Are Oil Price Movements Perverse?
A Critical Explanation of Oil Price Levels
1950 – 1985

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Oxford Institute for Energy Studies

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1. INTRODUCTION

The purpose of this paper is to provide analytical explanations for the price trends and the important oil market episodes of the past three decades.

The main features of oil price movements between 1950 and 1984 may be summarized as follows. Although changes in world oil prices are not easy to measure (because of the diversity of relevant oil price concepts) some broad characterisations are possible. Oil prices - measured in constant 1974 dollars - fell at a rate of 2.7 per cent per annum between 1950 and 1960 and at a rate of 6.5 per cent per annum between 1960 and mid-1970. This declining trend was reversed later in 1970 when oil prices began to rise for the first time in twenty years. This was followed by the price "shock" of 1973-74 which quadrupled the posted price of Arabian Light from $3.011/b (Oct 1, 1973) to $11.651/b (Jan 1, 1974). Between 1974 and 1978 real oil prices declined despite small increases in nominal prices. The second "shock" occurred in 1979-1981: on this occasion price escalation took place over a fairly long period but it still raised the price of Arabian Light (in current dollars) from $12.7/b in December 1978 to a peak level of $34/b in 1981. The first reduction in the official price of the marker crude was agreed by

OPEC in March 1983 when Arabian Light was set at $29.0. In January 1985 OPEC cut this price again to $28.0.

The structure of the paper is as follows. In Section 2 we attempt to explain why the real price of oil was falling from 1950 to 1970. Despite the importance of this period for the understanding of subsequent events no systematic explanation of the falling oil price has been given so far. In Section 3 we examine oil prices in the post-1970 period. Since this period has been the subject of extensive study we present and criticize the various arguments in the literature. In particular we examine two alternative hypotheses: a) that the reversal of the oil price trend in 1970 was the result of OPEC's cartelization of the oil market and b) that this reversal was due to the underlying (dynamic) competitive forces and a number of market failures other than cartelization. In the concluding section we provide our own explanation of the oil price movements based on the analysis of the previous sections.

It is probably needless to say that this paper is not intended to be a comprehensive survey of the literature nor to contain a full historical account of oil market events.

2. THE OIL PRICE DECLINE 1950-1970

With very few exceptions, recent academic studies of oil prices have tended to concentrate on the post-1973 years. Yet the oil events of the 1970s cannot be properly understood without a proper account of earlier price movements. The absence of a "systematic" explanation of the oil price decline of the 1950s and 1960s has often misled analysts who concentrate on the period of price shocks and price escalation.

A "systematic" explanation of oil price trends requires the adoption of the same theoretical framework for the whole of the period considered. However this methodological principle is often ignored. Thus, the economic theory of exhaustible resources[1], which is frequently applied to the analysis of post-1973 oil events, is rarely used for the earlier period.[2] The argument that "in the 1950s and 1960s, economic agents operating on the oil market were behaving as if oil was not exhaustible" does not excuse the methodological inconsistency. The application of a coherent approach would have led economists to ask and attempt to explain why economic agents tended to behave as if petroleum were a renewable resource.

In this paper, we shall apply the same analytical framework for the whole period 1950-1984. Let us begin with the

first episode, that of the long oil price decline.

Economic theory predicts that the price of an exhaustible resource declines continuously if (a) the marginal cost of extraction falls over time, and (b) the scarcity rent is negligibly small.[3] The question, therefore, is whether these two conditions were characteristics of the oil market of the 1950s and 1960s. Unfortunately, the answer may prove elusive.

First, a time-series of marginal extraction costs does not seem to exist for the relevant period. True, Adelman (1972) has compiled certain data on development and operating costs in the 1950s and 1960s, but the observations are few in number and irregularly scattered over many years. The only impressions formed are that average extraction costs were very low (a few cents per barrel) and that they did not vary much over time.

Secondly, the scarcity rent is not an observable variable but must be estimated on the basis of certain parameters. A major difficulty arises in this context because one of the relevant parameters, the size of remaining reserves, is never known with certainty. To simplify the issue (we shall consider later the implications of uncertainty) let us assume first that the initial stock is known, and define the conditions under which the scarcity rent would be negligibly small. An example provided by Kay and Mirrlees (1975) may help. These authors showed that the scarcity rent of a resource extracted at constant marginal cost, given a discount rate of 0.05 and a stationary demand schedule with price elasticity of -0.5 to -1.0, will tend to zero if the reserves/production (R/P) ratio exceeds 120.

A tentative approach to the question of the scarcity rent for oil in the 1950s and 1960s is to compare the R/P of 120 to actual estimates for the period. Data presented in Figure 3 suggest that R/P ratios were much lower than 120 (remaining years of supply at current annual production rates). If this were the case, considering further that the demand for oil was not stationary but rising at a compound rate of 6-7 per cent p.a. during these years, we would be justified in concluding that the scarcity rent of oil was not zero in the 1950s and 1960s.

However, matters are not that simple. The R/P data in Figure 3 are based on the concept of <u>proven</u> reserves (defined as the amounts which could be produced in the future, under current economic and operational conditions, from deposits established on the basis of actual geological and engineering data). This concept tends to measure reserves in a very conservative manner. The alternative concept of ultimately recoverable reserves (the resource base) seems preferable but its estimates are highly uncertain because the exploration of the globe is far from being complete, and because the evaluation of ultimate reserves also depends on the future state of technology. As a result, estimates of the oil resource base tend to vary significantly from one source to another (see, among others, Odell and Rosing (1983)).

Figure 4 indicates the very large discrepancy between the "average" of some 30 assessments of ultimately recoverable world oil reserves made since 1945 and the trend line of proven reserves. It would be wrong, however, to move to another extreme and infer that the scarcity rent was negligibly small because the

Figure 1

Posted Price of Arabian Light Deflated by Export Prices of Industrialized Countries.1950-1973.

