), Chapter 4.

even greater differences between the simulated and actual gross output requirements once they apply the UK matrix of I-O coefficients to Scottish final demands.

3. Matrix triangulation

3.1 Basic concepts

In the previous section we have analysed the individual I-O coefficients and here we shall concentrate on some general properties of I-O matrices. In particular we shall examine the triangular property of the two I-O matrices.

The aim of triangulation is to arrange sectors in the first quadrant of the I-O table in the order which places I-O entries in that quadrant on only one side of the main diagonal. Since this first quadrant represents inter-industry relations, triangulation attempts to systematically rearrange sectors to form an apparent hierarchy.[14] If all I-O flows are placed on one side of the main diagonal, the sectoral rearrangement leads to 'perfect triangularity'. In such a case, the hierarchy of sectors takes the form of what is known as 'one-way dependence'. In specific terms, sectors make deliveries to other sectors but receive no inputs in return. In the context of the I-O table this means that:[15]

(i) sectors that are making deliveries to others and receive no input in return, and those that are receiving only inputs from others but make no deliveries in return occupy the rows and columns at the extreme sides of the matrix;

(ii) other sectors receive inputs from the preceding sectors and make deliveries to the following ones (or vice versa depending on whether

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14. In the earlier writings in the area, triangulation was suggested as a method for approximating the solution to simultaneous equations in the I-O system. See Chenery and Clark (1959), Appendix to Chapter 2, pp. 43-6. The use of triangulation for this purpose was obviously an entirely different issue from the purpose for which the method is used in this study, i.e. a study of sectoral interdependence.

15. Adapted from Rasul (1964), p. 70.

the elements in the matrix are to be above or below the main diagonal respectively).

The hierarchy in a perfectly triangularized I-O matrix in which all entries lie below the main diagonal is represented by sectors arranged in the order from final production down to primary production[16] (vice versa in the case of the I-O matrix in which all entries lie above the main diagonal).

In practice, it is highly unlikely for sectoral interdependence to be represented by perfect triangularity. Some sectors such as mining, metals and machinery are usually not characterized by one-way dependence but what is known as circular dependence, which allows for sectors to receive inputs from other sectors in return for their own deliveries (e.g. coal mining → steel production → mining equipment → coal mining). The consequence of circularity for the triangularized I-O table is the appearance of non-zero entries above the main diagonal when most entries are located below it, i.e. when sectors are arranged in the order from final production to primary production (vice versa when sectors are arranged in the order from primary production to final production). This leads to complications in the ordering of industrial sectors according to stages of production.

3.2 Method of analysis

The matrix triangulation approach is used here to see whether there was any common production structure of Czechoslovakia and Austria which in turn can be attributed to common technological origin. In this respect we follow the methodology of Simpson and Tsukui.[17] However, to the extent that the transaction matrices of these countries are not perfectly triangular it may be useful to extend the analysis into further aspects of the inter-country comparison per se. The aspect which will be examined

16. In other words, each sector is assumed to represent a separate stage of production.

17. Simpson and Tsukui (1965), pp. 434-46.

here in some detail is the nature of circular feedback.

Prior to the application of a matrix triangulation procedure it was thought useful to discard small (i.e. 'unimportant') entries in the transaction matrices of these two countries.[18] This can be justified on the following grounds: (i) Large entries are likely to be more accurately observed in industrial accounts.[19] (ii) Some I-O entries are relatively small and can be disregarded for practical purposes.[20] Similarly, some circular flows may be relatively small in that mutual deliveries between two sectors are dominated by deliveries of one of these sectors. (iii) Some I-O entries (including circular flows) in a particular year may not represent systematic intra-industry dependence. It is likely that these transactions will be relatively small. But most importantly, the reason for discarding small entries is that small flows indicate very little dependence while the opposite is true for large entries. Hence, by discarding the small entries we are able to show more clearly the basic structure of interdependence in the matrix. Following Simpson and Tsukui, the transaction matrix, which is generated by discarding 'unimportant' I-O entries and which is represented by 'important' ('key') entries only, is called here the framework matrix.

Several criteria have been suggested in the literature for

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18. The transaction matrices used for this purpose were based on the actual flows of goods rather than any standardized form of these flows (e.g. I-O coefficients). Even though the triangulation solutions depend on the size of I-O entries, the differences in the hierarchy obtained from triangularizing the matrices of actual flows and I-O coefficients respectively are likely to be small. Empirical evidence for this proposition can be found in Korte and Oberhofer (1971), pp. 519-21. For a definition of 'important' entries, see discussion below.

19. Simpson and Tsukui (1965), p. 436.

20. See, for example, Allen (1974), p. 217 who shows that only a relatively small number of individual I-O coefficients are major influences on intermediate demand.

distinguishing among I-O entries according to their importance in the transaction matrix. Simpson and Tsukui (1965) used a simple measure based on the absolute size of I-O entries. Chenery and Clark (1959) used a criterion based on 'tolerable' limits which was also used extensively in various studies of the ECE.[21] Further criteria based on hypothetical changes of I-O coefficients and gross output were suggested by Allen (1974) and Watanabe (1964) respectively.[22]

The procedure adopted here is different.[23] The I-O entries in the two transaction matrices are considered 'unimportant' and consequently discarded if they are smaller than a given 'critical' value of these entries. The 'critical' value was varied arbitrarily and this led to correspondingly different framework matrices. Increasing the 'critical' (i.e. cut-off) value of the entries led, therefore, to a reduction in the number of non-zero entries in the framework matrix in each step (iteration).[24] The proportion of non-zero entries in the framework matrix will be identified in the text with the term 'coverage'(of the framework matrix).

The advantage of considering 'important' ('key') entries only is that, by concentrating on large entries, it is hoped to minimize the effect of

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21. See, for example, United Nations (1971) where the concept is also described.

22. Allen's proposal was to select any I-O coefficient and hypothesize a given 100 per cent change in its value. 'The resulting effects on the inverted matrix of full coefficients ... was then calculated and, by pre-multiplying the new inverse by the (unchanged) base-year vector of final dema and by subtracting this vector from the resultant of the first operation, an index (I_{ij}) is derived ...' Allen (1974), pp. 216-17.

23. A major criticism of the criteria suggested by Simpson and Tsukui (1965) and Chenery and Clark (1958) respectively was that they impose arbitrary limits of acceptability on changes in the value of I-O coefficients or in output requirements. The subsequent proposal made by Allen (1974) deals successfully with this problem even though it avoids an assessment of the choice of 'critical' values entirely. One way to evaluate the appropriateness of the 'critical' values was suggested by Watanabe (1969), p. 192. For further discussion concerning the definition and identification of major coefficients, see Allen (1974), pp. 216-17.

24. Setting 'critical' (i.e. cut off) value at zero, the framework matrix is, of course, equal to the original transaction matrix. The 'critical' values took the following magnitudes: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50.

accounting distortions.[25] Equally important is the fact that the framework matrix facilitates the matrix triangulation since the number of non-zero entries in the framework matrix is reduced in comparison to the original transaction matrix.[26] Finally, while the 'critical' values themselves are chosen arbitrarily, our method of selecting 'important' entries enables us to study the impact of different 'critical' values on the structure of the framework matrices. Thus, in contrast to the method mentioned above, we operate with a set of 'critical' values rather than with a single number of the 'critical' value. This procedure will constitute our new method of sensitivity analysis.

Given the presence of circular flows, different solutions towards matrix triangulation have been suggested, for example, by Aujac (1960), Chenery and Watanabe (1958), Helmstädter (1957) and (1964) and Simpson and Tsukui (1965).[27] An assessment of these solutions is provided in Helmstädter (1969) and Korte and Oberhofer (1971) and it need not, therefore, delay us here. The matrix triangulation procedure adopted here follows the established practice of arranging the sectors in such a way that the sum of all transactions below the main diagonal is maximized and the sum of all transactions above the main diagonal is minimized. This procedure was applied for a number of framework matrices of each country (i.e. in a number of iterations) which, in turn, are defined by a given 'critical' value of I-O entries.

In triangularizing the framework matrices we have further used two

25. See the beginning of this section for arguments justifying the use of framework matrices.

26. This amounts to saying that we are looking for a fundamental structure of production which, according to our hypothesis, should be triangular. This point is expanded below and corresponds to the point made by Simpson and Tsukui (1965), p. 443.

27. A systematic presentation of the 'matrix triangulation problem' and its solution can be found in Helmstädter (1957), (1962) and (1964). For further refinement, see also Korte and Oberhofer (1971).

different procedures. First of all, the triangulation algorithm was applied to the actual framework matrices in each iteration. In other words, each iteration is specified by a given 'critical' value of I-O entries and the actual values of I-O entries. We call this procedure a Full Method. However, the solution to matrix triangulation depends, inter alia, on the distribution of each industry's intermediate output across the rows of the I-O matrix. As a check, therefore, it was thought useful to triangularize those framework matrices in which the influence of some dominant I-O entries is eliminated. This was done by converting all zero and non-zero entries in the framework matrices into binary numbers; non-zero entries taking the value of ONE, zero entries retaining the value of ZERO. In this way we given each non-zero entry the same weight. We call this procedure the Binary Method (or 'Bullion Method').

We can now turn to our method of measuring the impact of technology on the form of transaction matrices. It is generally believed that technology is a determining factor in establishing a 'natural' hierarchy of sectors.[28] However, empirical studies of the structure of I-O tables of different countries have already established that the triangular property of I-O matrices is not determined by technology alone.[29] For example, circular flows may appear in I-O matrices due to institutional or accounting peculiarities or, as suggested by Lamel et al., due to imports.[30] Nevertheless, an arrangement of sectors which is triangular in form should be expected both in Czechoslovakia and in Austria. Even though the original transaction matrices are likely to contain circular flows, the triangular pattern of sectoral arrangement should emerge in the framework matrices, that is, provided that both countries indeed used common

28. See, for example, Chenery and Clark (1959), p. 208 and Allen (1974) who argue that the (fundamental) hierarchical arrangement remains constant over time.

29. This point was recognized by Chenery and Clark but was made explicit only in later studies. See, for example, Simpson and Tsukui (1965), p. 442 and Lamel et al. (1972), p. 55.

30. Lamel et al. (1972), p. 55.

technology. It is customary to assess the resulting arrangment of sectors by means of the Spearman rank correlation technique[31] and this technique will also be used in the empirical part below.

In addition, triangulation procedure leads to the possibility of calculating various structural ratios.[32] We have calculated one of these which we call 'degree of circularity ratio' and this ratio is obtained according to the following formula:[33]

$$\omega = 100 \times \frac{V_{Min}}{V_{Max}} \qquad (11)$$

where V_{Min} is the value of the sum of entries above the main diagonal and V_{Max} is the value of the sum of entries below the main diagonal.

3.3 The main results of matrix triangulation: the sensitivity analysis

In order to compare the sectoral hierarchy which results from matrix triangulation in each country, Spearman rank correlation coefficients (R_S) were computed for the sectoral ordering after each iteration. The values of these correlation coefficients are reported in Table IV.3. These correlation coefficients were computed for sectoral ordering obtained from the application of the Binary Method which, it will be recalled, used binary numbers in the procedure of matrix triangulation. In addition, the table also reports a set of Spearman rank correlation coefficients for sectoral ordering obtained from application of the Full Method.

As the presence of circular feedback (interdependence) leaves certain entries above the main diagonal after matrix triangulation, the proportion of these transactions can be used as a measure of the circular feedbacks or (which amounts to the same thing) as a measure of the degree of

31. See, for example, Simpson and Tsukui (1965), Chenery and Watanabe (1958), Song (1977).

32. For a review of these ratios, see Helmstädter (1969), p. 234 and Korte and Oberhoffer (1971), pp. 507-9.

33. This ratio corresponds to what is usually known as 'degree of linearity' ratio.

reduced number of non-zero entries in the total number of non-zero entries in the matrices (i.e. in the "coverage" of the matrices). The share of non-zero entries in the total number of entries in the 'backbone' matrices is 18.83 per cent in the case of Austria and 8.95 per cent in the case of Czechoslovakia.[44] The transaction matrices based on these non-zero entries were then triangularized and the resulting patterns of circular feedback are summarized in Figures 1 and 2.

The two figures show, first of all, the most important delivering industries in the two countries. These industries are identified by encircled numbers[45] and in the left margin. Each delivering sector is then connected with purchasing sectors through its 'important' deliveries since non-important deliveries have been dropped and treated as zero. There are two types of important deliveries: (i) those which represent deliveries to sectors which in turn lie in the industrial hierarchy above the supplying industries, i.e. closer to final demand[46] (e.g. raw materials → steel). This (one-way) intra-industry dependence is shown in the figures by solid lines connecting the supplying sectors with purchasing sectors. (ii) If delivering sectors supply (intermediate) goods to sectors which, in fact, lie below them in the industrial hierarchy, this circular intra-industry dependence is shown by broken lines which, in addition form 'loops' in the figures. For example, sector 12 in Figure 2 (ferrous and non-ferrous metals) delivers an 'important' volume of goods to sector 11 (non-metallic mineral products) which lies in the industrial hierarchy above sector 12. This kind of delivery represents a case of one-way intra-

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44. It may be useful to recall that the shares of non-zero entries in the original transaction matrices were 71.30 per cent for Austria and 70.06 for Czechoslovakia.

45. All the numbers in Figures 1 and 2 refer to industrial codes used in the I-O methodology and these codes are listed in the Appendix.

46. The hierarchy should theoretically represent a hierarchy of different stages of production. While the 'service' sectors (trade and transport) can be interpreted as those 'closest' to final demand they normally service all or most other sectors in the economy and will, therefore, appear as 'delivering' sectors even to primary industries.

Table IV.3 Similarity of sectoral positions in triangulated framework matrices[a]: Czechoslovakia (1962) and Austria (1964) in the experimental design

(Spearman rank correlation coefficients)

	Steps										
Cut-off points ('Critical' values)[b]	0	5	10	15	20	25	30	35	40	45	
Full Method[c]	-0.2776	0.6595	0.6430	0.8989	0.6512	0.8205	0.8205	0.5377	0.6760	0.5542	0.7
Binary Method[d]	-0.1021	0.3932	0.4283	0.6636	0.2013	0.3168	0.7111	0.4005	0.5119[e]	0.2209[f]	-0.0

Notes:
(a) Transaction matrices include domestic deliveries and imports.
(b) Millions of national currencies.
(c) Based on actual ('full') data.
(d) Based on binary data.
(e) Transaction matrix of Czechoslovakia perfectly triangularized.
(f) Sectoral positions in Czechoslovak transaction matrix derived from that obtained in the ninth iteration. See also note (e) above.

Table IV.4 Circular feedback in triangulated framework matrices[a]: Czechoslovakia (1962), Austria (1964) (percentages)

Cut-off points ('Critical' values)[b]:	0	5	10	15	20	25	30	35	40	45	50	
	Steps (Iterations)											
'Full' Method[c]												
Circular feedback[e]												
Austria	21.14	18.35	8.37	7.14	3.94	3.39	3.03	2.84	1.77	1.32	1.34	
Czechoslovakia	24.67	19.77	14.64	13.16	8.47	8.84	8.46	5.51	6.33	6.33	6.64	
Coverage[f]												
Austria	71.30	62.65	49.07	38.58	32.10	29.01	27.47	25.00	22.22	20.37	18.83	
Czechoslovakia	70.06	61.11	53.70	49.69	38.27	27.47	21.60	19.14	15.12	10.49	8.95	
'Binary' method[d]												
Circular feedback[e]												
Austria	51.97	43.36	26.92	19.64	19.78	12.00	10.77	12.73	15.22	15.63	6.90	5
Czechoslovakia	46.45	45.71	40.00	27.72	19.78	10.94	10.91	4.88	0	-	-	6
Coverage[f]												
Austria	71.30	63.27	50.93	41.36	33.64	25.93	22.22	19.14	16.36	11.42	9.57	7
Czechoslovakia	70.06	62.96	54.01	43.21	33.64	21.91	18.83	13.27	9.26	-	-	8

Notes: (a) Transaction matrices include domestic deliveries only.

(b) Millions of national currencies

(c) Based on actual data

(d) Based on binary data. For methodology, see the text.

(e) Defined as the ratio of entries above the main diagonal and entries below the main diagonal. For more details, see the text.

(f) Defined as the ratio of non-zero entries and the total number of entries. For more details, see the text.