Index. 1950 = 100.

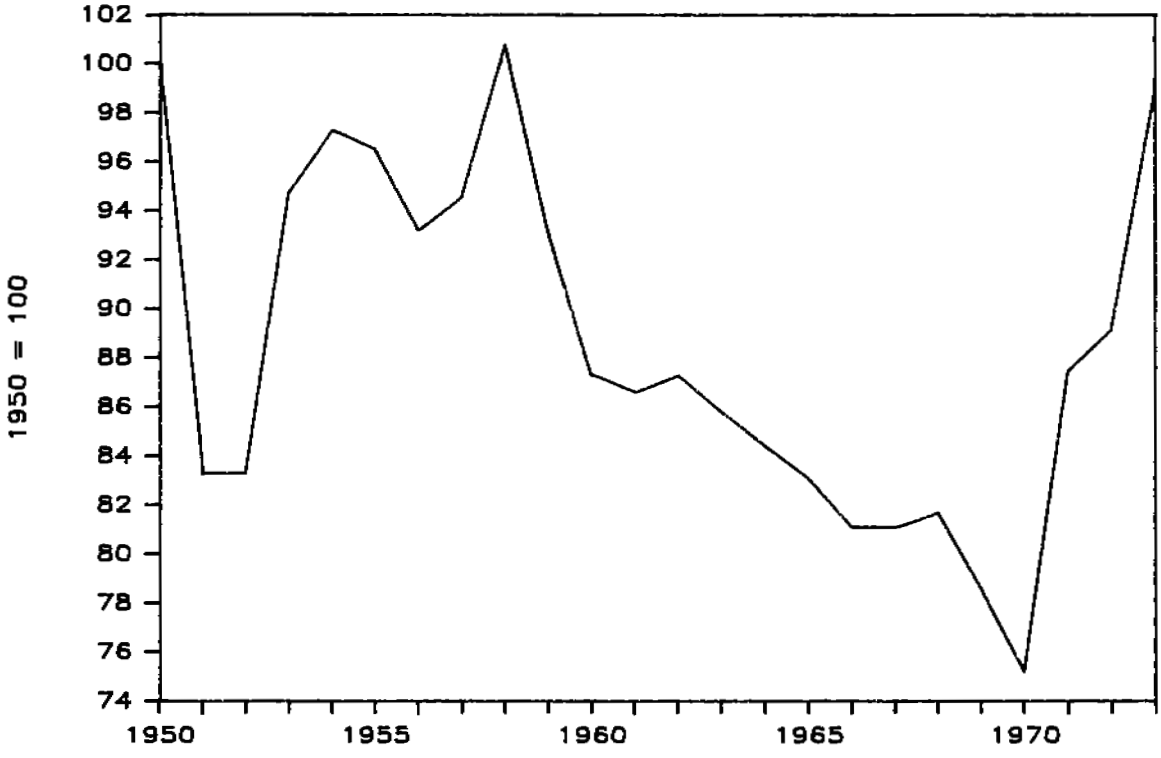


Figure 2

Official Prices of Arabian Light Deflated by Export Prices of Industrialized Countries. 1974-1984.

Index. 1974 = 100.

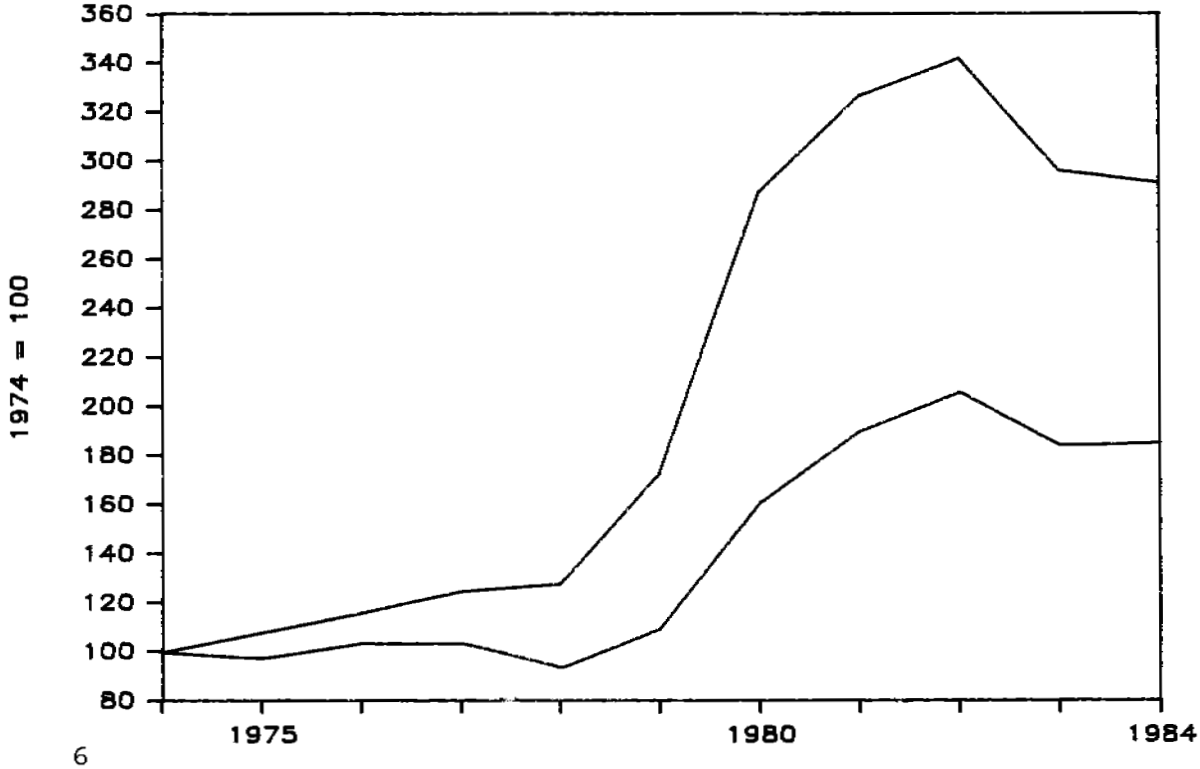


Figure 3

Remaining Years of Oil Reserves. Years.