Table IV.5 Circular feedback in triangulated framework matrices[a]: Czechoslovakia (1962), Austria (1964) (percentages)

Cut-off points ('Critical' values)[b]	Steps (Iterations) 0	5	10	15	20	25	30	35	40	45	50	Rows
Full Method[c]												
Circular feedback[e]												
Austria	23.13	21.47	15.09	10.77	8.23	5.94	3.63	2.06	2.26	2.36	1.01	1
Czechoslovakia	26.16	16.03	14.14	17.32	14.96	10.83	10.26	9.91	7.29	8.67	0.00	2
Coverage[f]												
Austria	66.67	55.56	46.60	35.49	29.63	22.22	19.44	14.51	11.42	10.19	7.10	3
Czechoslovakia	67.28	59.88	51.23	42.28	37.65	27.78	21.91	18.21	13.58	8.95	5.25	4
Binary Method[d]												
Circular feedback[e]												
Austria	60.00	50.00	44.86	27.96	25.97	23.88	23.73	23.08	15.00	12.50	5.26	5
Czechoslovakia	50.34	44.70	34.75	29.70	25.00	22.95	16.98	13.89	6.90	5.88	0.00	6
Coverage[f]												
Austria	66.67	58.33	47.84	36.73	29.94	25.62	22.53	19.75	14.20	11.11	6.17	7
Czechoslovakia	67.28	58.95	49.07	40.43	29.32	23.15	19.14	12.65	9.57	5.56	3.09	8

Notes:

(a) Transaction matrices include domestic deliveries and imports.

(b) Millions of national currencies.

(c) Based on actual data.

(d) Based on binary data. For methodology, see the text.

(e) Defined as the ratio of entries above the main diagonal and entries below the main diagonal. For more details, see the text.

(f) Defined as the ratio of non-zero entries and the total number of entries. For more details, see the text.

the finding is consistent with findings obtained elsewhere for other pairs of countries.[37] This absolutely high level of similarity indicated that the distribution of large-size entries in the Czechoslovak transaction matrix was similar to that of the Austrian matrix.

The findings based on the Full Method are also much less dependent on the choice of 'critical values'. Even though the size of the correlation coefficients varies from iteration to iteration, the variations are within a reasonably narrow range of values. Since the values of cells which are smaller than the 'critical value' are dropped in successive steps, this suggests that the hierarchies do not change considerably or they change in a similar fashion in both countries. On the other hand, this is not the case with the 'similarity indicators' obtained from the application of the Binary Method, where the values of the Spearman rank correlation coefficients vary quite considerably.

A detailed comparison of the results of triangulation shows the emergence of circular feedback which in turn seems to be different in both countries. This can be seen from Table IV.4. The differences in the circular feedback appear to be reflected in differences in its structure (rows 5 and 6) as well as its magnitude (rows 1 and 2). An increase in the 'critical' values does not seem to increase the similarity in the degree of circular feedback. Moreover, the circular feedback appears to be more 'spread over' in Austria than it is in Czechoslovakia. Hence, the prevalence of the feedback in row 5. In fact, using the Binary Method, the Czechoslovak matrix is perfectly triangularized while the Austrian matrix is not.[38]

Nevertheless, there are further similarities which suggest that there

37. An example is Song (1977), p. 156.

38. All these findings, however, may be due to the fact that the coverage changes differently to some extent in Czechoslovakia in comparison to Austria as 'critical' values are increased (rows 3, 4, 7 and 8).

was a 'fundamental characteristic' common to both economies.[39] On the one hand, neither of the two matrices is perfectly triangularized in the first two iterations. However, using our circular feedback ratios and referring to the Full Method, the degree of circularity is very similar in the first and second iteration, i.e. in the original transaction matrices and in the framework matrices constrained by 'critical' values of 5 mil. (in terms of units of national currencies). In addition, the degree of circularity is highly comparable to that obtained in other studies for different countr

Moreover, increasing the 'critical' value tends to reduce the degree of circular feedback (i.e. to increase the degree of triangularity) in both countries. In other words, whatever circular feedback exists it tends to take relatively small values; both economies are therefore dominated by inter-industry relations which are representative of one-way dependence. This finding is confirmed by the results of triangulation using the Binary Method which shows a much greater role of circular feedback once all non-zero entries are given the same weight.[41] This leads to what is perhaps the most important finding emerging from Table IV.4. Referring to results obtained from the application of the Full Method, both matrices are very close to being triangular in form particularly as far as the most

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39. It should be noted that the proportion of the original non-zero entries is highly comparable in both countries (rows 3, 4, 7 and 8, iteration 1). While this finding can be interpreted as an indication of similarity between both countries, it is also helpful in interpreting findings obtained from matrix triangulation. Namely, given this basic similarity in the shares of non-zero entries, any differences arising from triangulating the matrices must be due to differences in the structure and/or size of non-zero entries and not due to distribution of cells in the transaction matrix between zero and non-zero entries.

40. See Helmstädter (1969), p. 234. Also, Korte and Oberhofer (1971), p. 508 who report on the results of triangulation of 80 empirical I-O matrices which show the degree of circularity in the region of 30 to 10 per cent.

41. The proportion of the above diagonal entries in the Binary Method is considerably greater than that obtained from the Full Method. This suggests that the relative weight of circular entries is smaller in terms of the magnitude than in terms of the total number of entries representing circular flows. In other words, the structure of circular flow is different.

important ('key') flows are concerned.[42] The circular feedback represents only some 4 per cent in Austria and 8 per cent in Czechoslovakia after the fifth iteration, i.e. after discarding entries smaller than 20 mil.

Finally, the exclusion of imports from the framework matrices tells a very similar story. This can be seen from the data summarized in Table IV.5. Therefore, imports do not seem to be the (main) factor preventing matrix triangulation.

3.4 Circular feedback in the Czechoslovak and Austrian input-output table

One of the findings of the previous section emphasized the different degrees of circular feedback in the Czechoslovak and Austrian I-O tables. We have also suggested earlier that the different results obtained from applying the Full and Binary Methods indicate that the structure of circular feedback was indeed different in these countries. However, the degree of similarity ratios *per se* does not reveal anything specific about the structure of the circular feedback and, consequently, about the extent to which it was generated by technological factors which might have been common to both countries.

This section considers circular feedback in more detail by examining the most important transaction flows of the two framework matrices or what we call the 'backbone' of the economy. We define the 'backbone' of the economy as all transaction flows which in our iterative procedure were equal to or exceeded a 'critical value' of 50 (in millions of units of national currencies).[43] The exclusion of 'unimportant' cells resulted in a substantially

42. The biggest drop in the share of circular feedback was between step 2 and step 3, i.e. reaching the stage in which the framework matrix is defined by entries greater than 10 million units of national currencies. This can be observed in Table IV.4. The only exception was Czechoslovakia when the Binary Method was used. However, even in that case, the circular feedback drops rapidly in the subsequent two steps. Moreover, the share of circular feedback in both countries is virtually insensitive to further increases in the cut-off points after the fourth step, i.e. in the framework matrices defined by entries greater than 20 million units of national currencies.

43. For more details concerning the definition and treatment of 'critical values' see Section 3.2 above.

Table IV.3 Similarity of sectoral positions in triangulated framework matrices[a]: Czechoslovakia (1962) and Austria (1964) in the experimental design

(Spearman rank correlation coefficients)

	Steps										
Cut-off points ('Critical' values)[b]	0	5	10	15	20	25	30	35	40	45	50
Full Method[c]	-0.2776	0.6595	0.6430	0.8989	0.6512	0.8205	0.8205	0.5377	0.6760	0.5542	0.7325
Binary Method[d]	-0.1021	0.3932	0.4283	0.6636	0.2013	0.3168	0.7111	0.4005	0.5119[e]	0.2209[f]	-0.0154[f]

Notes:
(a) Transaction matrices include domestic deliveries and imports.
(b) Millions of national currencies.
(c) Based on actual ('full') data.
(d) Based on binary data.
(e) Transaction matrix of Czechoslovakia perfectly triangularized.
(f) Sectoral positions in Czechoslovak transaction matrix derived from that obtained in the ninth iteration. See also note (e) above.

Table IV.4 Circular feedback in triangulated framework matrices[a]: Czechoslovakia (1962), Austria (1964) (percentages)

Steps (Iterations)

Cut-off points ('Critical' values)[b]:	0	5	10	15	20	25	30	35	40	45	50	Rows
'Full' Method[c]												
Circular feedback[e]												
Austria	21.14	18.35	8.37	7.14	3.94	3.39	3.03	2.84	1.77	1.32	1.34	1
Czechoslovakia	24.67	19.77	14.64	13.16	8.47	8.84	8.46	5.51	6.33	6.33	6.64	2
Coverage[f]												
Austria	71.30	62.65	49.07	38.58	32.10	29.01	27.47	25.00	22.22	20.37	18.83	3
Czechoslovakia	70.06	61.11	53.70	49.69	38.27	27.47	21.60	19.14	15.12	10.49	8.95	4
'Binary' method[d]												
Circular feedback[e]												
Austria	51.97	43.36	26.92	19.64	19.78	12.00	10.77	12.73	15.22	15.63	6.90	5
Czechoslovakia	46.45	45.71	40.00	27.72	19.78	10.94	10.91	4.88	0	-	-	6
Coverage[f]												
Austria	71.30	63.27	50.93	41.36	33.64	25.93	22.22	19.14	16.36	11.42	9.57	7
Czechoslovakia	70.06	62.96	54.01	43.21	33.64	21.91	18.83	13.27	9.26	-	-	8

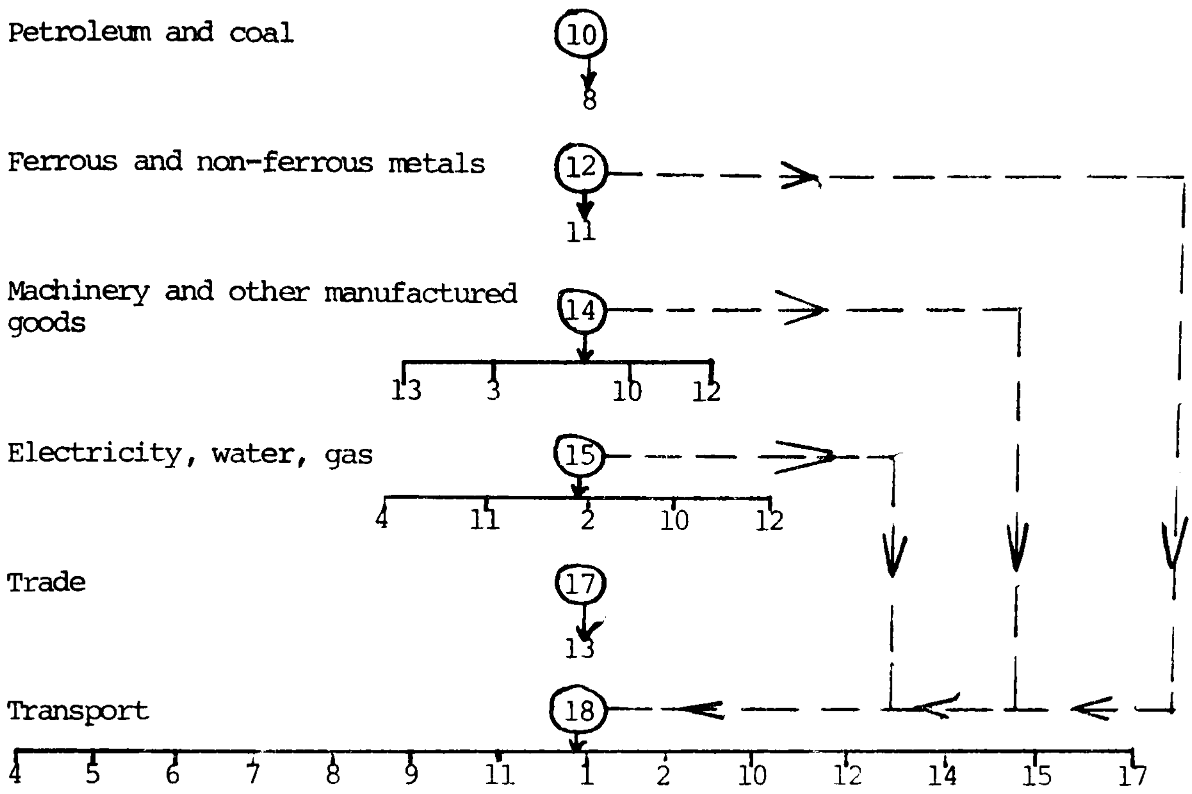

FIGURE 2. 'Key' deliveries and circular feedback in Czechoslovakia 1962[a]

(a) 'Key' delivering sectors are indicated by encircled numbers while the remaining numbers represent 'key' purchasing sectors. All the numbers are the industrial codes adopted in this study (see Appendix for details). The 'key' delivering sectors are also identified in the left margin. One-way intra-industry dependence is shown in solid lines, circular flows in broken lines and in 'loops'. The figures are based on the Full Method (see the text for details), total deliveries (i.e. domestic deliveries and imports) and a 'critical value' of 50.

industry dependence. In addition, the ferrous and non-ferrous metals sector 'supplies' an 'important' volume of products to the transport sector (18)[47] which lies below the supplying sector in the industrial hierarchy and this (circular) intra-industry dependence is portrayed by a 'loop' from sector 12 to sector 18.

A comparison of the two figures shows quite clearly that the two countries differed considerably in terms of 'key' sectors. Austria's economy was oriented heavily towards consumer-oriented industries (wood, paper, textiles, building and construction, transport equipment) while in the 'backbone' of the Czechoslovak economy these industries were almost completely missing (the only exception was 'trade'). In contrast, the Czechoslovak economy was oriented towards producer goods industries (coal, ferrous and non-ferrous metals, machinery, electricity, transport).

Both countries had some similar 'key' industries (petroleum and coal, ferrous and non-ferrous metals, machinery, electricity, trade and transport). However, 'important' deliveries of these sectors were allocated to almost entirely different purchasing sectors in each country. To some extent this reflects a different structure of the economy between sectors at the existing level of aggregation of the I-O tables, as has been shown. In addition, there were considerable differences within some sectors: e.g. different structures of deliveries of 'petroleum and coal' reflect the availability of petroleum and 'absence' of coal in Austria and vice versa in Czechoslovakia.

Moreover, it may be that the different structure of deliveries from sectors which are 'key' in both countries is due to different volumes of these transactions. If so, one would expect that, by reducing the 'critical value' of transaction flows, one should obtain a more and more similar pattern of deliveries to purchasing industries. The essential condition for meaningful inference of this pattern by going backwards in

47. That is, the transport sector provides a service of delivering ferrous and non-ferrous metals to purchasers.

the iterative procedure is, of course, comparability of sectors in both countries. The comparability is actually increasing as we reduce the 'critical value' of the entries[48] and it may be interesting to recall from the previous section that the 'average' of the original transaction matrices was, in fact, very similar.

It seems, therefore, that differences in the degree of circularity were, at least to some extent, brought about by different structures of output in the two countries and not by differences in technology. The importance of technological differences is even further diminished if one refers to one of our earlier findings, namely that the number of non-zero elements in the original transaction matrices was very similar in both countries.

3.5 Block decomposability

We have established in the discussion earlier that the hierarchy of sectors after matrix triangulation was quite similar in the two countries. The purpose of this section is to see how similar this hierarchy actually was. In particular it may be interesting to know whether NRP producing industries can be located in particular positions of this hierarchy. More specifically, since NRP industries were defined according to NRP intensity (i.e. the size of NRP input coefficients) it may be that these industries should be located at an extreme position of the sectoral hierarchy of the triangularized matrix.[49] Alternatively, it may be that some or all NRP industries can be located in groupings of industries which are defined according to particular properties.

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48. For example, if the 'critical value' is high in a sector such as petroleum and coal (which it was argued earlier is highly heterogeneous in the comparison of Czechoslovakia and Austria), the petroleum component will be positive due to small quantities of petroleum produced domestically.

49. Whether these industries should be located on top or at the bottom of the hierarchy depends, of course, on whether it is the entries below or above the main diagonal which are to be maximized.

In their well known study of the structure of production in the United States, Japan, Norway, Italy and Spain, Simpson and Tsukui (1965) argued that the I-O structures of these economies exhibited the following fundamental properties: (i) decomposability, (ii) block independence, (iii) triangularity and (iv) physical homogeneity of blocks.[50] These criteria for analysing I-O structures can be usefully adopted in the present context to study in more detail the nature of industrial interdependence. In particular, this section deals with the above fundamental properties (except for triangularity which has been discussed in the previous two sections). As far as the author knows, the properties of decomposability, block independence and physical homogeneity have never been tested for any CPE.

Following the usual procedure, the I-O sectors were grouped according to their physical qualities to form blocks in the following order:

(i) METALS;

(ii) NON-METALS;

(iii) ENERGY;

(iv) SERVICES.

In principle, it is possible to use either the original transaction matrices or any other form of the framework matrices or both. The original transaction matrices include some 'noise' and it was decided, therefore, to concentrate on the framework matrices. The choice of the framework matrices was arbitrary but this should not affect the analysis significantly. The framework matrices actually chosen were those generated in the fifth iteration, i.e. the original transaction matrices after discarding entries smaller than 20 mil. units of national currencies. It is hoped that in this manner we were able to reduce the impact of the 'noise' and, at the same time, to obtain a reasonably high coverage of the tables (i.e. to retain

50. All these properties have been described earlier in this study. See Chapter III.

a reasonably high share of non-zero entries in the tables). No attempt was made to triangularize the entries within each block.