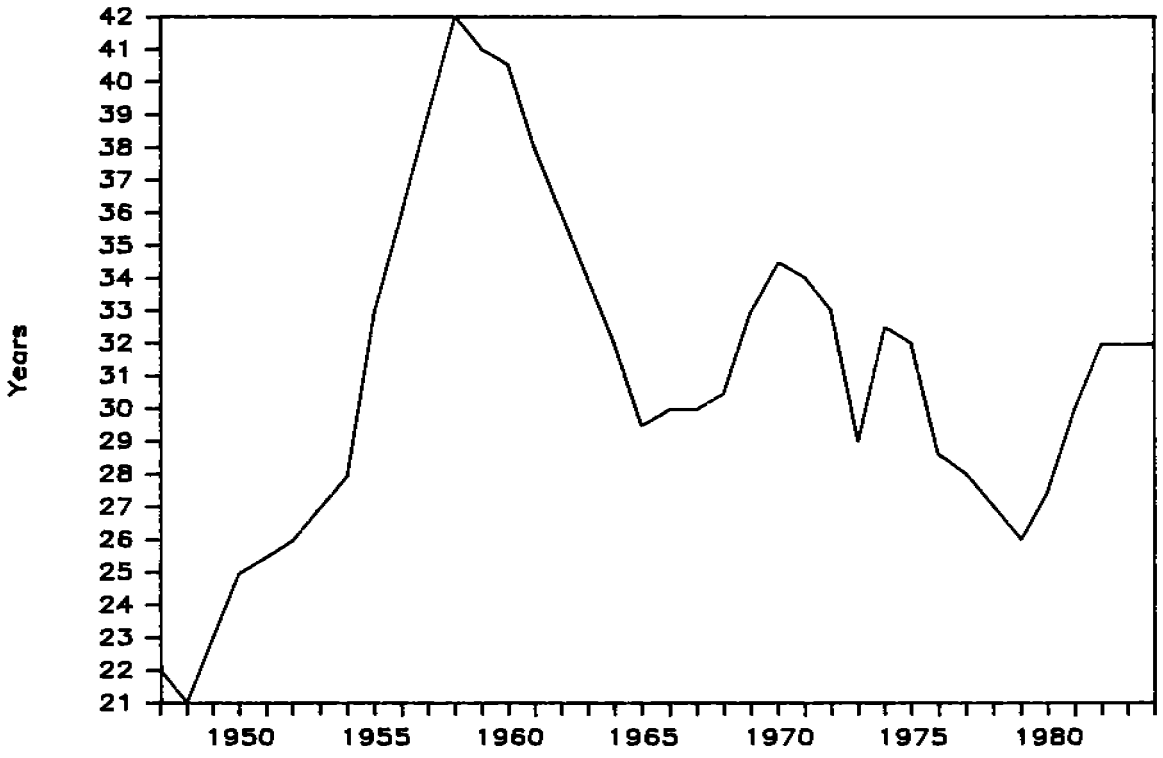
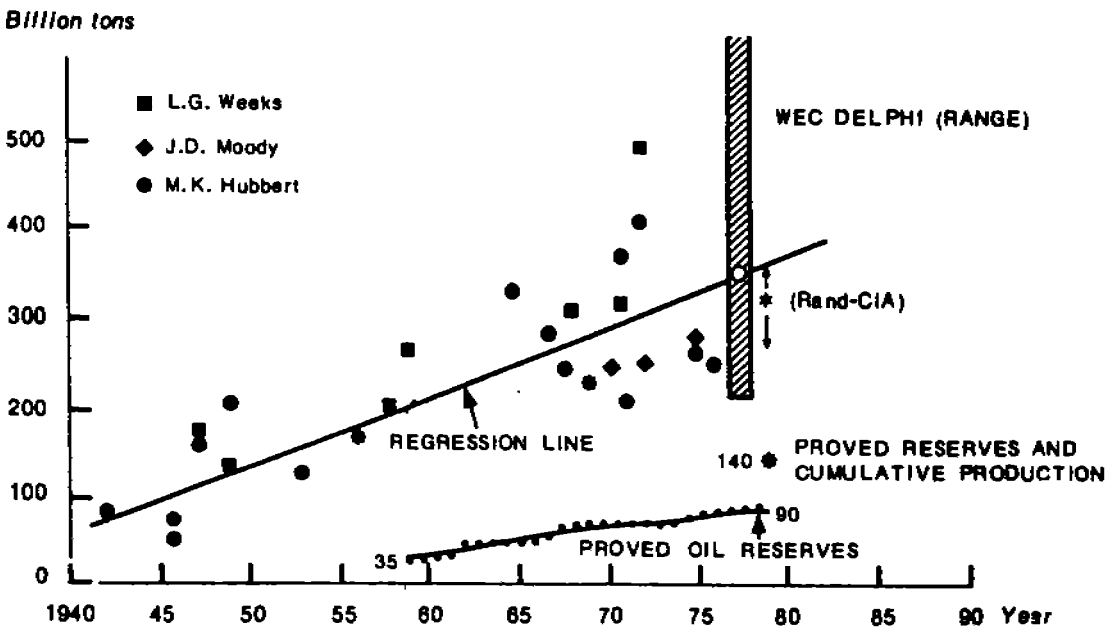


Figure 4

Estimates of World Oil Resources



Source: International Energy Agency: World Energy Outlook, 1982.

resource base appears to have been very large. Such a conclusion would not be warranted given that the exploration, development and production costs are likely to be much higher for yet undiscovered than for proven reserves.

The distinction between proven and ultimately recoverable reserves of unknown extraction costs introduces the notion of uncertainty into the analysis. In what follows we shall concentrate on one particular aspect: the effects of unanticipated discoveries on the price of oil. This seems to be the appropriate approach since it is widely believed and argued that the large oil discoveries made in the Gulf in the late 1930s and the 1940s are the cause of the decline in oil prices in our period.

Economic theory predicts that the price of an exhaustible resource (a) will fall in the event of unanticipated discoveries, and (b) will increase at an exponential rate (related to the rate of interest) between any two discoveries (see, among others, Dasgupta and Heal (1979)). This expected pattern of price changes does not seem to have obtained. Figure 1 shows that prices declined between 1950 and 1970 and that the fall was almost continuous. Although prices rose on two occasions - between 1952 and 1954 and between 1956 and 1958 - these episodes were both rare and of short duration.

Technical features of oil exploration, reservoir appraisal and oilfield development as well as certain historical and geopolitical factors may help to reconcile theory with empirical observations. To take one example, consider the implications of the fact that the size of a field remains

uncertain for a long period after an initial discovery. Following the initial discovery, an appraisal of the field is undertaken in order to define the amount of oil in place. More wells are drilled and the reserves estimate usually increases (we will attempt to explain this below). Finally the development of the field leads to a further revision of the initial reserves estimates since new information about the characteristics of the field become available. This process which involves at least three stages spreads out the initial discovery over a number of years and makes it appear to some extent as a continuous activity. We believe that this phenomenon played an important role in the period (1950-1970) studied in this section.

We need to explain, however, why the revision of expectations about the size of ultimately recoverable oil reserves after an initial discovery always increased the estimate during the period in question. We believe that this can be attributed to two factors. The first is risk aversion: oil companies were cautious - partly because of legislation[4] - in their declaration of discoveries and in their estimates of total oil in place. The second and more important factor is partly geological and partly political. Earlier geological information available at the beginning of the century pointed to the existence of significant oil deposits in the Middle East. However, for complex political reasons, exploration and development did not take off in the area, except in Iran, until 1935. In that year, an agreement between Britain, France and the USA gave a boost to exploration, but the outbreak of war in 1939

seriously constrained the development of these activities. In the immediate post-war period the seven major oil companies started large scale exploration and development in areas where the discovered fields proved to be prolific. As Odell (1983, p.86) has put it "....even the earlier very optimistic evaluations of [Kuwait's] fields was quickly shown to be much too low. In Kuwait, it seemed, the companies could hardly put a drill in the wrong place, for almost every "wildcat" and development well that was sunk proved to be a producer of an enormous size, with many wells capable of producing up to 10,000 barrels per day".

There is a different way (perhaps more appealing to economists) to express the same argument. Devarajan and Fisher (1982) suggested that the marginal discovery cost can be used as an index of resource scarcity when there is uncertainty about the size of the resource base. This proposition is based on the simple notion that the shadow price (scarcity rent) of a resource is the price which a firm, or society under ideal conditions, is prepared to pay to relax the reserves constraint. In equilibrium, this price is equal to the marginal exploration (discovery) cost. Although data on marginal exploration costs are not available, it seems that the Middle Eastern finds of the 1940s and 1950s made with a modest and low-expenditure exploration programme involved falling (average) discovery costs.

However, the fact that these costs were probably declining is not sufficient to explain why the real price of oil continued to fall in the 1950s and 1960s for so many years afterwards despite a rapid growth in oil consumption. Yet there

was a further element (Odell and Rosing, (1983); Roumasset, Isaak and Fesharaki (1983)). Oil companies' forecasts made in the 1950s and 1960s predicting sustained growth in oil use in the following decades were based on expectations of a continuing flow of substantial discoveries or of declining discovery costs due to technical progress. This suggests that the long period of falling oil prices was not sustained only by declining average discovery costs but by expectations that this trend would continue far into the future. That these expectations turned out to be wrong had serious implications as this can partly explain the oil price explosion of the 1970s (see further below).

We can now summarize the above arguments. The real world price of crude oil (as measured by the f.o.b. price of Arabian Light) was falling almost continuously during the period 1950-1970 for the following three reasons. First, the oil industry had entered the era of increasing returns to oil exploration and discovery when it began to drill in the prolific Middle East. Secondly, it was firmly believed that this era would continue far into the future. Finally, the fall in the price was almost continuous due to the process of "spreading out" initial discoveries over a period of years.

Having provided what, in our opinion, seems to be the main explanation of the period's price trend we can now refer to some other factors that may have reinforced it.

The introduction of oil import quotas in the USA by the Eisenhower Administration in 1959 is one such factor. The protection afforded to US domestic oil producers, who had lobbied