The results of our manipulations are shown in Tables IV.6 and IV.7. The main findings can be summarized as follows:

(i) The block of METALS which was found so frequently in the literature to be a distinctive feature of developed market economies was relatively undeveloped in Austria, certainly in comparison to Czechoslovakia.

(ii) The most important suppliers of the METALS block were the METALS block itself, ENERGY and SERVICES. Essentially the same was true for NON-METALS.

(iii) The NON-METALS block did not really represent an important supplier for the METALS block. For Czechoslovakia this can be seen outright since there are only few non-zero entries in the appropriate block. But even in the case of Austria, the feedback from NON-METALS to METALS comes largely from 'Construction' - a sector which may in some respects be treated as a service sector or should be dropped entirely.[51]

(iv) Both METALS and NON-METALS blocks as well as the other blocks are not entirely independent of each other. Apart from the important role played by SERVICES and ENERGY, the other important supplier was the METALS block. For both countries, this pattern is to a large extent due to sector 14 (machinery and equipment except transport equipment).

(v) Simpson and Tsukui identified three sources of block interdependence, i.e. (1) SERVICE block industries, (2) ENERGY block industries and (3) other industries. This also appears to be the pattern in Czechoslovakia and Austria. The emergence of services and energy is not surprising in view of their universal role in the economy. It was not possible to analyse the role of 'other industries' in further detail since a higher degree of disaggregation of the I-O tables would be required.

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51. The construction sector was dropped from all I-O tables used by Simpson and Tsukui.

TABLE IV.6. Sectoral block arrangement and interdependence in Czechoslovakia 1962[a]

	3	11	12	13	14	1	4	5	6	7	8	9	16	2	10	15	17	18
3			X						X	X	X							
11		X	X		X	X	X			X			X					X
12	X			X	X	X	X	X		X	X	X			X	X		X
13		X	X			X	X						X	X				X
14	X		X	X			X			X	X			X		X		X
1																		
4								X										
5			X				X	X	X	X								
6			X				X	X		X				X				
7							X	X	X	X				X				X
8										X								
9					X					X				X		X		X
16		X			X					X								X
2														X				
10	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X
15	X	X		X	X	X	X	X	X	X			X	X	X			
17			X	X	X	X	X	X	X	X			X	X	X	X		X
18	X	X	X			X	X	X	X	X		X	X	X	X	X	X	

Note: (a) METALS: 3, 11, 12, 13, 14
ENERGY: 2, 10, 15
SERVICES: 17, 18
NON-METALS: OTHER

Based on the actual data ('Full Method') and framework matrix with critical value of 20 mil. units of national currency. The data include both domestic deliveries and imports. The vectors are identified by numbers; for sectoral codes, see Appendix.

Table IV.7. Sectoral block arrangement and interdependence in Austria 1964[a]

	3	11	12	13	14	1	4	5	6	7	8	9	16	2	10	15	17	18
3												X						
11		X					X					X	X					
12							X					X	X				X	X
13	X				X							X					X	X
14	X	X		X	X	X	X		X		X	X		X				
1												X						
4												X					X	X
5								X				X						
6									X								X	
7				X				X	X	X								
8											X							
9	X	X	X	X	X		X	X	X	X	X	X			X	X		
16	X	X	X	X	X	X	X	X	X	X	X	X						X
2												X						
10								X		X	X	X			X			
15				X		X	X	X		X		X		X		X		
17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
18	X	X	X									X					X	X

Note: (a) METALS: 3, 11, 12, 13, 14
ENERGY: 2, 10, 15
SERVICES: 17, 18
NON-METALS: OTHER

Based on the actual data ('Full Method') and framework matrix with critical value of 20 mil. units of national currency. The data include both domestic deliveries and imports. The sectors are identified by numbers; for sectoral codes, see Appendix.

(vi) Austria had at the time a much more developed chemical industry (sector 9) than Czechoslovakia, which was reflected in its role as purchaser and supplier of inputs. In the latter case it can be seen, however, that inputs originating in the chemical industry were also most likely used as alternative inputs in Austria, particularly iron and steel inputs which, in turn, appears to be the case of Czechoslovakia (refer to 'Basic metals', sector 12).

(vii) The NON-METALS block appears to be the only important customer of the ENERGY block in Austria. However, the most likely interpretation of this finding is that it reflects a different industrial structure and not the fact that METALS were technologically independent of ENERGY, viz., the smaller role played by METALS in Austria in comparison to Czechoslovakia.

(viii) It should be noted that the above test is highly sensitive to the level of aggregation of I-O tables, given the groupings of industries into 'physically homogeneous' blocks. In this respect, the level of aggregation is high and further disaggregation would be desirable. For example, the 'other mining' sector (3) includes not only mining of metal ores but also quarrying.

(ix) Bearing in mind the shortcomings as well as various specific differences between the two economies, nevertheless it is possible to infer from the tables common elements of industrial structure. In particular, the I-O matrices are decomposable according to common physical qualities ('physical homogeneity') and show a high degree of block diagonality. It appears, therefore, that those 'fundamental' properties discussed by Simpson and Tsukui are not entirely restricted to developed market economies and signs of these properties can be discovered in the CPEs for which Czechoslovakia is being used as a case study.

Finally, we have also analysed the sectoral hierarchy which resulted from matrix triangulation in each iteration and found no evidence that the NRP industries should appear systematically at the extreme position of the

TABLE IV.8. Sectoral hierarchy in the framework matrices of Czechoslovakia (1962) and Austria (1964)[a]

AUSTRIA

Section																		
2									*						*			
1	*	=						*	*									
4		*							*									
3		*							*		*						*	*
6			*		=				*									
5					*	=			*									
8					*	*	=						*					
7		*						=										
9		*	*	*	*	*	*	*	=	*	*	*	*	*	*			
10		*			*	*	*	*	*	=								
11		*		*				*	*		=					*		
12				*	*				*	*						*	*	
13		*			*			*	*					*			*	*
14	*	*	*	*		*		*	*	*	*		*	=				
15	*	*		*	*		*		*			*	*		=			
16	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			*
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	=	*
18			*						*		*	*				*	*	

CZECHOSLOVAKIA

Section																		
3																		
1		=																
2		*	=		*	*	*	*		*		*			*			
4		*				*					*							
5		*		*	=	*	*			*		*						
6		*	*	*	*		*			*		*						*
7		*	*	*	*	*	=											*
16							*											
8		*					*							*	*			*
9	*	*	*	*	*	*	*		*		*	*		*	*	*	*	*
10	*	*	*	*	*	*	*			*	=	*		*	*	*		*
11		*	*	*	*		*	*	*	*	*		*	*	*		*	*
12	*	*	*	*	*	*	*			*	*	*			*	*		*
13		*	*	*			*	*				*	*		*			*
14	*	*	*	*	*	*	*			*	*		*	*		*		
15	*	*	*	*	*	*	*		*	*	*		*	*	*			*
17		*	*	*	*	*	*	*		*	*	*	*	*	*	*		*
18	*	*	*	*	*	*	*		*	*	*	*			*	*	*	

Note: (a) The triangularized matrices based on actual data ('Full Method') discarding entries smaller than 15 mil. units of national currencies. The Austrian matrix on the top is 36.58 per cent full (i.e. the coverage is 36.58 per cent) having 125 cells full, 199 cells empty. The Czechoslovak matrix on the bottom is 42.28 per cent full, containing 137 non-zero entries and 187 zero entries. The circular feedback in the Austrian matrix is 7.14 per cent and that of the Czechoslovak matrix is 17.32 per cent. The data used in these framework matrices include both domestic deliveries and imports. The sectors are identified by numbers ~~on the left side~~ of each matrix; for sectoral codes, see Appendix.

hierarchy. In fact, the best results, achieved in iteration 4, are paradoxical and they are reproduced in Table IV.8. While all the NRP industries (identified with numbers 1, 2, 3 and 4) are grouped together as suggested by the hypothesis, these sectors are located in the wrong position in the hierarchy. Given the aim to maximize entries below the main diagonal one would expect these industries to be placed at the bottom of the hierarchy, not on top. Clearly, the position of individual sectors in the hierarchy is dictated by the conditions of triangulation and the hierarchy reflects optimal sectoral arrangement in terms of the criteria of triangulation. It is, therefore, the block decomposability and diagonality which we would like to stress as the criteria for comparison and an assessment of similarity between both countries.

3.6 Evaluation and economic interpretation of the results of matrix triangulation

Inter-country comparisons of technology in the I-O framework require the study of structural properties of transaction matrices, which in turn demand formulation of structural characteristics. The triangulation of transaction matrices gives a broad basis for definitions of structural indicators, which reflect overall characteristics of the matrices rather than isolated transactions within such a matrix.

A detailed comparison of triangularized transaction and framework matrices of Czechoslovakia and Austria for 1962 and 1964 respectively shows that there were some specific differences between these economies. While neither of these matrices could be perfectly triangularized,[52] both the magnitude and the structure of the circular feedback appeared to be rather different. These differences are not entirely surprising given the variety and complexity of factors which can generate them. However, given the small

52. The only exception resulted from the application of the Binary Method when a perfectly triangular matrix was obtained for Czechoslovakia after the ninth iteration.

size of the sample, it would be unreasonable to attribute these differences to technological peculiarities.[53]

On the other hand, several structural similarities emerge from the application of the matrix triangulation procedure and these conform quite closely to patterns observed elsewhere in the empirical literature. First, while the transaction matrices of Czechoslovakia and Austria are not perfectly triangular, the magnitude of the circular feedback in both matrices was internationally comparable. However, the circular feedback was substantially reduced in both matrices after the first five iterations which meant, it will be recalled, discarding entries smaller than 'only' 25 mil. units of national currencies. Second, the hierarchy of sectors obtained from matrix triangulation was similar in both countries and the degree of similarity was, in turn, highly comparable to findings of other studies for different countries.

There have been several studies attempting to explain the inter-country variations in the 'degree of circularity' ratio. For example, Helmstädter (1969) tried to explain the variations on the basis of differences in the level of industrialization while Lamel _et al._ (1972) used the basis of the level of development. Such studies, however, were not on the whole very successful. A rather different attempt was made in this paper. Given the small size of the sample, we have concentrated on the detail of the circular feedback by analysing its structure. The comparison revealed that the structure of circular feedback was different, which seemed to reflect peculiar accounting or institutional practices rather than technological peculiarities.

It is important to note various constraints which operate on the interpretation of our results. It is generally believed that the 'degree of circularity' ratios are positively correlated with the degree of

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53. See the discussion below.

aggregation.[54] A test of this hypothesis which was undertaken for the Federal Republic of Germany confirmed this proposition.[55] Further difficulties of interpretation may arise due to differences in import patterns and their treatment in the I-O tables and due to differences in prices.

The interpretation of I-O relations which are not perfectly triangular is not entirely straightforward.[56] In general, the presence of circularity means that there exists no unique criterion for the ordering of industries.[57] However, the circular feedback observed in the transaction and, in particular, framework matrices was small and the degree of circularity could be substantially reduced by concentrating on the 'key' flows in the matrices. Moreover, since the degree of circularity seems to be positively correlated with the degree of aggregation, the triangularity of the matrices is likely to be increased with a higher level of disaggregation. Furthermore, given the high degree of similarity between sectoral arrangements as well as the degree of circularity arising from matrix triangulation in almost all iterations, this seems to provide some evidence that the differences in prices do not considerably affect the degree of comparability of Czechoslovak and Austrian matrices, at least with regard to the triangular property of these matrices.[58] Also, comparable tests were carried out on the basis of data which once included and another time excluded imports and no systematic influence of imports was discovered.

Thus, we are led to conclude that the 'fundamental' structures

54. Helmstädter (1969), p. 234 argues, for example, that there is a negative correlation between the degree of linearity and the degree of aggregation.

55. Korte and Oberhofer (1971), p. 509.

56. Some of these conceptual difficulties are discussed in Lamel et al. (1972), p. 48-50.

57. For a further discussion see Simpson and Tsukui (1965), pp. 437-9.

58. Once again, as in the previous chapter, we can only rely on empirically established standards to evaluate the degree of 'closeness' between two matrices, given the absence of unambiguous ('objective') standards.

of both Czechoslovakia and Austria were, at least in the period under consideration, triangular in form.[59] In addition, 'fundamental' I-O relationships which were found in empirical studies for different countries to form a hierarchical arrangement also hold for Czechoslovakia and Austria in 1962 and 1964 respectively, i.e. for two economies operating with different institutions.[60]

The triangular I-O matrices have been interpreted in a number of different ways. The interpretations have been given in detail by several authors and need not therefore be discussed here.[61] One of these is that the triangular arrangement of sectors is determined by technology. However, for reasons discussed above, the influence of technology on the triangular property of I-O matrices is likely to be less direct.[62] Consequently, the matrix triangulation technique should be used with caution and perhaps only as a supplementary test to other tests of technological similarity among countries.

This holds for empirical studies in international trade in which one is often interested in technological similarities and differences among countries. More specifically, one is often concerned about whether technological structures exhibit what is known as factor reversals or not. Typically, such studies employ tests of capital and labour intensities of technological processes. Nevertheless, by representing the matrix

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59. Following Simpson and Tsukui, the emergence of a consistent picture in various iterations suggests that differences in relative prices do not 'obscure the underlying common structure'. See Simpson and Tsukui (1965), pp. 434-6.

60. Given the findings of Allen (1974) and Tilanus (quoted in Korte and Oberhofer (1971)), to use a few examples, these differences in the time periods under consideration should not be serious.

61. The interpretation of triangular I-O matrices can also be varied together with changes in the basic form of the transaction matrices. For example, Korte and Oberhofer interpreted the triangulation of matrix of I-O coefficients as maximization of the sum of all weighted marginal input ratios in ascending direction. For more details and other interpretations as well as the list of references to the relevant literature, see Korte and Oberhofer (1971), section 6.

62. For footnote 62, please see page 208.

of interdependence among industrial sectors which, in turn, is assumed to be determined to a large extent by technology, the matrix of current material inputs should have similar properties among countries - that is if those countries use essentially the same technology. Moreover, since the natural resource factor is represented in this study by NRP as a proxy, one would expect a particular position of NRP industries in the sectoral hierarchy.

Attempts made in the literature to test the above hypothesis have not been successful. Nor were the results of our triangulation procedure satisfactory in this respect. However, we have undertaken further tests of 'fundamental' structures and found that in both Czechoslovakia and Austria there were clear signs of (i) decomposability (ii) block diagonality and (iii) physical homogeneity of I-O structures.

Our findings also pointed to a number of specific characteristics of Czechoslovak and Austrian economic structures. Some of these differences can be explained by differences in the structure of final demand and hence by the difference in the structure of production. In addition, the studies of 'fundamental' properties are sensitive to the level of aggregation of I-O tables. The 18 x 18 aggregation of the tables used in this exercise does not always allow reasonable homogeneity and sector size and therefore vitiates our findings. The specific differences about which we have spoken above or those which we observed from a detailed comparison of the two countries[63] can be analysed only in further studies based on a higher level of disaggregation of the data. Only then and with a larger sample of countries will it be possible to attempt to attribute the above differences to technological peculiarities or to some other factors.

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62. For further discussion, see Simpson and Tsukui (1965), pp. 442-3 and Carter (1970), pp. 33, 114-27.

63. These findings are part of a separate study which can be obtained on request from the author.

Having said all that, however, the similarity between economies in terms of their 'fundamental' properties is quite striking. We must conclude, therefore, that the forces of common technology which have been found to generate 'fundamental' properties of production structure in developed market economies can also be found in the CPEs.

CHAPTER V PRODUCT SUBSTITUTION AND TECHNOLOGICAL CHANGE IN CZECHOSLOVAKIA AND AUSTRIA: THE RAS APPROACH

1. Introduction

The reader will recall from the discussion in the previous chapters that the technological comparison of Czechoslovakia and Austria is based on the assumption that inputs are used in production processes in fixed proportions (the assumption of fixed coefficients). In specific terms, the assumption states that input requirements are fixed irrespective of the rates of output (i.e. the scale of output) and even in time, implying that changes in I-O coefficients over time would be attributed only to changes in technology. We have also mentioned that this assumption of temporal stability has been criticized in the literature since it is said to 'deny the distinction between substitution and technological change'.[1] Thus while they recognize the possibilities of substitution of primary factors, I-O economists typically suggest that inputs of intermediate goods are inelastic with regard to price changes.[2]

The assumption of temporal stability of I-O coefficients has been rejected even by some I-O economists and various solutions have been suggested.[3] Perhaps the best known is the so-called RAS method due to Stone and his colleagues. This has already been applied in several studies to update and project I-O coefficients.[4] It will be adopted in our international comparison of technology in this chapter.

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1. Sato and Ramachadran (1980), p. 1004.

2. See, for example, Simpson and Tsukui (1965), p. 434 and Carter (1970), p. 85.

3. For a survey of methods of updating and projecting I-O coefficients, see Sato and Ramachdran (1980), pp. 1004-12.

4. The method was originally formulated in Stone (1961) and Stone and Brown (1962), pp. 287-310. It was first applied by Stone, Bates and Bacharach (1963). For a list of studies which have examined the RAS method since it was originally applied in the UK, see Lynch (1979).