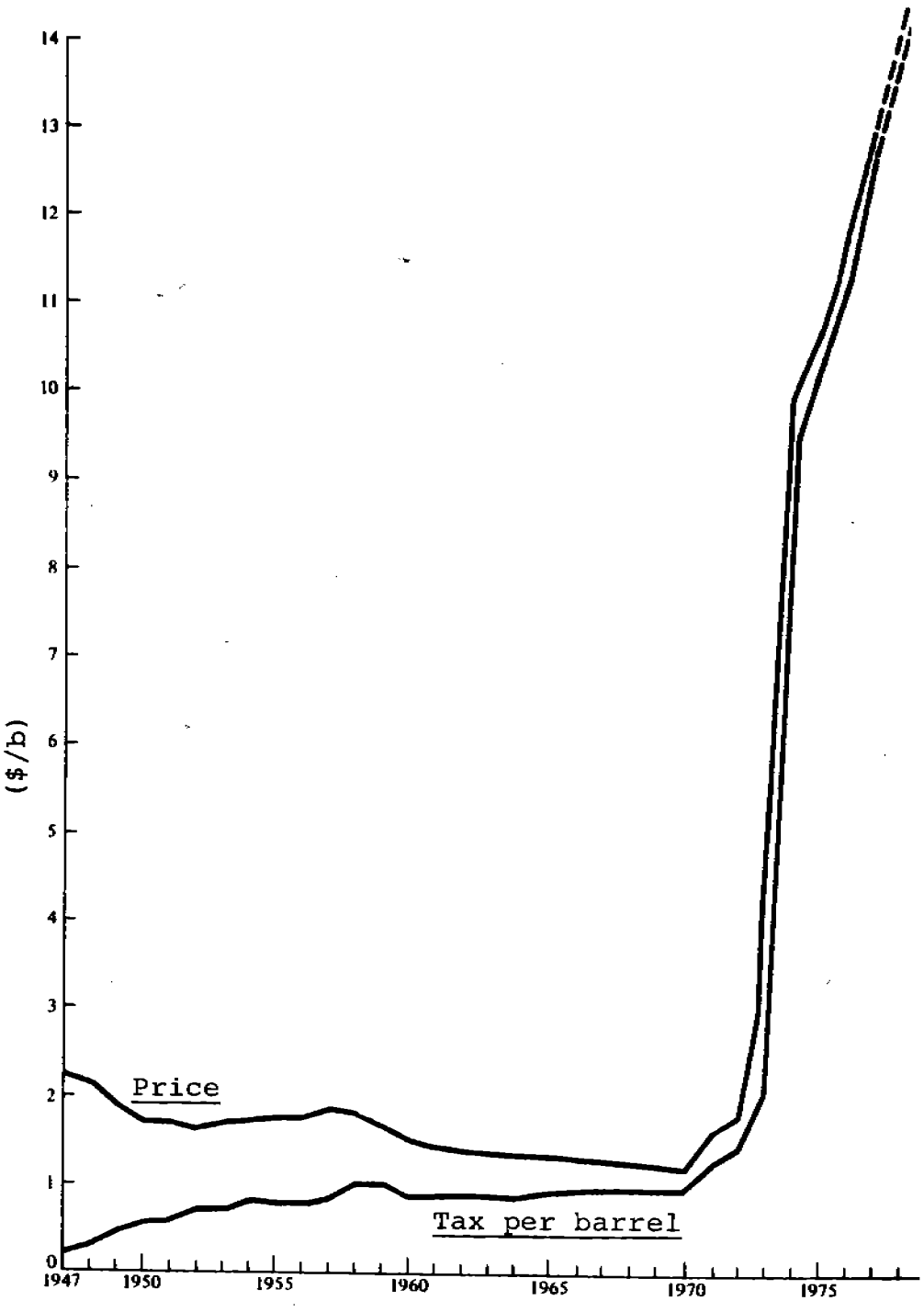
for import restrictions, also reduced the world demand for oil. This effect was important because of the large size of the US oil market relative to the rest of the world. In fact, the f.o.b. price of Arabian Light started falling faster after 1960 than before.

The emergence of excess supply outside the USA was also reflected by the efforts of the international oil companies to reduce the "posted" price (i.e. the fiscal reference price against which their tax liabilities towards the host governments of oil-exporting countries were calculated). An immediate consequence was the creation of the Organization of the Petroleum Exporting Countries (OPEC) in 1960 whose initial aim was to prevent the tax revenues of the member countries from falling. It is a classic example of a coalition of sellers created in order to countervail the oligopsonistic power of buyers: the USA, whose power became effective with the imposition of import quotas, which caused a significant fall of the world price of oil, and the major international oil companies, which were able to co-ordinate their policies vis-a-vis the oil-exporting countries through the system of joint concessions.

According to some authors the fall in the real price of crude oil during the 1950s and 1960s reflected the growing bargaining power of the oil companies vis-a-vis the oil-exporting countries (Heal (1975)). There is no doubt that during most of this period oil exporters were getting less for a barrel of crude oil than the value of its marginal product (we will explain the reasons immediately below) but this is not sufficient proof of increasing company power. While posted prices (in constant

Figure 5

Oil Market Prices and Exporter Government Taxes per barrel



Source: Griffin J. and Steele H. (1980), Energy Economics and Policy, page 96, Figure 4.3

dollars) were falling the tax revenue per barrel increased during the period because of changes in tax coefficients and formulae (see Figure 5). This suggests that the bargaining power of the oil exporters vis-a-vis the oil companies was also increasing.

Figure 5 may be used to clarify another issue. Let us assume that the recorded arm's length price of crude oil during the period in question reflected the value of its marginal product. If this were the case we could infer that throughout most of the period oil exporters were subject to the oligopsonistic power of oil companies. Since exploration and development costs were small relative to the crude oil price, the gap between the arm's length price and the government's per barrel tax revenue provides an approximate index of the oil companies' market power vis-a-vis oil-exporting countries. Figure 5 shows that this gap, very large at the beginning, tended to decline continuously.[5] The power of oil companies was therefore being eroded over time. (On this point see also Penrose (1971, ch. 9)).

The counter-argument is that the arm's length price of crude oil during the period in question is not a reliable indicator of market forces because arm's length deals in the vertically integrated oil industry constituted a small proportion of total transactions. Yet according to Adelman (1972), the number of independent transactions among the major oil companies or between majors and independent companies was large enough to establish the recorded arm's length prices as true transaction prices.

It has also been suggested that declining oil prices reflected increasing competition due to the entry of smaller, independent oil companies (see, among others, Griffin and Steel (1980)). Although this argument partly explains why many of the major oil companies lost market power, it cannot, by itself, explain the trend in oil prices. The theory of exhaustible resources teaches us that a shift in the market structure alone cannot sustain such a long period of declining prices. We can however retain this argument about increasing competition as suggesting an additional element to the three main reasons advanced earlier to explain the period's trend.

Finally, the growing uncertainty of oil companies about their property rights in the Middle East may have contributed to faster depletion of oil reserves in these concessions, and hence to the fall in real oil prices. This growing uncertainty was fostered by nationalisations and demands for equity participation by host governments made in the late 1960s. This important issue will be dealt with in the next section.

3. THE PERIOD 1970-1984

The declining trend in real oil prices began to change direction some time during the second half of 1970. Price movements were not smooth during 1970-1984. Prices rose significantly in the oil shocks of 1973-4 and 1979-81 but in the intervening years the real price of oil suffered some erosion. The price of the marker crude was brought down by a discrete reduction of $5 in March 1983 and another (much smaller) change of $1 in January 1985. Since 1981 the real price of oil (in US dollars) has been falling again but different trends obtained for oil prices measured in other currencies.

Unlike 1950-1970, the post-1970 period has been the subject of extensive study. Numerous articles and books have been produced to describe and explain the causes of the two oil shocks and their consequences. The arguments can be classified in two broad categories. The first is comprised of the main theories which attribute oil events to the cartelization of the crude oil market by OPEC. The second category includes theories which explain oil market events by the operation of underlying competitive forces marred by a number of market failures (other than cartelization).

A. Cartel Theories and the Oil Price

The "OPEC is a cartel" view has many variants. The most popular conceives OPEC (or a subgroup of it) as a cartel which chooses an intertemporal price path to maximize the present value of its oil wealth, subject to the constraints imposed by the existence of a competitive fringe[6] of producers and by the availability of substitute technologies. (See, among others, Salant (1976), (1982), Dasgupta and Heal (1979), Pindyck (1978), Ulph and Folie (1980), Gilbert (1978), Newbery (1981)).

These models can be interpreted as approximations of the rational expectations equilibrium price path, so long as their assumptions about the structure of the oil market are correct. They are difficult to test. Even if one accepts their assumptions, the fact that they are meant to approximate long-run equilibrium price paths clearly implies that they should not be used as explanations of relatively short episodes such as the 1973-1981 period.

An example will suffice to illustrate our objections. Pindyck (1978), in a simulation exercise which seems to have tracked OPEC pricing decisions rather successfully from 1975 to 1979 (although not beyond that), used an interest rate of 10 per cent to discount OPEC's future profits. Since the discount rate is treated as an exogenous variable in this model, the choice of this particular interest rate implies that OPEC was a price taker in the world capital market, getting a 10 per cent average rate of return. This is a very high rate by historical standards.[7] To make things worse, the average real rate of return in the

world capital markets during the period in question was very close to zero, if not negative (Amuzegar (1983)). Furthermore, there is evidence that decision makers in the relevant OPEC countries were not planning on the basis of some "long-term" estimate of the average world rate of return as they were concerned with the very low real rates actually obtained on their foreign investments (Al-Sabah (1980)).

The predictive ability of Pindyck-type models is also in question: the simulation exercises based on them failed to predict the 1979 events. Their ability to track the 1973-74 price rise has also been questioned. Dasgupta (1981) has suggested that the specification of the simulation exercises was made to accommodate an expost prediction of the magnitude of the 1973-74 oil price rise!

However, we believe that the real weakness of those models, as far as their relevance to the oil market is concerned, lies in their assumptions. First, they assume that OPEC is a monolithic cartel acting within a perfect capital market. This offers no insight into the workings of an organisation (consisting of thirteen members with fundamentally different economic, cultural and political characteristics) which never implemented the typical cartel arrangements in which weaker members receive side payments from the organisation. Anyone willing to pursue the "OPEC is a cartel" line must be able to answer the following questions. How can the different objectives of the OPEC members be reconciled? What are the difficulties in achieving a bargaining solution? How can OPEC enforce a collusive agreement? In addition, the cartel model cannot

provide an explanation of past events unless the following subsidary questions are addressed. Why did prices not start rising before 1970 given that OPEC came into existence in 1960? Has any collusive agreement been implemented during the period in which OPEC is said to have cartelized the oil market? Before examining the answers that can be (or have been) made to these questions we shall discuss two other objections to these models.

(a) To assume that the objective of an oil producer is to maximize its oil wealth evaluated at a vector of market clearing prices and discounted at the "world" rate of return is to postulate an economic environment with no distortions. Unfortunately this is not the environment in which makers of oil policy have to take their decisions. Oil-exporting countries of the OPEC region are developing economies, and this simple but often forgotten fact has far-reaching implications for oil supply which are not taken into account in the above models. We shall report later on certain results (Stournaras (1984,c)) about the economic distortions which affect oil-exporting, developing economies.

(b) Models which are essentially concerned with the properties of equilibrium paths do not usually offer answers to such important questions as: how is the intertemporal equilibrium achieved, and is this equilibrium stable? These questions have more than mere theoretical or academic interest. By failing to consider the role of the dynamic adjustment process in reaching equilibrium, the models cannot explain why small producers outside OPEC have repeatedly changed prices before and

independently of OPEC (for the relevant evidence, see Roberts (1984)). We have attempted elsewhere to provide some answers to these questions. In Stournaras (1984,a) we have shown that it is easy to construct plausible adjustment processes and prove the stability of the rational expectations equilibrium in partial models which assume a perfect capital market. Yet stability may cease to characterise equilibrium as soon as the model is made slightly more complicated. In a two-country, two-commodity, one-financial-asset world (in which an exhaustible resource like oil is one of the two commodities) stability depends on the exact relationship between the marginal propensity to consume in country A and in country B as wealth increased (Stournaras (1984,b)).