In applying the RAS method we will be able to relax one of the assumptions made at the outset of this study. The following assumptions are retained in this chapter: (1) the assumption of identity of products and industries, (2) the assumption of product homogeneity, (3) the assumptions of commodity and industry technology, (4) the assumption of fixed input coefficients with regard to scale of output and (5) the assumption of non-distorting commercial policies. As we shall see later, the application of the RAS method unfortunately involves making further specific assumptions in order to obtain results interpretable in the context of international comparisons of technology.

The chapter is divided into five sections. We shall start with a brief description of the method in the following Section 2. In Section 3 it will be suggested how the method can be modified to study inter-country differences in production structures. Section 4 reports the first set of empirical results obtained from the RAS transformation of the Czechoslovak transaction matrix. The actual hypothesis and its test are presented in Section 5 and the chapter concludes with an assessment of the results in Section 6.

2. The RAS method

The RAS method is based on the idea that changes in I-O coefficients over time may be due to two kinds of technological trends: (i) substitution effect reflecting substitution of one commodity by another as intermediate input ; and (ii) fabrication effect reflecting 'the extent to which commodity k has come to absorb a greater or smaller ratio of intermediate to primary inputs in its fabrication'.[5] There will be vectors of 'substitution' multipliers and 'fabrication' multipliers operating over the rows and columns of the matrix of I-O coefficients respectively.

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5. Stone et al. (1963), p. 28,

TABLE IV.8. Sectoral hierarchy in the framework matrices of Czechoslovakia (1962) and Austria (1964)[a]

AUSTRIA

Section	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'
2									*						*			
1	*	=						*	*									
4		*							*									
3		*							*		*						*	*
6			*		=				*									
5					*	=			*									
8					*	*	=						*					
7		*						=										
9		*	*	*	*	*	*	*	=	*	*	*	*	*	*			
10		*			*	*	*	*	*	=								
11		*		*				*	*		=					*		
12				*	*				*	*						*	*	
13		*			*			*	*					*			*	*
14	*	*	*	*		*		*	*	*	*		*	=				
15	*	*		*	*		*		*			*	*		=			
16	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			*
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	=	*
18			*						*		*	*				*	*	

CZECHOSLOVAKIA

Section	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'
3																		
1		=																
2		*	=		*	*	*	*		*		*			*			
4		*				*					*							
5		*		*	=	*	*			*		*						
6		*	*	*	*		*			*		*						*
7		*	*	*	*	*	=											*
16							*											
8		*					*							*	*			*
9	*	*	*	*	*	*	*		*		*	*		*	*	*	*	*
10	*	*	*	*	*	*	*			*	=	*		*	*	*		*
11		*	*	*	*		*	*	*	*	*		*	*	*		*	*
12	*	*	*	*	*	*	*			*	*	*			*	*		*
13		*	*	*			*	*				*	*		*			*
14	*	*	*	*	*	*	*			*	*		*	*		*		
15	*	*	*	*	*	*	*		*	*	*		*	*	*			*
17		*	*	*	*	*	*	*		*	*	*	*	*	*	*		*
18	*	*	*	*	*	*	*		*	*	*	*			*	*	*	

Note: (a) The triangularized matrices based on actual data ('Full Method') discarding entries smaller than 15 mil. units of national currencies. The Austrian matrix on the top is 36.58 per cent full (i.e. the coverage is 36.58 per cent) having 125 cells full, 199 cells empty. The Czechoslovak matrix on the bottom is 42.28 per cent full, containing 137 non-zero entries and 187 zero entries. The circular feedback in the Austrian matrix is 7.14 per cent and that of the Czechoslovak matrix is 17.32 per cent. The data used in these framework matrices include both domestic deliveries and imports. The sectors are identified by numbers on the left side of each matrix; for sectoral codes, see Appendix.

$$u^{t+1} = \hat{r}(A^t \hat{x}^{t+1})s \quad (5)$$

and

$$v^{t+1} = X'^{t+1} i \quad (6)$$

where the symbol ' ' ' identifies transpose.

or

$$v'^{t+1} = i' X^{t+1} \quad (6.1)$$

which, following the same procedure as the one used in obtaining equation (5) gives

$$v'^{t+1} = r'(A^t \hat{x}^{t+1})\hat{s} \quad (7)$$

Equations (5) and (7) represent all the necessary information needed to compute vectors r and s provided that vectors u^{t+1}, v^{t+1} and x^{t+1} are known in addition to matrix A^t. These are the so-called RAS equations. They contain 2n equations with 2n unknown multipliers. Values for the unknown multipliers r and s can be obtained by solving simultaneously the systems of equations or by means of an iterative procedure.[7]

The values of r and s have an economic interpretation[8] and, as we shall see later, they can be used in international comparisons. The 'substitution' multipliers (r_i) greater than one indicate that the relevant i-th commodities[9] are being used as substitutes as intermediate

7. There exists a short-cut method to solve for the multipliers r and s by starting with the base year matrix of intermediate flows and adjusting it to the new controls. However, the values r and s which are obtained in this way will be different from those which are computed on the basis of I-O coefficients and, more importantly, no economic meaning can be attached to this short-cut solution. For more details, see United Nations (1973), pp. 73-4.

8. But see also discussion below and previous footnote.

9. In view of the necessity to use industry-industry I-O tables in this study, i-th row of the tables refers to the output of i-th industry rather than to i-th commodity.

inputs for the other commodities. The 'substitution' multipliers (r_i) smaller than one indicate that the relevant i-th commodities are being replaced as intermediate inputs by the other commodities. The 'fabrication' multipliers (s_j) greater than one indicate that intermediate inputs of commodities are being relatively increased and inputs of primary inputs relatively reduced in the production of the j-th commodities. The 'fabrication' multipliers smaller than one indicate that intermediate inputs of commodities are being relatively reduced while inputs of primary factors are being relatively increased.[10]

Further advantages of the RAS method follow from its mathematical properties. First, there always exists an iterative solution which is unique and convergent provided that the transaction matrix is non-singular.[11] Second, zero entries in the original matrix (A^t) are preserved in the update matrix (A^{t+1}).[12] These properties make the method very suitable for computing since mistakes are not generated purely by computational manipulations which, in turn, are reliable and lead to rapid solutions. It should be noticed that the 'substitution' multipliers (r_i) and the 'fabrication' multipliers (s_j) are assumed to operate uniformly over the rows and columns respectively of the matrix. This obviously follows from equation (3) above.[13] Even though this assumption may seem intuitively untenable it is not entirely implausible.[14]

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10. We shall see in the following section that the above interpretation is not the only one. Moreover, if $\hat{r} A^t \hat{s}$ is a biproportional estimate of A^{t+1} then so is $(\lambda \hat{r}) A^t (\lambda^{-1} \hat{s})$, for any non-zero scalar λ. This means, as pointed out by Bacharach, that certain values of r (and s) may not be economically interpretable unless suitably 'normalized'. For more details, see Bacharach (1965), p. 295.

11. The 'uniqueness' of the RAS solution is particularly useful in international comparisons since it means that one does not need criteria to choose between solutions.

12. For proofs of these properties, see Bacharach (1970).

13. See also Stone and Brown (1962), p. 294.

14. See Allen (1974), p. 221.

3. The use of the RAS method in international comparisons

One of the most attractive features of the RAS method is that it is flexible and can be used for other purposes. For example, Allen adapted the method to incorporate exogenous information on a relatively small but important number of coefficients.[15] The method has also been used in studies of international trading matrices and the r and s vectors have been interpreted differently from the interpretation given in the previous section.[16]

Consider an I-O comparison of countries such as Czechoslovakia (C) and Austria (A), and assume that the I-O tables are perfectly comparable and both countries have identical prices. The matrices of I-O coefficients may, therefore, differ on account of (i) a different combination of intermediate products ('substitution' effect) and (ii) a different combination of intermediate products on the one hand and primary factors on the other ('fabrication' effect). Under these conditions, the differences will be reflected in differences in total intermediate outputs (vectors u) and total intermediate inputs (vectors v). Moreover, under these circumstances it is possible to identify the nature of the technological differences by constraining one country's matrix of I-O coefficients (say A) by vectors of the relevant output aggregates of the other country (i.e. C).[17]

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15. Allen (1974), pp. 215-28.

16. For example, the vectors r and s are known to have been interpreted as 'market shares' in studies of international trading matrices such as in Waelbroeck (1964). For a brief review of economic foundations of RAS, see Bacharach (1965), pp. 294-6.

17. In updating and projecting I-O coefficients, the problem is to find

$$A^{t+1} = \hat{r} A^t \hat{s}$$

so that $(A^{t+1} \hat{x}^{t+1}) i = u^{t+1}$

and $(A^{t+1} \hat{x}^{t+1})' i = v^{t+1}$

This formulation of the problem will often be used throughout the following text. Note also that $i = (1, 1, \ldots,)'$.

Let c (Czechoslovakia) replace t+1 from the previous section and let A (Austria) replace t. Then the RAS equations (5) and (7) are represented in international comparisons by the following:[18]

$$u_C = \hat{r}_C (A_A \hat{x}_C) s_C \tag{5.1}$$

and

$$v'_C = r'_C (A_A \hat{x}_C) \hat{s}_C \tag{7.1}$$

Thus, using the modified RAS equation (5.1) and (7.1) it is possible to compute vectors r_C and s_C. Similarly, it is possible to compute vectors r_A and s_A by constraining the other country's matrix of I-O coefficients (C in this example) by the relevant output aggregates of the original country, i.e. C in this case. Specifically,

$$u_A = \hat{r}_A (A_C \hat{x}_A) s_A \tag{5.2}$$

and

$$v'_A = r'_A (A_C \hat{x}_A) \hat{s}_A \tag{7.2}$$

Given r_C and s_C obtainable from equations (5.1) and (7.1) (and r_A and s_A from equations (5.2) and (7.2)) it is easy to compute a new matrix, say, $\tilde{A}_A$ (and resp. $\tilde{A}_C$) by premultiplying the matrix A_A by the diagonal matrix r_C(resp. $\tilde{r}_A$) and postmultiplying by the diagonal matrix $\hat{s}_C$(resp. $\hat{s}_A$), i.e.

$$\tilde{A}_A = \hat{r}_C A_A \hat{s}_C \tag{8}$$

and

$$\tilde{A}_C = \hat{r}_A A_C \hat{s}_A \tag{9}$$

18. The rest of the terminology is the same as before.

where A_A and A_C — the original matrices of I-O coefficients of countries A and c respectively

$\tilde{A}_A$ and $\tilde{A}_C$ — the original matrices of I-O coefficients of countries A and C after RAS transformation

r_C and s_C — adjustment factors for technology of country A using C's technology (vice versa for r_A and s_A)

Note that $\tilde{A}_A = \tilde{A}_C$ if $A_A = A_C$, i.e. the 'adjusted' I-O matrices are identical if the original I-O matrices are the same. Note further that differences in the 'adjusted' I-O matrices depend entirely on the differences in the original I-O matrices and, in addition, that prices are not treated explicitly since they are assumed identical.[19]

Now let us allow for inter-country differences in prices and consider the other extreme; namely, differences between $\tilde{A}_A$ and $\tilde{A}_C$ are entirely due to differences in prices. Thus, we can define a matrix A*.[20]

$$A^*_A = \hat{p}_A A_A \hat{p}_A^{-1} \tag{10}$$

and

$$A^*_C = \hat{p}_C A_C \hat{p}_C^{-1} \tag{11}$$

where A^*_A and A^*_C — the original matrices of I-O coefficients of countries A and C respectively adjusted to other country's prices

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19. The RAS problem in the present context is to find

$$\tilde{A}_C = \hat{r}_A A_C \hat{s}_A$$

so that $(\tilde{A}_C \hat{x}_A)\ i = u_A$

and $(\tilde{A}_C \hat{x}_A)'i = v_A$ where $i = (1, 1, \ldots, 1)'$

20. The following discussion refers to a treatment of price differences in the RAS inter-country comparison. No systematic attempt will be made, however, to apply this analysis in the empirical part. Unlike in the case of aggregation where starred symbols identified macro - rather than micro - I-O units, the starred letters identify in this chapter matrices obtained by RAS transformation.

p_A (and p_C) price vector relating prices of country A to prices of country c (and vice versa)

Note here that $A^*_A = \tilde{A}_A$ (and $A^*_C = \tilde{A}_C$) if $r_C = r_A = s_C = s_A = 1$. Now, given equations (8)-(11) and considering both technological <u>and</u> price effects we have

$$\tilde{A}_A = \hat{r}_C A^*_A \hat{s}_C \tag{12}$$

$$= \hat{r}_C \hat{p}_A A_A \hat{p}_A^{-1} \hat{s}_C$$

and

$$\tilde{A}_C = \hat{r}_A A^*_C \hat{s}_A \tag{13}$$

$$= \hat{r}_A \hat{p}_C A_C \hat{p}_C^{-1} \hat{s}_A$$

which can be written as

$$\tilde{A}_A = \hat{r}^*_C A_A \hat{s}^*_C \tag{14}$$

and

$$\tilde{A}_C = \hat{r}^*_A A_C \hat{s}^*_A \tag{15}$$

where

$$\hat{r}^*_C = \hat{r}_C \hat{p}_A \tag{16}$$

$$\hat{r}^*_A = \hat{r}_A \hat{p}_C \tag{17}$$

and

$$\hat{s}^*_C = \hat{p}_A^{-1} \hat{s}_C \tag{18}$$

$$\hat{s}^*_A = \hat{p}_C^{-1} \hat{s}_A \tag{19}$$

Notice that when one solves the RAS equations (5.1), (7.1) and (5.2) and (7.2) in the presence of price differences and computes the 'adjusted' matrices $\tilde{A}$ according to equations (12) and (13), one obtains vectors r* and s* rather than 'true' technologically determined vectors r and s. However, if vectors p_C (or p_A) are known it is easy to compute the 'pure' 'substitution' and 'fabrication' effects. Given equations (16)-(19) we have

$$\hat{r}_C = \hat{r}^*_C \hat{p}_A^{-1} \quad (20)$$

$$\hat{r}_A = \hat{r}^*_A \hat{p}_C^{-1} \quad (21)$$

and

$$\hat{s}_C = \hat{s}^*_C \hat{p}_A \quad (22)$$

$$\hat{s}_A = \hat{s}^*_A \hat{p}_C \quad (23)$$

Both vector r and vector s can be interpreted in economic terms. For example, i-th elements in vector r_C which are greater than one imply that the products of the i-th industry are being substituted as intermediate inputs for products of other industries in country c relatively more than in country A. Further, i-th elements in vector s_C which are greater than one imply that intermediate inputs of commodities are being used relatively more and primary inputs relatively less in country c in comparison to country A.

Note that it is possible to interpret the 'substitution' effect as 'absorption' of commodities in production. Different absorptions of commodities in production processes will be reflected in different intermediate uses of commodities per unit of output, i.e. in differences in I-O coefficients.

4. The impact of RAS transformation on the Czechoslovak transaction matrix

As we have seen above, application of the RAS technique to inter- country comparisons of production structures involves constraining the Czechoslovak

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21. See Stone and Brown (1965), p. 294. This interpretation was also adopted by Sato and Ramachandran (1980), p. 1009 and it is only slightly different from the interpretation of Leontief (1951).

transaction matrix to the Austrian control totals. Our first task here will be to see the impact of the transformation on the Czechoslovak transaction matrix. In specific terms, it might be conjectured that any differences between the transaction matrices of the two countries should be diminished as a result of this transformation.[22] The impact of this transformation will be measured here by means of a summary indicator which we call 'RAS transformation ratio' (δ^2) and which is defined below.[23]

Once again we started by defining and computing difference matrices[24] (D)

$$D^1 = A_C - A_A;\ D^1 = ({}_1d_{ij}) \tag{24}$$

$$D^2 = \tilde{A}_C - A_A;\ D^2 = ({}_2d_{ij}) \tag{25}$$

where A is the matrix of direct I-O coefficients and the symbols 'c' and 'A' stand for Czechoslovakia and Austria respectively. The matrix $\tilde{A}_C$ represents the Czechoslovak transaction matrix of I-O coefficients after the RAS transformation. We then computed the 'RAS transformation ratio' which is defined as the ratio of the sum of squared differences of all elements of matrix D^1 (i.e. δ_1^2) and the sum of squared differences of all elements in matrix D^2 (i.e. δ_2^2). So

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22. The procedure is similar to the test of accuracy of RAS-based updates and projections. Thus, the actual matrix of I-O coefficients A^{t+1} is compared with the matrix A^{t+1} updated on the basis of control totals u^{t+1}, v^{t+1} and x^{t+1}. Similarly, the control matrix A_A (i.e. the actual matrix of Austria) will be compared with the transformed matrix of Czechoslovakia $\tilde{A}_C$ which was computed on the basis of the RAS method using control totals u_A, v_A and x_A.