Let us now return to the initial questions raised by the proposition that "OPEC is a cartel". It has been suggested that differences of objective between OPEC members stem from the fact that capital markets are not perfect. Hnyilicza and Pindyck (1976) assumed that OPEC can be adequately characterised as a two-part cartel consisting of one group of saver countries (Saudi Arabia, Libya, Iraq, Abu Dhabi, Bahrain (sic), Kuwait and Qatar) and a second group of spender countries (Iran, Venezuela, Indonesia, Algeria, Nigeria and Ecuador). Since the world capital market is imperfect saver countries discount their future profits using a lower discount rate than spender countries. In other words, spender countries have a more immediate need for "cash" than saver countries. The authors use the concept of a Nash bargaining solution to determine the cartel's optimal policy (an intertemporal price path and an allocation of production

quotas among the OPEC members). Their major finding is that production quotas ought to satisfy the following rule: saver countries do not start extracting until spender countries have exhausted their reserves.

Although the result may seem bizarre, it has an appealing intuitive explanation. Saver countries' oil in the ground loses value less rapidly than that of spender countries because the former discount the future at a lower rate. It follows that saver countries should keep their oil in the ground until all the spender countries' oil is exhausted.

As the authors themselves accept, this is quite an unrealistic conclusion which does not correspond at all to actual behaviour. The assumption mainly responsible for this implausible result relates to capital market imperfections. It is assumed that the two groups of countries face different interest rates which are given exogenously. This means, for example, that Saudi Arabia can borrow money at a constant interest rate to finance spending throughout the whole period during which it refrains from producing oil. Obviously such a situation is inconceivable in the real world.

Of course it would be rash to reject the cartel hypothesis just because one observes that both saver and spender countries within OPEC were producing oil simultaneously in plain contradiction to the Pindyck-Hnyilicza result. But can we retrieve the argument by examining whether this result approximates the pattern of production? It would be reasonable to accept that in an imperfect world the immediate implementation

Table 1: Share of the Saver Countries on OPEC Oil Production. 1973-1984. Percentages.

Year	Share	Year	Share
1973	41.2	1979	46.8
1974	43.1	1980	51.4
1975	41.6	1981	56.6
1976	43.0	1982	46.7
1977	43.8	1983	43.0
1978	43.0	1984	42.1

Note: Saver countries are Saudi Arabia and Kuwait (incl. Neutral Zone), the UAE and Qatar.

Source: BP Statistical Review of World Energy

Table 2: Oil Production. World and OPEC. 1973-1984. Million Barrels/Day

Year	World	OPEC	Year	World	OPEC
1973	58.5	31.3	1979	65.8	31.5
1974	58.6	31.0	1980	62.7	27.5
1975	55.7	27.5	1981	59.4	23.4
1976	60.1	31.1	1982	57.0	19.9
1977	62.6	31.7	1983	56.7	18.5
1978	63.0	30.3	1984	57.8	18.3

Source: ibid

of agreed co-operative policies is not possible but nevertheless to expect that the allocation of oil production among OPEC members after the supposed cartelization of the oil market in 1973 will show a tendency to converge to the Pindyck-Hnyilicza pattern. In other words, if the hypothesis that the cartelization of the crude oil market caused the increase in oil prices in the 1970s were true, we would expect the share of the saver countries in total OPEC production to fall over a period of time. A sufficient period of time should be allowed to lapse because agreed co-operative policies are difficult to implement in full with immediate affect. Delays would also occur for other reasons: for instance, oil production capacity in spender countries cannot be installed instantaneously.

Table 1 presents the share of the saver countries of the Gulf (Saudi Arabia, Kuwait, UAE, Qatar) in total OPEC production since 1973. We have excluded Libya and Iraq from the Pindyck-Hnyilicza definition because Libya's oil price policy has been erratic (causing sharp fluctuations in production), and because Iraq in our judgement was a spender country (despite an occasional accumulation of surplus funds). We observe that the saver countries' share rose between 1973 and 1974 (i.e. at the time of the first oil price shock). The shares remained very stable at around 43.1-43.8 per cent between 1974 and 1978. However, there is a small drop in the share in 1975 (41.6 per cent) when OPEC production declined from about 31.0 mb/d to 27.5 mb/d. The saver countries absorbed 1.6 mb/d of a total reduction in OPEC's output of 3.52 mb/d (45.3 per cent). Though the data indicate that the saver countries absorbed a larger proportion of

a drop in the demand for OPEC oil than their average share, the difference between the two numbers (41.6 and 45.3 per cent) is small. During the second oil price explosion (1979-1981) the share of saver countries increased considerably, as these countries successfully compensated for the drop in Iranian, and later in Iraqi, oil production. Thus the evidence does not favour the hypothesis that, during 1973-1981, OPEC acted as a two-part cartel. The allocation of production between the two groups of member countries is too different from the pattern predicted by the Pindyck-Hnyilicza model.

This test has the merit of cutting across an important controversy. Authors who deny that the cartelization of the oil market caused the oil price increases usually point to the fact that OPEC had never used an output quota system prior to March 1982. Their opponents argue that an explicit production programme is not necessary because prorationing could be informally agreed and implemented. Yet if OPEC is seen as a two-part cartel it follows that the share of saver countries in total OPEC production will fall irrespective of whether production agreements are explicit and formal or implicit and informal. We have seen (Table 1) that this share has not declined.