23. The test may be useful in the light of extensive discussions concerning the accuracy of the RAS technique. In the earlier stages of the Cambridge Growth Project, Stone et al. (1963) reported successful updating of a Belgian table by Paelinck and Waelbroeck (1963). Some doubts about this evidence were expressed by Barker (1975) and further evidence suggests that the accuracy of the method is not entirely satisfactory. See, for example, the study of Lynch (1979) who discusses an update of the UK 1963 matrix for 1968 and Parikh (1979) who assessed RAS updates for nine countries.

24. The reader may recall that difference matrices were used in Chapter IV, sect: dealing with further tests of similarity of I-O coefficients.

$$\delta^2 = \frac{\delta_1^2}{\delta_2^2} = \frac{\sum_{j=1}^{18} \sum_{i=1}^{18} ({}_1d_{ij})^2}{\sum_{j=1}^{18} \sum_{i=1}^{18} ({}_2d_{ij})^2} \qquad (26)$$

The ratio (δ^2) is greater than 1 (resp.less than 1) if the RAS transformati of the Czechoslovak matrix of direct I-O coefficients leads to a reduction of differences from the corresponding Austrian matrix - that is $\delta_1^2 > \delta_2^2$ (resp. $\delta_1^2 < \delta_2^2$). The ratio is equal to 1 if the sum of squared differences δ_2^2 is the same as the sum of squared differences δ_1^2.

The computed value of the 'RAS transformation ratio' was in our case 0.9655. This indicates that there was hardly any change in the transformed Czechoslovak matrix, at least as far as the average difference between corresponding cells of the matrices of direct I-O coefficients is concerned. That is, the average difference between the corresponding cells of the two matrices is about the same irrespective of whether we compare the actual Austrian matrix A_A with the actual Czechoslovak matrix A_c or with the transformed Czechoslovak matrix $\hat{r}\, A_C \hat{s}$ (= $\tilde{A}_C$).

However, this finding does not mean that the individual coefficients in the transformed matrix $\tilde{A}_C$ did not change. The coefficients were indeed affected by the RAS transormation and the results are presented in Table V.1 which shows the distribution of the differences of I-O coefficients before and after RAS transformation. As can be seen quite clearly, the transformation of the Czechoslovak transaction matrix produced in some respects a greater degree of similarity with the actual transaction matrix of Austria. Thus, while 55 per cent of all non-zero coefficient differences can be located in the class interval of -0.019 to +0.020 before the transformation, the corresponding share is increased to 58.5 per cent after the transformation. On the other hand, the RAS transformation increased the number of 'anomalous' coefficients as can be seen from a comparison of both tails of the distribution. The value of 'RAS transformation ratio' implies, therefore, that while some coefficients were made more similar to the corresponding Austrian ones as a result of the transformation other coefficients were made correspondingly

Table V.1 Distribution of differences of I-O coefficients: Czechoslovakia (1962) and Austria (1964)[a]

Class interval		Number of non-zero coefficients		Percentage of total	
		$A_C - A_A$	$\tilde{A}_C - A_A$	$A_C - A_A$	$\tilde{A}_C - A_A$
	≤0.240	2	4	0.7	1.4
-0.220	-0.239	0	1	0.0	0.4
-0.200	-0.219	0	0	0.0	0.0
-0.180	-0.199	1	0	0.4	0.0
-0.160	-0.179	2	1	0.7	0.4
-0.140	-0.150	4	0	1.4	0.0
-0.120	-0.139	6	3	2.1	1.1
-0.100	-0.119	5	1	1.8	0.4
-0.080	-0.099	6	6	2.1	2.1
-0.060	-0.079	9	11	3.2	3.8
-0.040	-0.059	8	15	2.8	5.3
-0.020	-0.030	15	15	5.3	5.3
0.0	-0.019	71	86	25.2	30.5
0.001	0.020	84	79	29.8	28.0
0.021	0.040	20	19	7.1	6.7
0.041	0.060	14	12	5.0	4.3
0.061	0.080	10	12	3.5	4.3
0.081	0.100	6	4	2.1	1.4
0.101	0.120	8	2	2.8	0.7
0.121	0.140	4	2	1.4	0.7
0.141	0.160	1	2	0.4	0.7
0.161	0.180	1	0	0.4	0.0
0.181	0.200	0	0	0.0	0.0
>0.200		5	7	1.8	2.5
TOTAL		282	282	100.0	100.0

Notes: (a) Computed as the difference between corresponding cells of the actual transaction matrix of Czechoslovakia and that of Austria (i.e. $A_C - A_A$) and the difference between corresponding cells of the transformed transaction matrix of Czechoslovakia (i.e. $\tilde{A}_C = \hat{r}_A A_C \hat{s}_A$) and the actual transaction matrix of Austria. For more details, see the text.

Table V.2 R and s vectors used to transform the transaction matrix of Czechoslovakia, 1962[a]

Sectors	Vector r	Vector s
Agriculture	1.2988	0.4146
Coal, oil and gas	0.4886	0.1823
Mining	3.6624	8.7248
Food processing	2.4133	0.6940
Textiles	1.3261	1.3115
Shoes, clothing, leather, furs	1.0997	1.2366
Wood processing	0.8922	1.4513
Rubber	0.8568	0.5811
Chemicals	1.2118	1.0714
Oil, coal processing	0.3885	0.9072
Non-ferrous metallurgy	0.1290	0.2218
Basic metals	0.7461	0.7609
Transport vehicles	0.8816	0.5527
Engineering	0.6659	0.8604
Electricity	0.6470	1.8850
Construction	15.0920	1.0930
Trade	4.6931	5.0569
Transport	0.5020	1.6959
Geometric average:	0.9970	1.0222

Notes: (a) Computed from the Czechoslovak transaction matrix, 1962 constrained by row and column total of the Austrian transaction matrix, 1964.

different. The final result is that the reduction in the difference in some coefficients is counterbalanced by corresponding increases in the differences of others.[25]

It should be noted that the individual elements in vector r as well as the individual elements in vector s should be the same if there were no differences between the two countries. However, as can be seen from Table V.2 the multipliers differ quite substantially in each of the two vectors, which suggests that both the 'substitution' and 'fabrication' effects were taking place.[26] Since the actual values of the two vectors depend on units of measurement[27] we have computed the (geometric) average (g) of the multipliers of each of the two vectors.

$$\log g = \frac{1}{N} \sum_{i=1}^{18} \log x_i \qquad (27)$$

where x_i are the individual elements in vectors r and s respectively and N = 18.

The interesting pattern of r multipliers is that they are greater than one in the case of sectors which were all without exception 'the less preferential sectors' in Czechoslovakia. The sectors include agriculture (101), food processing (104), other consumer goods industries such as textiles (105), shoes, clothing and furs (106) and trade (117), which were low on the planners' priority list. The case of 'other mining' (103) may reflect greater abundance of minerals other than fuels in Austria. In contrast, r multipliers smaller than the geometric average appear to be associated with highly preferential

25. In the earlier study of Paelnick and Waelbroeck (1963) it was suggested that the s multipliers should be considered more as devices to correct errors arising from the rigidity of the r multipliers than as true measures of 'fabrication effects'. Our findings may be related to this argument which will be discussed further below.

26. The interpretation of the results is, however, more cumbersome and it will be left to the end of this chapter. We have nevertheless retained the same terminology for the r and s vectors at this stage in order to conform with the description of the technique above.

27. See the discussion above concerning the RAS solution and its interpretation in the previous section.

producer goods industries in Czechoslovakia.

With regard to s multipliers the picture is not as clear but some systematic pattern can be suggested. (i) Consumer goods industries are associated once again with s multipliers which are systematically greater than the geometric average. This was not, however, the case with agriculture (101) and food processing (104). (ii) S multipliers greater than the geometric average are also systematically linked to the service sector (trade 117, transport 118). (iii) The sectors linked with s multipliers smaller than the average were all producer goods industries,[28] i.e. rubber (108), oil and coal (102) and their processed derivatives (110), non-ferrous metals (111), basic metals (112), transport vehicles (113), other engineering (114).

5. The hypothesis and further empirical findings

In theory, the technological similarities or differences could be observed from an inter-country RAS-based comparison with the help of r and s vectors which represent the RAS solution. We have seen earlier that, under certain conditions which will be elaborated in the next section, these vectors could be interpreted in terms of 'substitution and fabrication effects'. We have also observed that if both economies were identical one would expect that the individual elements in vector r should be identical and similarly with regard to individual elements of vector s. Moreover, using our earlier findings we can postulate certain *a priori* expectations concerning the r and s multipliers. More specifically, it was suggested that one could observe in the Czechoslovak economy a different level of 'intermediation' in comparison to Austria as far as NRP were concerned. This finding lends itself to a testable hypothesis. If it is true that the I-O coefficient (a_{ij}) differs between the two countries one should

28. Except for agriculture and food processing mentioned earlier.

expect a particular size of the i-th element in vector r and the j-th element of vector s. Before stating the hypothesis more systematically it may be useful to note another facet of our finding. The NRP I-O coefficients tended to be higher in Austria before price adjustment.[29]

Therefore, the null hypothesis (H_o) can be stated as follows:

$$H_o: (a^c_{ij}) > (a^A_{ij}) \qquad \text{for } i = 1, 2, 3, 4 \text{ (NRP sectors)} \qquad (28)$$
$$j = 1, 2, \ldots, 18$$

where a refers to the I-O coefficient, c represents Czechoslovakia and A represents Austria. This null hypothesis is assumed to be valid before price adjustment and it can be set against an alternative hypothesis which is assumed to be valid after price adjustment, i.e.

$$H_1: ({*a}^c_{ij}) < ({*a}^A_{ij}) \qquad \text{for } i = 1, 2, 3, 4 \text{ (NRP sectors)} \qquad (29)$$
$$j = 1, 2, \ldots, 18$$

where all the symbols are the same as above except that $*a_{ij}$ now refers to the I-O coefficient adjusted for price differences.

If the null hypothesis is true, one would expect the relevant elements $r_i^{!}$ s and $s_j^{!}$ s to be smaller than the (geometric) average.[30] This would indicate that the higher Czechoslovak I-O coefficients were generated by two forces: (i) the 'substitution effect' whereby NRP are replacing other commodities in production processes and (ii) the 'fabrication effect' whereby production processes of j-th industries are using relatively more intermediate inputs certainly including also relatively more NRP.[31]

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29. See the analysis of individual I-O coefficients above.

30. That is, if one uses the Czechoslovak transaction matrix of I-O coefficients and applies the constraints represented by the relevant Austrian totals as we did in our computations.

31. It is, of course, also possible that, for example, the 'substitution effect' may simply outweigh the (opposite) 'fabrication effect' and still produce the results stipulated by the null hypothesis.

Alternatively, one could compare the I-O coefficients directly and proceed along the lines adopted earlier when we compared individual I-O coefficients. This approach has been adopted here as well, even though we decided not to go all the way in that direction. One reason for this decision was that no price readjustment of the I-O tables was undertaken in the context of the RAS comparison.[32] The second and perhaps the most important reason was our desire to see the 'substitution and fabrication effects' as they operated separately. In contrast, the comparison based on I-O coefficients only does not allow this sort of analysis. Third, as shown in the previous section, the RAS transformation increased the number of anomalous coefficients in the Czechoslovak transaction matrix, even though the transformation made the matrix more similar to the Austrian matrix in another respect. We believe that the increase in anomalous coefficients could be due to deficiencies in the Czechoslovak I-O table. In particular, it is suspected that some cells in the Czechoslovak I-O table differ from the corresponding Austrian cells on account of the treatment of trade and transport margins as well as the treatment of accounting profits arising from differences between domestic and foreign prices.[33] However, if one element in the matrix is overestimated this leads to understimation of the other elements in the same row and column in order to compensate.[34] Hence, it was felt that further improvement of the Czechoslovak I-O table is called for before any treatment of anomalous coefficients can be attempted. Finally, the assumption that the 'substitution effect' is uniform across the row is too rigid. The i-th product is not necessarily replacing other inputs in industry j at the same rate as this may be the case in industry

32. However, the price effect will be taken into account in the interpretation of the results in the next section.

33. For more details, see Chapter I.

34. This is known as 'ripple effect' and it is elaborated in Stone et al. (1963), p. 31.

k. For this reason, a comparison of I-O coefficients as an indication of the relative use of, say, product i in industries k and j would not be theoretically meaningful.

Our findings based on the r and s vectors do not lead to a unique answer with regard to H_o.[35] Looking first at the r multipliers, the null hypothesis would be rejected for all but one case of NRP; the relative use of agricultural products (101), food products (104) and products of other mining (103) was relatively greater in Austria while Czechoslovakia used relatively more coal and oil (102). On the other hand, the absorption (intermediation) level of major NRP users is represented by values of s multipliers which support the null hypothesis. This concerns the sectors of oil and coal processing (11), non-ferrous metallurgy (111), basic metals (112), production of transport vehicles (113) and other engineering (114). As we have seen above, the absorption level was higher in Austria only in the case of industrial consumer goods industries.

Our findings concerning products of the coal and oil industry are entirely consistent in that the tendency in Czechoslovakia to use relatively more of these products ($r_{102} < 0.9970$)[36] was accompanied by a higher level of intermediation in the coal and oil processing industry ($s_{110} < 1.0222$). On the other hand, the r multipliers for products of agriculture, other mining and food processing and s multipliers of major NRP using industries (food processing 104, non-ferrous metallurgy 111 and basic metals 112) indicate that there were two opposing forces operating in these NRP using sectors in the Czechoslovak economy, a downward 'substitution effect' but an upward 'fabrication effect'.

In sum, the null hypothesis with regard to products of the coal and oil industry should be accepted. There was a relatively greater use of these

35. The following discussion is based on Table V.2.

36. The numbers in brackets in this paragraph refer to the geometric average of all the elements in vectors r and s respectively.

commodities in Czechoslovakia in comparison to Austria and this was reflected by appropriate values of r and s multipliers. The higher level of intermediation of NRP in Czechoslovakia which was found earlier on the basis of individual I-O coefficients is confirmed by these RAS findings.

With regard to other NRP (agricultural commodities, products of other mining and processed food) the RAS picture is not as clear. On the one hand, the values of s multipliers of most producer goods (and NRP-intensive) industries as well as most NRP industries were consistent with the null hypothesis. However, the r multipliers appear to be contradictory and, therefore, favour acceptance of the alternative hypothesis.

6. An assessment of the RAS findings

We can now turn to the question of assessment and interpretation of our findings. Our results concerning the NRP industry of coal and oil confirm our previous findings and it is, therefore, the findings concerning agricultural products, processed food and products of other mining (sectors 101, 104 and 103) on which we wish to concentrate in this assessment. Before proceeding any further, however, we wish to make clear that there are three specific factors which affect our findings and complicate interpretation of the results.

First, each r_i represents an average degree of substitution of products of the i-th industry for products of other industries. One of the implications is that an increased use of the i-th product group by one industry (say 'j') is spread across the row to other industries leading to corresponding increase in the I-O coefficients in other purchasing industries (say 'k' where $k \neq j$) and, therefore, the other industries are assumed also to be users of the i-th product group even though, in reality, this may not have been the case. Another implication is that each r_i is not necessarily comparable on an inter-country basis, given differences in product-mix for each i-th product group between the countries concerned. For example, our sector 102 includes both coal and oil extraction, the former being characteristic of the factor endowment of Czechoslovakia, the latter of Austria. But it is precisely the substitution effect between coal and oil as alternative sources of energy which we would wish to measure. All in all, the degree of aggregation of our I-O tables was such that it does not always allow meaningful inferences about the substitution effect.[37]

Second, as we have already pointed out in the previous section, one should interpret s multipliers more as 'devices to correct the errors arising from the rigidity of r multipliers than as true measures of fabrication effects'.[38] As suggested by Stone et al., however, this correcting function is not completely successful.[39]

Third, it could be argued that a transaction matrix based on industry-industry classification does not reflect truly technological processes and, indeed, it was suggested in at least one study that 'product is more important'. At the same time it should be noted that the 'substitution effect' is assumed to be uniform across the row and, since the changes due to substitution may vary from industry to industry, the use of industry based classification of I-O tables on the input side might be more suitable.[40]

In terms of intermediate demand for NRP, the s vector is useful only indirectly. The individual values of s multipliers relate the intermediate demand of all material inputs to primary inputs with no distinction being made among individual material inputs. We will, therefore, restrict ourselves to a few remarks below. In contrast, the r multipliers are in

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37. While the other implication mentioned in this paragraph is a specific 'RAS problem' this implication is due to the statistical deficiency of the I-O tables. An additional difficulty arising from aggregation is that a suitable assumption had to be made about relative product prices, particularly with regard to commodities which are aggregated into each commodity group.

38. Stone et al. (1963), p. 31.

39. Ibid.

40. Op. cit., p. 34. With reference to 'substitution effect', one is naturally interested in substitution of product X for product Y rather than in substitution of products of industry X for products of industry Y.

this respect theoretically much more interesting since, under the assumptions mentioned earlier, they can be used to identify the process of substitution between NRP and non-NRP as intermediate inputs.

In terms of our hypothesis, i.e. that NRP are being absorbed in production processes to a greater extent in Czechoslovakia in comparison to Austria, the relevant values of the r vector should not indicate greater substitution of non-NRP by NRP in Czechoslovakia if we wish to separate the effects of 'substitution' and 'technology'. This would be reflected by r multipliers smaller than the geometric average. Indeed the conclusion that NRP were not replacing other material inputs in production processes in Czechoslovakia seems to be suggested by our results.

How can we explain these findings? Keeping in mind the limitations of the RAS method mentioned above, there may be a number of explanations of the relatively greater use (i.e. 'substitution') of products of sectors 101, 103 and 104 in Austria (as reflected by the relevant values of r-multipliers).[41] Among these explanations, however, there is one which has not yet been considered but which we believe to be plausible. That is, the phenomenon can be explained by 'systemic factors', i.e. by factors which reflect characteristic features of the centrally planned system, including particularly 'physical' (i.e. quantity) planning. In specific terms, what seems to support this argument most is that the r and s multipliers differed in accordance with the pattern of priorities of resource allocation in Czechoslovakia. The macro-economic management of priorities under central planning may also involve various forms of price fixing and it is, therefore, possible that the level of r and s multipliers could be explained by differences in relative prices.

41. In a way it seems more important to concentrate on r multipliers which in theory, indicate the degree of substitution between, in the present case, NRP and product groups of intermediate inputs. On the other hand, s multipliers reflect, in theory, the 'fabrication effect' on all intermediate input without distinction among individual intermediate inputs.

SUMMARY AND CONCLUSIONS

The purpose of the study was to establish whether the centrally-planned economies (CPEs) are characterized by what may be called a bias in the absorption of natural resource intensive products or, for short, natural resource products (NRP). Unlike market-type economies, there is a lack of empirical studies of absorption in the CPEs of such commodities as fuels (and energy in general), raw materials and agricultural products. Moreover, in contrast to the wide range of studies on the role of technical progress in determining demand for intermediate inputs in market-type economies (MTEs), there is a notable absence of such studies with regard to CPEs intermedi demand. This study is the first systematic attempt to fill this gap. At a time of rising scarcities of energy in general and fuels in particular in the world economy and increasing participation of CPEs in world commodity markets, the issue of NRP absorption has become widely discussed not only in the CPEs themselves but also in the West. In attempting to answer this question we have carried out an assessment of NRP absorption and, in this final part of the study, we shall summarize and evaluate our findings. At the end of the chapter we shall also suggest several theoretical and policy implications.

1. Evaluation of the findings

For the purpose of the study we have defined a 'bias' in terms of inter-country differences. Thus, instead of relating actual performance to a particular theoretical paradigm, the actual performance of, say, country A which is found to be different from the actual performance of country B will be characterized as 'biased' even though the latter itself may be 'theoretically biased' as well. The latter notion of bias is not considered here since the original arguments about 'excessive' NRP absorption in CPEs were justified precisely on the grounds of international comparisons.

One shortcoming of the empirical literature is that the studies were of a micro-economic nature and provided very limited scope for generalizations. As a result, the approach adopted in this study was that of an economy-wide analysis. Furthermore, various adjustments of data and considerable research to ensure data comparability restricted our analysis to a case-study approach. The countries selected were Czechoslovakia and Austria which can be regarded as highly similar in terms of size, factor endowments and, in the period under consideration, even in terms of income levels. Both countries have fundamentally different economic institutions and it is hoped that this study sheds some light on the comparative performance of their institutions. In choosing these countries, we have also restricted the analysis to cases for which we thought we would be able to ensure the greatest data comparability. Even though it may be tempting and perhaps even possible to generalize from the findings of this study to other countries, we are not interested here in international comparisons *per se*.

Relevant data were available for Czechoslovakia for 1962 and for Austria for 1964. Nevertheless, the study should be of more than just historical interest. The economic system of management and the overall strategy in Czechoslovakia at the time had a distinct character identified in the literature as the 'highly centralized model of planning'. The system has been changing in the meantime but the findings of this study should be a statement about the 'system' as much as about the past.

The analysis of NRP absorption (or absorption of any other commodity) consists of two separate parts: analysis of intermediate demand and analysis of final demand. Under conditions which would exist in a perfectly competitive (or 'planned') world, the intermediate demand for NRP would depend on the structure of production which, in turn, would be a function of final demand patterns. In addition, intermediate demand would depend on technology used by individual firms, substitution processes and effects of scale economies. Final demand would depend on the level of income, preferences of households (or 'planners' in CPEs) and relative prices.

The contribution of some of the above factors to output can be estimated empirically on the basis of production functions of either econometric, engineering or input-output (i.e. Leontief) type. The approach adopted here is that of input-output (I-O) analysis but the procedure employed goes beyond the use of traditional I-O methods. Perhaps the most frequent criticism of international comparisons of the 'technological matrices' is (i) the alleged reluctance of I-O economists to acknowledge the distinction between substitution and technology, (ii) that the effect of differences in relative prices has usually been ignored or assumed away (this problem also pertains, of course, to comparisons of final demand patterns), (iii) that too much emphasis has been put by I-O economists on differences in I-O coefficients which may be brought about by such 'uneconomic' (and, consequently statistically undesirable and distorting) effects as data imperfections, seasonality, etc. In addition, international comparisons of production structure are subject to ambiguities in defining 'matrix space', or to put it differently, the interpretation of 'similarity'.

This study attempts to answer two aspects of the above criticism in a novel and, therefore, original way. In order to minimize the effects of seasonal influences and some data imperfections we have designed a new method of sensitivity analysis of 'fundamental properties' of production structures, the latter representing a technique employed to analyse only 'characteristic' (i.e. 'fundamental') influences. The method of sensitivity analysis relies on an 'iterative' procedure of eliminating smaller than 'critical' values of entries in I-O tables and, in addition, on a novel application of binary numbers in I-O analysis.

We have relaxed the assumption of temporal stability of I-O coefficients and applied further for this purpose the RAS method originally developed in Stone and Brown (1962) and Stone, Bates and Bacharach (1963). The method which is computationally simple and theoretically justifiable can be very useful in estimating the temporal changes of I-O coefficients and, under certain assumptions, it can be used in international comparisons of production structures. However, the assumptions which constrain the RAS analysis are very severe and, as a result, the interpretation of findings may become difficult. In fact, as we shall see below, our estimations based on the RAS method are perhaps least satisfactory. This point is perhaps not surprising since there are too many factors which are 'activated' once the assumption of intertemporal stability of I-O coefficients is relaxed.

The actual measurement of intermediate NRP absorption in the I-O system can be undertaken by means of indicators of (i) structural interdependence, (ii) intermediate use, and (iii) production techniques, and by means of (iv) general indicators. The technique used in this study included the comparison of I-O coefficients and an examination of the so-called 'fundamental properties' of I-O matrices. The use of the coefficient matrix rather than the flow matrix is intended to diminish the effects of demand pattern on the structure of the transaction (technological) matrices. The comparison of final demand involved a simple (and direct) comparison of the final demand vectors and the use of the so-called Leontief statistic. Unfortunately, there is no unambiguous measure of a 'matrix space' for the task at hand. We have, therefore, defined the 'matrix space' with the help of two <u>alternative</u> techniques: viz., the Euclidean distance and correlation techniques.

The calculations presented in this study led to the following findings. The NRP embodied both directly and indirectly in exports in

Czechoslovakia and Austria were substantially smaller than the NRP content of imports, i.e. the Leontief statistics were smaller than unity. However, the values of the Leontief statistics differed in both countries due to much higher NRP requirements per unit of imports in Czechoslovakia. On the one hand, this difference, identified as NRP import bias in Czechoslovaki suggested the possibility of a domestic bias against NRP output and/or in favour of NRP final and intermediate consumption (i.e. domestic absorption) in Czechoslovakia. These findings have been interpreted as deviations from 'normal' trade (e.g. van Brabant (1973)) once we allow for possible differences in the level of total trade of both countries.

The comparison of the structure of gross aggregate output indicated a relatively high degree of similarity between both countries (the Spearman rank correlation coefficient, as the measure of the degree of similarity, was 0.82). Since the overall degree of similarity in the structure of gross aggregate output was high, the differences in trade structures should be sought in differences in 'domestic absorption' and/or domestic prices.

The first indication that domestic absorption of NRP in Czechoslovakia was high compared to that of Austria was provided by a significantly reduced degree of similarity in the structure of output if output was measured on a net basis. Since there is no straightforward relationship between value added (i.e. rewards of production factors) and production efficiency in the CPEs, the comparison of the use of NRP in the process of production was made on the basis of direct comparison of the two technological matrices. The findings were as follows: no significant evidence was found that the technology of domestic production with respect to the use of NRP was different and/or subject to what is known as 'factor reversals'.

The NRP import bias in Czechoslovakia could also have been generated from a bias existing in final consumption, particularly that of private consumers. The findings in Chapter III supported this view. As far as private consumption of food was concerned (which represented the most important element of NRP in private consumption), the comparison showed a significant bias in favour of food consumption in Czechoslovakia.

However, the interpretation of some of these findings depends on the structure of prices which were implicit in both I-O tables. More specifically, the bias may disappear if relative NRP prices in Czechoslovakia discriminated against the use and consumption of NRP. Some evidence was provided from the analysis of indirect taxes in Czechoslovakia, as shown in Appendix 1. Turnover taxes which represented the most important element of domestic taxation in Czechoslovakia affected the pattern of domestic prices in that the taxes were imposed more heavily on food prices for private consumers. Since taxation in Austria was oriented much more towards direct taxes, the analysis of the rates of turnover taxes in Czechoslovakia provided a useful indication that commodity prices differed substantially between the two countries.

Even though no attempt was made to separate the physical and price circuits in the RAS model and in testing the triangular property, we can also draw on the literature to make some general observations about the effect of relative prices on our I-O comparisons. A detailed review of the literature dealing with the general price issue can be found, for example, in Bornstein (1970), Kaser (1968), Rozsypal (1967).

The comparison of relative prices in Czechoslovakia and Austria comes essentially from detailed comparative studies of actual relative NRP prices in Czechoslovakia and developed MTEs; (some of these include Austria)[1]. They analyse various NRP prices and their changes over time.

1. In addition, several attempts have been made in the literature to assess the price structures on the basis of econometric methods of price simulation. In the West, this approach has been used, for example, by Ke-Young and Feltenstein (1974), Wolff (1975), Okishio (1959), Nordhaus and Godley (1972), Pesaran (1974). Following the work of Morishima and Seton (1961) and Seton (1976) the approach has been also adopted in the CPEs. A convenient survey in the literature can be found in Brown and Licari (1974), Kasan (1974), Walker (1971) and (1973), Brody (1969) and (1970). Estimates can be found for example, in Osiatynski (1969), Kyn, Sekerka and Hejl (1967), Brown (1972), Walker (1973), Brown, Hall and Licari (1973).

With reference to the period under consideration in this study, the outcome of such comparisons strongly suggests that the relative prices of agricultural products were lower than those of comparable products in MTEs. However, such clear-cut evidence is not available for other NRP[2].

To the best of my knowledge, there has been only one current attempt to compare the relative prices implicit in I-O tables and their effect on I-O flows internationally. Kyn and Simerda (1973) extended the use of mathematical price models to estimate the influence of prices on the transaction matrices of Western Europe, the United States and the Soviet Union. Using the I-O model, they derived a price system which corresponds to the characteristic vector of the transaction matrix and applied these prices to the 'similarity transformation' of the above transaction matrices. Their method was severely criticised by Osiatynski (1974) and I have also assessed the technique elsewhere[3].

The results of their experiments were disappointing. It is suggested, for example, that the 'similarity transformation' of the transaction matrices by the I-O prices has led to a reduction of the total share of (all) material inputs in GNP of the Soviet Union. This is a surprising finding because it is contrary to the widespread belief that the price system in the Soviet-type economies generally induces a downward rather than an upward bias in the aggregate I-O ratio.

Their other results of 'similarity transformations' were also inconclusive. The degree of similarity was increased for some sectors but

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2. The evidence and related discussions can be found, for example, in Hladik (1970), Jenicek (1968), Nevaril (1974), Plichta (1967), Vostatek (1969), Vlach (1966), Klouckova and Kloucek (1969), Hinke (1969), Jilek (1967), Vitvar (1968), Branik (1966).

3. See my 'Efficiency in Natural Resource Usage: A Comparison of Market and Central Planning Policies'; Journal of Policy Modelling, Vol. 3, (1981), No. 1; 'Heckscher-Ohlin Model and the Centrally-Planned Foreign Trade'; Mimeo and 'Input-Output Price Models and Their Use in Inter-Country Comparisons'; Vancouver, B.C.: The University of British Columbia, Discussion Paper of the Department of Economics No. 80, 26 July 1980. See also Kyn (1974) for his response to Osiatynski (1974).

reduced for others. No overall improvement in the degree of similarity between matrices of different countries was achieved by price transformation. This seemed to indicate that the differences in actual relative prices worked as a 'random noise' which increased the degree of similarity for some sectors but diminished it for others, leaving the overall degree of similarity unchanged.

In sum, it is generally agreed that the relative prices of Czechoslovakia and Austria were different in the period under consideration. On the other hand, there is no evidence to suggest that NRP prices were systematically biased in one direction or another. While the prices of selected agricultural products were below world prices, as shown by the evidence provided in detailed case studies, such clear-cut evidence is not available for other NRP. With regard to our I-O comparison, there are strong indications that whatever differences existed between the actual technological matrices measured in value terms, these differences were mainly due to differences in prices rather than technology.

The NRP intensity of production was quite similar in both countries, indicating absence of the 'factor reversal' phenomenon. Direct as well as full (i.e. direct-plus-indirect) I-O coefficients were also highly similar before any price adjustment.

Moreover, the 'fundamental properties' of I-O matrices of both countries seem to be present. While the transaction matrices of Czechoslovakia and Austria are not perfectly triangular, the magnitude of the circular feedback in both countries was internationally comparable. The circular feedback was also substantially reduced after the first five iterations. In addition, the hierarchy of sectors obtained from matrix triangulation was similar in both countries and the degree of similarity was, in turn, highly comparable to findings of other studies for different countries.

Other structural similarities emerge from the application of the matrix triangulation procedure and these conform quite closely to patterns observed elsewhere in the empirical literature. We have undertaken further tests of 'fundamental properties' and found that in both Czechoslovakia and Austria there were clear signs of (i) decomposability, (ii) block diagonality and (iii) physical homogeneity of I-O structures.

We have also seen that the NRP input coefficients were in most cases lower in Austria than in Czechoslovakia even though the average level of NRP intermediation was greater in Austria at existing prices. With the exception of 'fuels', these results are not fully confirmed by the results obtained from applying the RAS technique. The relevant r values were greater for agricultural products, products of mining and food, and only the r value for 'fuels' was smaller than the geometric average. Under the very restrictive assumptions required in the RAS framework, the former finding was interpreted as a 'pro-NRP substitution bias' in Austria. On the other hand, the s values which we obtained are consistent with the above findings, even though only indirectly. On the whole, the RAS findings are not entirely surprising given the factors (some of which have no economic meaning) which can influence the size of the r and s coefficients. Moreover, it can be suggested that the values of the r coefficients can be explained by differences in relative prices which have not been considered specifically in the application of the RAS method and which can be regarded as a 'systemic' feature of the centrally-planned system.

Nevertheless, it is the high degree of similarity between the two technological matrices which we would like to emphasize rather than the particular differences. The existence of elements in the technological matrix which are common to both countries is confirmed by a variety of tests applied in the study. Moreover, the presence of 'similar' structures is suggested irrespective of the similarity test we used, viz., the Euclidean distance and correlation coefficient techniques. Given the assumption of fixed I-O coefficients, the impact of any difference in factor endowments or of the effects of economies of scale or income is diminished so that the technological matrix of I-O coefficients reflects predominantly technology. Under this assumption, the common elements in the technological matrix represent common elements of the 'true' technology existing in both countries.

There might possibly be additional factors which could affect the technological matrices and, consequently, our comparisons. These include, first of all, the effects of 'distorting' commercial policies, transport costs and other impediments to foreign trade and efficiency of domestic operations (i.e. the failure to minimize costs). Transport costs are unlikely to affect our findings since (1) the geographical proximity to trade partners should not be too dissimilar for both countries and (2) transport costs account for a relatively small part of foreign trade prices. However, commercial policies and/or domestic inefficiencies are likely to affect the matrices to some extent and it is very likely that the latter could be a particularly important factor in explaining the remaining differences of the matrices.

However, the impact of commercial policies (as well as of the terms of trade) does not appear to be as damaging as we might have feared. We have run several tests on the role of imports in the transaction matrices; in particular the fact that the 'fundamental properties' did not seem to be affected by the inclusion or exclusion of imports seems to suggest that imports were predominantly 'competitive' in both countries. On the other hand, a large proportion of NRP imports in Austria was complementary and this suggests a similar nature of NRP imports in Czechoslovakia (and, consequently, factor endowments).

The high degree of similarity in the input structures of Czechoslovakia and Austria is reassuring, particularly considering the number of potential factors which might have affected the input structures. Factors such as relative product prices, factor prices, vertical or horizontal integration of enterprises, commercial policies, factor endowments, etc. could all produce considerable differences in the input structures except in the extremely unlikely case that the effects of all these factors cancelled out one another. Hence, the high degree of similarity found in the input structures between both countries must have been due to similarities in technology, a conclusion which is in contrast to the suggestions made in the literature earlier.

Two further points should be mentioned in this context. We have assumed throughout that products supplied by comparable 'industries' are homogeneous and that whatever secondary production exists is produced on the basis of 'industry technology'. We have argued that in a number, perhaps a majority of, cases these assumptions are perfectly reasonable. However, in some other cases they are evidently not true (e.g. oil vs. coal in 'fuels' or staple food vs. luxury food in 'food products') but, in general, it is not possible to assess the role of these assumptions in economy-wide studies such as ours. Clearly, some products can be treated as 'identical' for all statistical purposes while others cannot. For example, coal and oil can be regarded as 'identical' inputs in producing electricity provided that the electricity producing branch employs one particular technology for burning coal or oil by 'switching a button'. Nevertheless, as a suggestion for further improvement, it would be desirable to further disaggregate the tables and to use the tables based on commodity × commodity classification.

On the other hand, while one would always wish to refine the data as much as possible, it is not entirely clear that the above refinements would represent a considerable improvement on our own approach, to which we were restricted by data availability. Whatever the level of disaggregation, some differences will always exist, particularly in product quality. Similarly, what is considered 'wasteful' in one country may not be considered wasteful in another. For example, greater use of metal or a metal industry in country A may be due to market requirements for packaging, advertising, etc. which may not be considered an important part of a 'product' in a 'supply-dominated' economy such as Czechoslovakia. It is also for these reasons that we would attach more importance to the similarities in the technological matrices rather than to the differences.

We were usually looking at the absorption of the NRP group as a whole. However, in theory or, for that matter, even for policy considerations, there is no unambiguous reason to treat all NRP together - without the distinction between exhaustible and reproducible resources or between food and other NRP typically purchased by households. Even though we have usually referred to NRP as one group we nevertheless made the above distinction in the actual data base and a further and more detailed analysis could be carried out on that basis.

2. Some theoretical and policy implications

The findings of this study have several theoretical and policy implications. The following discussion refers only to those which we believe are original and, therefore, should be emphasized.

There has been considerable discussion in the literature as to the applicability of the Heckscher-Ohlin model to countries under central planning. The studies include, for example, Rosefielde (1973) and (1974a), and McMillan (1973). The validity of the model is known to depend on a number of assumptions and one of these states that technology of production is the same in every country. The technological similarity which we found for Czechoslovakia and Austria in this study confirms the validity of that important assumption.

It is also suggested by one of our findings that Czechoslovakia's foreign trade behaviour appeared to be more systematic than has been argued by trade theorists in the past (e.g. Wilczynski (1965)). It has been suggested recently in a number of studies such as Holzman (1976), Brada and Wipf (1974) and (1975), Hewett (1974) and Drabek (1980a) that planners are very sensitive to price differentials and they do not completely disregard relative factor endowments in their foreign trade decisions. This study confirms this view, as indicated by the findings obtained through the sensitivity analysis of 'fundamental properties'. It is obviously not argued here that foreign trade decisions were dominated by factor endowment considerations nor that some foreign trade transactions were not outright uneconomical, as we know from detailed product-based studies. Such information would hardly be revealed from economy-wide studies. Moreover, theoretical deviations from the optimum have long been established in the literature, particularly through the contributions of Zauberman (1964), Boltho (1971) and others. What we would like to suggest, however, is that the bulk of imports has always been determined by decisions which wil be subject to the technological constraint. Since technological requirements may may not be compatible with domestic factor endowments, trade choices had to be made in conjunction with the availability of factors of production. Thus, as we have seen in Chapter III, the differences in the structure of domestic aggregate output were clearly affected by the availability of domestic resources.

On the policy side, the argument of 'excessive' NRP absorption raises an important question as to correct pricing procedures in the CMEA market. It is sometimes argued that CMEA relative prices differ from world market prices (wmp). This is explained by: (1) the special CMEA price rule introduced in the early 1950s; (2) unrealistic exchange rates; (3) the transportation rule; and (4) the use of commodity bilateralism (e.g. Hewett (1974)). Furthermore, the divergence between wmp and CMEA prices is claimed to be responsible for strong substitution effects in the structure of intra-CMEA trade (Vanous (1980), p. 176). Consequently, it has been suggested that the CMEA price rules must be altered and CMEA price ratios made more consistent with wmp ratios.

However, this argument is based on the assumption that the relative pattern of scarcities in the CMEA is the same as in world markets. If, for example, each CMEA country's preferences with regard to the use of NRP were biased in terms of preferences revealed through wmp, the CMEA price rules would have to accommodate this bias.

The argument goes even further. According to trade negotiators among CPEs, two groups of commodities can usually be distinguished in negotiating trade agreements (Ausch (1972), p. 165). These are the so-called 'hard-commodities' which include products for which there exists an excess demand in the CMEA market, and 'soft-commodities' which are in excess supply in the CMEA market. In specific terms, the 'hard' commodities are presumed to include raw materials, food and other agricultural products and fuels, while 'soft' commodities include manufactures. Thus, CMEA prices are claimed to exhibit a systematic bias which favours exports of 'soft' and imports of 'hard' goods (Montias (1976), Vanous (1980), Brada, King and Schlagenhauf (1981)). This argument seems to be confirmed by our findings obtained in the analysis of the trade structure of Czechoslovakia which exhibited a 'pro-NRP import bias'. Moreover, our findings also indicate that there may be possibilities of regulating the emergence of 'hard' and 'soft' commodities through domestic policy interventions since the bias arises from domestic final demand which is responsive to policy interventions.

In conclusion, we should like to return to the finding that both Czechoslovakia and Austria exhibited similar technology, a finding which should not be surprising. The central planners of Czechoslovakia of the early 1960s were still operating in a majority of cases with technology which they inherited from the previous regime, i.e. before the introduction of central planning. In addition, studies of technical processes in the CPEs in general and in Czechoslovakia in particular have never produced any evidence, to the best of our knowledge, that the CPEs attempted and successfully developed new technologies which were fundamentally different from those existing elsewhere and, *pari passu*, which would be 'natural-resource-product-using' or 'natural-resource-product-saving' or that the technology would have been employed on a mass scale. On the contrary, there has been a 'systematic' pattern of technology dependence of CPEs on the West which was reflected in technology flows from the West to CPEs over the period.

APPENDIX I THE IMPACT OF TURNOVER TAX IN THE 1962 INPUT-OUTPUT TABLE OF CZECHOSLOVAKIA

1. The basic source

This appendix includes an examination of the impact of turnover tax on the 1962 I-O table of Czechoslovakia which was used in this study. The 1962 I-O table of Czechoslovakia, which was originally supplied to the Economic Commission of Europe and published under the auspices of the United Nations will be called here the 'UN' version. Following the standardized rules of the United Nations, the I-O flows were valued in terms of market prices which include turnover taxes, and exclude trade, transport and distribution margins. Unfortunately, similar analysis cannot be undertaken for the Austrian table since the necessary information is not available.

A relatively less known version of the I-O table was published in *Statistika* which appeared in two variants: one in which I-O flows were valued in terms of purchaser prices and other in which the flows were expressed in terms of producer prices. In the *Statistika* publication, the purchaser prices are defined as follows: 'Prices accounted by the consumers for their own use. In the case of intermediate consumption of industrial products the prices are basically represented by wholesale margins as well as turnover tax where applicable. In the case of private and social consumption, the prices are represented mostly by retail prices. Finally, in the case of investment, wholesale prices include trade, distribution and transport margins. Producer prices are defined as prices used by the actual producers to account for the value of their production. They include basically wholesale prices at enterprise level excluding turnover tax in the case of industrial production, and procurement prices net of price interventions in the case of agricultural products.'[1]

1. The above definitions are translated directly from *Statistika* (1966), Appendix. For a more general discussion concerning the purchaser and producer prices see United Nations (1967), pp. 116-7.

Unfortunately, a direct assessment of prices used in the construction of the I-O table is not possible because turnover tax rates are not available. The table only enables us to compute the turnover tax content of supplies. This is quite easy to do in the UN version of the I-O table where net turnover tax is reported as part of the third quadrant. On the other hand, turnover tax was not reported in the *Statistika* version but an attempt can be made to separate the tax content from the table. There are some basic differences between the methodologies adopted in the construction of the UN and *Statistika* versionsof the table. First, the degree of disaggregation is larger in the *Statistika* version (25 rather than 18 sectors as in the UN version). Second, the classification of industry is also to some extent different (e.g. mining of non-fuel materials is included with ferrous and non-ferrous metallurgy). Third, entries in the first quadrant in the *Statistika* version do not make any distinction between domestic and imported supplies. Fourth, the description of the methodology in the *Statistika* version is very limited: e.g. it is not clear how imports were treated in the table. It appears, however, that imports were included as supplies of domestic industries but the pricing of imports as well as exports was not explained. Fifth, the second quadrants are similar in that they contain columns of private and public consumption and a column of investment. However, other components of final demand are merged into a single column in the *Statistika* version which may include such economically different magnitudes as those resulting from changes in stocks and from supplies for net exports. Sixth, while the UN version reports the values of intra-industry deliveries of domestically produced goods as well as imports, the total values of intra-industry deliveries are represeneted only by the value of imports. In contrast, the *Statistika* version appears to report the full value of intra-industry deliveries.

In order to see how the turnover tax can be separated from the *Statistika* version of the I-O table we prepared a highly aggregated I-O table with the following sectors: production, trade, transport and distribution (abbreviated in the table as TTD), total final demand. The third quadrant shows data on wages and total value added and, finally, aggregates for total supplies and resources are provided. In order to assess the degree of comparability of the UN and *Statistika* tables, each of the above elements of the table is shown in three variants, one for the United Nations version (abbreviated as UN), another for the *Statistika* version in purchaser prices (abbreviated as S_1) and the third for the *Statistika* version in producer prices (abbreviated as S_2). The *Statistika* table, in particular the version in purchaser prices (S_1), has a number of peculiarities in comparison to the UN table. Let us start first with the treatment of trade, transport and distribution margins. Generally, values of supplies of the trade sector in terms of purchaser prices were treated as costs of industries which were using trade services. This methodology treats supplies of trade services to other producing sectors inclusive of turnover taxes. As a result, the material inputs in general and costs in trade services in individual sectors in particular may be extremely inflated. At the same time, trade services provided to final consumers are dealt with indirectly, i.e. they are recorded as supplies of material products to final consumption. Consequently, the trade row in the second quadrant should include only zeros as long as commodities sold to final consumers originated in the production sphere. Similar reasoning applies to charges made by the sectors of distribution, transport and procurement of agricultural products where applicable, i.e. wherever these sectors enter into a relationship with final (particularly private household) demand.

Neverthelss, the S_1 entry for the TTD row and final demand column is actually positive which indicates that some margins or some form of tax were attributed to these sectors directly. The *Statistika* version does not provide any explanation of the treatment but it is possible that the positive entries for these sectors in the second quadrant include services not directly associated with material production (e.g. transport of workers to and from the place of their employment). It should be kept in mind that the I-O table which was valued in terms of purchaser prices includes transport, trade, distribution and agricultural procurement margins once as the value of supplies of material products to consuming industries and another time as values of services of these (i.e. TTD) sectors (representing the TTD margins on output of industries). The margins are, therefore, double counted, and constitute a source of 'value-inflation' of total intermediate inputs.

As can be seen in Table 1, another problem with the comparability of the UN and *Statistika* tables are the differences in total supplies and resources of material products and total value of trade, transport and distribution services (compare, for example, TTD row sums). In the case of differences in TTD values, one definite reason appears to be a different treatment of imports. As can be seen in the table, the total value of gross aggregate output of TTD in the UN version was 31117.4 mil. Kcs while total supply was 32303.1 mil. Kcs. The difference between these two numbers is 1184.7 mil. Kcs, a number which appears in the original UN table under imports in the 'transport' row and 'trade' column. Another important difference between the UN and *Statistika* versions of the table is the different size of the total wage bill which is higher in the UN version than that which appears in both *Statistika* versions (by 8.6 per cent), indicating, perhaps, that some form of wage tax was included in UN table. In fact, as we shall see shortly, the differences in the size of the total wage bill may explain the estimated difference in the total volume of turnover tax between both versions of the table.

We can now attempt to estimate turnover tax in the *Statistika* version of the I-O table but, in view of the above discussion, differences in the volume of turnover tax implicit in the *Statistika* table can be expected. The volume of the turnover tax can be estimated in two different ways and both the procedures and results are shown in Table 2. It should be pointed out at this stage, however, that the negative number in the TTD column of Table 2 represents (negative) 'turnover tax' on TTD services, i.e. a 'subsidy' to the TTD sector in a very specific sense, namely, as some

TABLE 1: AGGREGATED INPUT-OUTPUT TABLE FOR CZECHOSLOVAKIA, 1962 (mil. Kcs)

		PRODUCTION			TTD			FINAL DEMAND			TOTAL SUPPLY		
		UN	S_1	S_2	UN	S_1	S_2	UN	S_1	S_2	UN	S_1 [a]	S_2 [a]
1. PRODUCTION	UN	101964.1			5913.3			213720.8			321598.2		
	S_1		160520.8			6054.4			195751.4			362326.3	
	S_2			150344.3			4824.7			139008.6			294177.6
2. TTD	UN	12745.0			2177.6			17379.5			32302.1		
	S_1		24747.4			1868.0			3446.9			30062.3	
	S_2			11757.9			2102.3			16202.1			30062.3
3. WAGES	UN	73017.4			12355.2			-			-		
	S_1		67402.8			10645.0			-			-	
	S_2			67402.8			10645.0			-			-
4. TOTAL VALUE ADDED	UN	176575.1			23026.5			-			-		
	S_1		177058.1			22139.9			-			-	
	S_2			132075.4			23135.3			-			-
5. TOTAL OUTPUT	UN	291284.2			31117.4			-			-		
	S_1		362326.3			30062.3			-			-	
	S_2			294177.6			30062.3			-			-
6. IMPORTS	UN	30314.0			1184.7			-			-		
7. TOTAL RESOURCES	UN	321598.8			32302.1			-			-		

Source: Aggregated from the UN and *Statistika* version of the 1962 I-O table of Czechoslovakia
S_1 - *Statistika* version in purchaser prices
S_2 - *Statistika* version in producer prices
UN - United Nations version

a. - Total Gross Output

TABLE 2: Estimation of the volume of turnover tax in the *Statistika* version of the I-O table (Czechoslovakia, 1962)

		Production Sector (mil. Kcs)	TTD Sector (mil. Kcs)
1.	OUTPUT (purchaser prices)	362326.3	30062.3
2.	TTD[a]	24747.4	-234.3
3.	1-2	337578.9	29828.0
4.	OUTPUT (producer prices)	294177.6	30062.3
5.	Turnover tax (3-4)	43401.3	-234.3
6.	TOTAL VOLUME OF TURNOVER TAX	43167.0	
7.	Value Added (purchaser prices)	177058.1	22139.9
8.	Value Added (producer prices)	132075.4	23135.3
9.	7-8	44982.7	-995.40
10.	Material consumption (purchaser prices)	160520.8	6054.4
11.	Material consumption[b] (producer prices)	162102.2	4824.7
12.	10-11	-1581.4	1229.7
13.	Turnover Tax (9 + 12)	43401.3	-234.3
		43167.0	

Source: Based on Table 1

Notes:
a. Trade, transport and distribution (TTD) margins on output of the production sector

b. Material consumption (in producer prices) plus trade, transport and distribution (TTD) margins on inputs of the production sector.

statistical adjustment dictated by the methodology of I-O compilation. The estimated volume of the turnover tax (43167.0 mil. Kcs) in the *Statistika* version is 9.8 per cent higher than the reported volume of the tax in the UN version.

2. Turnover tax content

In order to obtain some idea about the structure of the turnover tax in Czechoslovakia we have compiled a table which shows the total volume of the tax, its structure by individual industries and, finally, the proportion of this tax in total supplies (see Table 3). In other words, the table shows the turnover tax content of material supplies in Czechoslovakia in 1962. The rates of the tax shown in column 3 of Table 3 give, therefore, the average rate of the tax levied on supplies of the industry concerned, i.e. they do not distinguish among rates levied on the same product allocated to different users. The basic statistical source in the present calculation was the UN version of the I-O table where data on the turnover tax content are readily available.

The conversion rates are very diversified, as shown in Table 3. The lowest rates were applied to supplies of construction, fuels and other mining products, non-metallic mineral products, basic metals and products of engineering which further underlines the pattern of priorities known in Czechoslovakia as the strategy of the 'steel-concept'.[2] On the other hand, the highest rates were applicable on processed food, clothing, rubber, oil and coal products and textiles. Interestingly enough, there was only one sector - electricity - which obtained net subsidies.

The turnover tax rates above confirm several arguments concerning the tax burden and the structure of turnover tax resources which have been suggested in the literature.[3] For one thing, the turnover tax was levied primarily on

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2. For more on the concept, see, for example, Goldman (1976).

3. See, for example, Adam (1974) and Drabek (1979).

Table 3: Turnover tax content in the 1962 I-O table

	1 Net Indirect Tax (mil. Kcs)	2 Total supplies[a] (mil. Kcs)	3 Column 1 as per cent of column 2
Agriculture	1094.0	33045.7	3.3
Fuels	363.0	9586.7	3.8
Other mining	0.1	2336.1	0.0
Food processing	25530.5	58249.6	43.8
Textiles	4002.1	12158.1	32.9
Clothing	4501.9	12450.7	36.2
Wood Products	2083.5	12837.3	16.2
Rubber	945.5	3057.2	30.9
Chemicals	1966.3	12106.9	16.2
Oil and coal products	4306.6	9111.7	47.3
Non-metallic mineral products	492.2	8294.9	5.9
Basic metals	274.8	16170.1	1.7
Transport vehicles	1748.6	11330.9	15.4
Engineering excl. transport vehicles	2673.5	47689.6	5.6
Electricity	-78.3	6753.1	-1.2
Construction	97.0	35883.0	0.3
Trade, machines	0.0	16561.3	0.0
Transport	0.0	11033.8	0.0
TOTAL	50001.3	320123.9	

Source: UN (1971)

Notes: a. Excluding exports on which turnover tax is not normally levied.

consumer goods. In addition, turnover tax levied on food represented the dominant source of fiscal revenue of the government. On the other hand, the data in Table 3 throw some doubts on the well established arguments in the theory of taxation in centrally-planned economies. Unfortunately, the I-O table is highly aggregated and the following interpretation is only tentative.[4] First, the objective that turnover tax should discriminate in favour of low-income groups does not appear, according to the data, to have been met. Not only food (which might have included such items as alcohol and tobacco) but also textiles and clothing were heavily taxed. Second, the tax policy was supposed to distinguish between consumption of 'necessities' and that of 'non-necessities' with high rates being levied on the latter. There again, the evidence is not conclusive. The extremely heavy taxation of processed oil and coal is the case in point. In fact, as the data in Table 3 suggest, the rate of turnover tax on the 'necessities' such as processed coal and oil was the highest among all the eighteen product groups. Third, it was widely believed that a levy of turnover tax on producer goods is to be considered as an exception.[5] But, as the data shows, even typical producer goods such as basic metals were levied with turnover tax.[6] In general, it appears that fiscal policy has been wider than it was commonly believed.[7]

3. Distorting effects of purchaser prices on selected input-output coefficients

The purpose of this section is to show some features of the input-output

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4. The present findings conform with those in Drabek (1979) where further discussion of these points is provided in more detail.

5. The references frequently quoted in the literature include electricity, natural gas and oil. See, for example, Nove (1968), p. 113.

6. More precisely, the total value of basic metals supplied to private consumers was 97.4 mil. Kcs. The total volume of turnover tax levied on basic metals was 274.8 mil. Kcs.

7. A similar position can be found even in the East European literature. See, for example, Picmaus (1966).

table valued in purchaser prices. In particular, our main concern will be to investigate the effect of TTD margins and turnover tax on I-O coefficients. Rather than providing a complete survey of the I-O coefficients, the following discussion refers to selected I-O coefficients only. In this respect, natural resource intensive products (NRP) will be used as an example. Our interest will centre on two aspects among various forms of effects which the turnover tax could produce, viz.,

(a) NRP intensity of production;

(b) the structure of final demand (i.e. the share of NRP in final consumption).

In neither of the two cases is an attempt made to distinguish between domestic and imported supplies.

Let us start with case (a) and consider first the ranking of the individual sectors, according to the level of their input coefficients with respect to NRP. Thus, the most NRP intensive sector would rank first, the second most NRP intensive sector would rank second and so on. The reader will undoubtedly recognize that this was one of the techniques used in the text. In addition, we shall also examine the impact of turnover tax on the absolute level of the input coefficients (which we may define as an indicator of efficiency).

Both the relative and the absolute levels of input coefficients of NRP have been calculated in producer and purchaser prices and they are shown in Table 4. It is clear that it will be the absolute level of the coefficients (the efficiency measure) which will be more sensitive to pricing methodology. Only if the real technology of the NRP use was highly similar among individual sectors, combined with significant differences in the indirect taxation of material inputs and final output would the change in the pricing methodology also lead to significant differences in the observed technology as represented by NRP rankings.

The differences in indirect taxes would have to be such that the indirect tax rates on non-NRP input and/or the rates applied to final outputs would have to be relatively bigger than the rates applied on NRP inputs. This point can be shown in a simple example related to technological similarity, rather than technological difference, before and after the introduction of turnover taxes, viz., a two-sector economy in which the matrix of input coefficients is defined as follows:

$$(A^p) \quad \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ {}_t t_1 & {}_t t_2 \end{bmatrix} \qquad (A^s) \quad \begin{bmatrix} a^s_{11} & a^s_{12} \\ a^s_{21} & a^s_{22} \\ {}_t t^s_1 & {}_t t^s_2 \end{bmatrix}$$

where

$$a^s_{ij} = \frac{X_{ij} + X_{ij}\lambda_{ij}}{X^s_j}$$

$$_t t^s_j = \frac{t_j + t_j\lambda_j}{X^s_j}$$

A^p, A^s	matrix of input coefficients in producer and purchaser prices respectively
X_{ij}	value of commodity i in producer prices supplies to industry j
X^s_j	gross aggregate value of commodity j in purchaser prices
λ_{ij}	turnover tax rate on input i supplied to industry i
λ_j	turnover tax rate on output j
t_j	value added in industry j

In order for a_{ij} to be similar to a^s_{ij}, where a_{ij} and a^s_{ij} stand for the input coefficients of/ the i-th industry's output to j-th sector, it must hold that $\lambda_{1j} = \lambda_{2j} = \lambda_j$. If $\lambda_{1j} > \lambda_{2j}$, a_{1j} will be smaller than a^s_{ij} and vice versa. Hence, taking a_{1j} for NRP input coefficient, its change will depend on indirect taxes levied on non-NRP input (a_{2j}) and/or on taxes on final output in the j-th sector It is the relative difference in indirect taxes which, therefore, determines the movement of a_{1j}.

Now assume inter-sectoral similarity in real NRP input coefficients (i.e. net of any price effects) as between Czechoslovakia and other countries. The ranks of NRP input coefficients will be similar before rather than after the introduction of indirect taxes if both the indirect taxes on non-NRP inputs and indirect taxes on final outputs are similar to indirect taxes on NRP inputs. With zero taxes on NRP inputs, any positive tax rate of non-NRP inputs must be 'compensated' by negative taxes on final output.

However, no determinate solution emerges if the assumption is relaxed concerning inter-sectoral similarity in real technology with respect to the use of NRP. The ranking similarity of technology before and after the introduction of turnover taxes could be due to:

(1) the significant inter-sector differences in real technology, or

(2) the neutral structure of indirect taxation. The structure of indirect taxation is neutral in the sense that it does not produce differences in ranks. The indirect taxes may still vary to some extent which depends on real inter-sectoral differences in technology.

As the results in Table 4 show, the conversion of purchaser into producer prices has very little impact on the ranks indeed. This is underlined by the value of the Spearman rank correlation coefficient which is highly significant ($R_S^2 = 0.9784$). In other words, the conversion of purchaser into producer prices has hardly any impact on the observed technology of NRP use.

As predicted, by far the more significant impact of pricing methodology was on the absolute level of input coefficients. This is also shown in Table 4 in the column indicating the direction (signs) of the changes. Only 7 out of 25 sectors were unaffected by turnover taxes and TTD, in 6 cases the NRP input coefficients increased and in 7 cases they declined. The increase in the coefficients for sectors 20-24 is subject to a different interpretation.[8]

The data base could permit a demonstration of the relative indirect

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8. See discussion in Section 1.

Table 4: Natural resource product[a] input coefficients valued at producer and purchaser prices: Czechoslovakia (1962)

(percentages of gross aggregate output)

		NRP input coefficients valued at			Ranks		
		Producer prices	Purchaser prices	Sign[b]	Producer prices	Purchaser prices	Difference
Fuels	01	32.09	23.91	≪	4	5	-1
Electricity	02	29.62	26.74	<	5	4	+1
Ferrous metallurgy	03	12.56	13.38	=	8	8	0
Non-ferrous metallurgy	04	3.50	3.89	=	15	17	-2
Chemicals	05	9.05	8.65	=	11	10	+1
Engineering	06	0.94	1.41	>	23	23	0
Construction materials	07	7.11	8.37	>	13	12	+1
Wood processing	08	20.26	17.66	<	6	7	-1
Paper	09	18.46	18.29	=	7	6	+1
Glass, china	10	6.46	6.72	=	14	14	0
Textiles	11	11.01	8.39	<	9	11	-2
Clothing	12	0.50	0.36	<	24	25	-1
Leather, shoes	13	9.71	7.15	<	10	13	-3
Printing	14	0.44	0.54	>	25	24	+1
Food processing	15	66.10	36.88	≪	1	3	-2
Other industrial products	16	56.03	56.51	=	2	1	+1
Construction	17	1.42	3.18	>	19	18	+1
Agriculture	18	50.17	48.90	=	3	2	+1
Forestry	19	3.97	5.94	>	16	15	+1
Freight transport	20	7.23	12.33 .	>	12	9	+3
Communications	21	1.41	3.07	>	20	19	+1
Distribution	22	1.10	1.74	>	22	22	0
Trade incl. restaurants	23	1.83	2.25	>	18	21	-3
Procurements of agricultural products	24	1.89	4.38	>	17	16	+1
Other material production	25	1.33	2.49	>	21	20	+1

$R^2 = 0.9784$

(a) Not comparable with NRP as defined in the Introduction. The present definition includes fuels (01), food processing (15), agriculture (18), forestry (19).

(b) For description of the sign, see Table III-17 Chapter III. The sign refers now to the difference between input coefficients valued at purchaser prices and those valued at producer prices.

Source: Based on *Statistika* /1966/, Appendix.

taxes and TTD on NRP inputs, non-NRP inputs and on final outputs. But this is neither necessary nor would it be useful for the purpose of explaining the neutral effect of pricing methodology on technology. This is due to the fact that both relative indirect taxes and real inter-sectoral differences in technology may have been responsible for the observed similarity. For this reason, the effect of pricing methodology on the technology indicators remains undetermined.

The explanation of the movement in the absolute levels of the coefficients would be much more straightforward. It is clear that in contrast to the examination of technology, knowledge about relative indirect taxes (and subsidies for that matter as well) would be essential for the application of input coefficients as measures of efficiency. In this respect, a distinction can be made between sectors where the effect of relative taxation was neutral (which may have implied zero relative taxes), sectors with positive relative taxation of NRP inputs (implying heavier taxation of NRP inputs as compared to the combined effect of indirect taxes on non-NRP inputs and final products), and sectors where the relative indirect taxes on NRP inputs were negative. Zero relative taxes on NRP inputs imply stability of the input coefficients (characterized by a sign '=' in Table 4), positive relative taxes lead to an increase of the input coefficient in terms of purchaser prices (sign '>') and negative relative taxes lead to a decrease (sign '<').

To the extent that the classification of industries in the *Statistika* version is roughly comparable to the UN version, we can compare the NRP input coefficients from the UN table.[9] At this stage it will suffice to indicate the sectors where the NRP input coefficients are overstated or understated in terms of producer prices.

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9. The NRP input coefficients calculated from the UN I-O table can be found in Chapter III.

Sectors with overstated NRP input coefficients

Statistika version	Corresponding 'UN' industries
Engineering	Production of transport vehicles, other engineering
Construction materials	Agriculture etc., mining
Printing	Manufacture of wood, etc.
Construction	Construction
Forestry	Agriculture
Freight transport	Transport, communications
Communications	Communications
Distribution	Trade and distribution
Trade	Trade

Sectors with understated input coefficients

Fuels	Fuels
Electricity	Electricity, etc.
Wood processing	Manufacture of wood, etc.
Textiles	Manufacture of textiles
Clothing	Manufacture of footwear, etc.
Leather, shooes	Leather, shooes
Food processing	Food processing

Sectors with unchanged input coefficients

Ferrous metallurgy	Basic metals
Non-ferrous metallurgy	Manufacture of non-metallic mineral products
Chemicals	Chemicals
Paper	Manufacture of wood, etc.
Glass, china	Manufacture of non-metallic mineral products, other engineering
Agriculture	Agriculture

We turn now to the impact of turnover taxes and TTD on the structure of final demand, and particularly, the impact on the share of NRP in final demand (Table 5). The share of processed food which accounted for more than 50 per cent if valued in purchaser prices declines to about 36 per cent if valued in producer prices.

Thus, the consequences of using the UN version of the 1962 I-O table of Czechoslovakia in inter-country comparisons could be quite significant. For example, using the table in the comparison of structure of private consumption in Czechoslovakia and Austria (1964) the findings would indicate a substantial bias of consumers in Czechoslovakia towards consumption of food.[10] However, bearing in mind possible differences in industrial classification between the UN version and the *Statistika* version of the table, the share is not as different in comparison to the share existing in Austria in 1964 as it was before we allowed for the impact of turnover taxes and TTD.

Table 5 Structure of domestic final demand valued at producer and purchaser prices: Czechoslovakia (1962)

(in percentages)

	Private consumption		Public consumption		Investment	
	Producer prices	Purchaser prices	Producer prices	Purchaser prices	Producer prices	Purchaser prices
1. Fuels	1.98	1.96	8.36	11.43	-	-
2. Food processing	36.47	50.74	10.58	13.44	-	-
3. Agriculture	13.10	10.42	3.32	2.95	-	-
4. Forestry	0.30	0.24	0.17	0.17	-	-
Total 1+2+3+4	51.85	63.36	22.43	27.99	-	-

Source: *Statistika* (1966), Appendix

10. See Chapter III.

In sum, the findings in this appendix imply the following:

(1) We are fully justified in using the UN I-O table of Czechoslovakia in our international comparisons in spite of the inclusion of turnover taxes included in 'market prices' used in the compilation of the table - provided the similarity of the technological assessment is carried out on the basis of the rank correlation technique.

(2) In addition, contrary to the usual claims of economists that turnover tax is levied in the CPEs, with a few exceptions, on consumer goods only, it is suggested that turnover tax was levied quite extensively on producer goods as well. Thus, since the turnover tax was levied not only on sales of output but, simultaneously, also on inputs, the I-O flows in the first quadrant of the table are inflated. On the whole, the inclusion of the turnover tax has both a direct and an indirect influence on value inflation in the 1962 I-O table.

(3) The finding (2) above implies, however, that we have no *a priori* knowledge about the impact of indirect taxes on the comparison of NRP input coefficients without a detailed analysis of indirect taxes and their structure in Austria. The latter analysis was not possible due to the absence of required data.

APPENDIX II ESTIMATES OF COMPLEMENTARY IMPORTS OF AUSTRIA, 1964

		(mn. Sch.) IMPORTS		(%) Share
		Complementary	Total	3 = 1 of 2%
		1	2	
I	Agriculture, Forestry, Fishing	3286.0	6622.7	49.6
II	Fuels	2490.2	2906.4	85.7
III	Other mining	454.4	1618.9	28.1
IV	Food processing	1165.0	2062.4	56.5
	Sub-total	7395.4	51350.0[a]	14.4
			13210.4[b]	56.0

Source: Based on OECD Trade Statistics, Series C, 1964

a Total imports

b Total NRP imports

APPENDIX III GLOSSARY OF CODES IN THE INPUT-OUTPUT TABLES

Industrial branches*

I-O code	
101	Agriculture and forestry
102	Coal, oil and natural gas
103	Other mining
104	Food processing
105	Textiles
106	Shoes, clothing, leather, furs
107	Wood processing, paper and paper products
108	Rubber
109	Chemicals
110	Oil and coal processing
111	Non-ferrous metallurgy
112	Basic metals
113	Transport vehicles
114	Engineering excluding transport vehicles
115	Electricity
116	Construction
117	Trade, warehouses
118	Transport

* A more detailed description of industrial branches and their link with ISIC 1958 can be found in Chapter 1.

Final demand

I-O code	
301	Private consumption
302	Public consumption
303	Investment
304	Change of stocks
305	Exports

Value added

I-O code	
501	Depreciation
502	Wages
503	Indirect taxes minus subsidies
504	Other value added

Row sums

I-O code	
801	Intermediate deliveries
804	Total final demand (301+302+303+304+305)

Column sums

I-O code	
901	Material inputs
904	Total net value added (501+502+503+504)
905	Gross output (901+904)

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