Since many economists object to the application of bargaining to a situation where the individual producers are governments (it is sometimes argued that there is no reason why bargaining - a purely descriptive approach - should be the appropriate procedure to determine the weights in a social welfare function instead of moral standards), another

Table 3: OPEC Members' Shares in OPEC Total Oil Revenues. 1973-1983. Percentages

Year	Saudi Arabia	Kuwait	UAE	Qatar	Total(Gulf)
1973	22.1	8.8	5.0	1.7	37.6
1974	27.5	8.2	5.6	1.7	43.0
1975	27.9	7.4	6.4	1.7	43.4
1976	30.1	6.9	6.5	1.7	44.6
1977	31.1	6.2	6.6	1.4	45.3
1978	28.4	7.1	6.5	1.7	43.7
1979	29.8	8.5	6.5	1.8	46.6
1980	36.6	6.4	7.0	1.9	51.9
1981	44.7	5.9	7.4	2.1	58.1
1982	37.6	4.9	7.9	2.0	52.4
1983	28.7	6.1	7.9	1.8	44.5

Source: OPEC Annual Statistical Bulletin 1982

Petroleum Economist 1984

interpretation of the two-part cartel hypothesis might be useful. The Pindyck-Hnyilicza result could be construed as a normative proposition concerning the allocation of revenue between the "rich" and the "less rich" members of OPEC because the small population of saver countries enjoy very high income and wealth levels per capita.

Given the importance of oil in the economies of OPEC countries, and considering that direct income transfers do not take place among these countries, we would expect the revenue

share of the "rich" countries to be declining. Table 3 presents the share of every member country in OPEC's aggregate oil revenues since 1973, and shows that the trend of the "rich" countries' share in OPEC's total oil revenue was rising during 1973-1983. The above interpretation of the two-part cartel hypothesis does not appear to be borne out by the evidence.

These negative results would not surprise those who have followed closely the evolution of OPEC since 1973 and who are perfectly aware of the conflict between member countries over the choice of the relevant control variables, namely the price of the marker crude and the appropriate price differentials. (See, among others, Mabro (1984), Moran (1982) and Teece (1982)).

Recognising the lack of evidence to support the view that oil price increases have been achieved through OPEC's collusive policies some authors had to modify their assumptions and suggest that the OPEC cartel only consists of a subgroup of countries. Some assume that this cartel core is comprised of the Gulf countries (as they have very similar economic and political characteristics, the bargaining costs of achieving a collusive agreement among themselves are thought to be very small); while others go further and argue that the cartel need not include any countries but Saudi Arabia (the dominant producer hypothesis).

The way that this hypothesis is usually tested is to look at the dominant producer's share in world oil production (not only in OPEC's output) during the period of the price increase (Griffin and Teece (1982, p. 28)). If the hypothesis were correct we would expect the cartel's market share to shrink

Table 4: Shares of Saudi Arabia and Gulf in World Oil Production. 1973-1984. Production in Million Barrels/Day. Shares in Percentages.

Year	World Oil Production mb/d	Saudi Arabia % share	Gulf % share
1973	58.5	13.1	22.0
1974	58.6	14.7	22.8
1975	55.7	13.0	20.5
1976	60.1	14.6	22.2
1977	62.6	15.1	22.2
1978	63.0	13.6	20.7
1979	65.8	15.0	22.4
1980	62.7	16.3	22.5
1981	59.4	17.1	22.3
1982	57.0	12.0	16.3
1983	56.7	9.6	14.0
1984	57.8	8.5	13.4

Source: BP (ibid)

(because the dominant producer is supposed to cut production to sustain a price increase) and the non-cartel market share to increase. Table 4 provides the relevant information. We observe that Saudi Arabia's market share rose from 1973 to 1974, and once again from 1979 to 1981, whereas the Gulf countries' market share rose slightly between 1973 and 1974, and more significantly between 1978 and 1980.

That Saudi Arabia's market share rose in the very years of the two price increases casts serious doubt on the hypothesis that the country engineered the price rises of the 1970s.[8]

A possible objection to the above arguments is that the behaviour of market shares should be observed over shorter periods, say during certain critical months when significant price increases took place. This has led some economists in favour of the "OPEC is a cartel" view (notably Adelman (1982)) to concentrate on specific episodes during the two oil price shocks (1973-74, 1979-80) and the role played by OPEC, and Saudi Arabia in particular, in them. According to Adelman (1982) the first oil price shock occurred because OPEC cartelized the oil market by introducing production cuts at the end of 1973 and in early 1974 (the Arab embargo); the second oil price shock occurred because Saudi Arabia decided to exploit the Iranian Revolution by cutting its own oil production in January 1979.

There are a number of objections to this view. First, the embargo (and production cuts) of 1973-74 was a purely political act, undertaken by a group of exporting countries outside the OPEC framework. The production cuts were not imposed by Arab countries for the purpose of reaping economic benefits but to achieve a political objective in the context of the Arab-Israeli conflict.[9] Secondly, the production cuts were small and lasted for a very short period. As far as the second oil price shock is concerned, Adelman's (1982) account is in sharp contrast to this period's events as presented in Seymour (1980, pp. 183-184). Adelman claims that it was not the cuts in Iranian production due to the revolution that caused the price rise but

Saudi Arabia's decision, taken in January 1979, to cut her own production from 10.4 to 8.0 mb/d. According to Seymour (1980) this was not what had actually happened: Saudi Arabia had increased its oil production to over 10 mb/d in November and December 1978 from lower production levels in September, in order to compensate for the cuts in Iranian production which had occurred earlier. The decision taken in January 1979 was not to cut oil production as Adelman claims but to increase annual output to 9.5 mb/d for the first quarter of 1979 (annual output was in the range of 8.5 mb/d during the previous year). It was only in April 1979, after Iranian exports had resumed and the spot market eased a little bit, that Saudi Arabia reverted to its traditional output of 8.5 mb/d from the 10 mb/d that had been produced to compensate for the Iranian losses. A glance at Table 2 also reveals that total world oil production was higher in 1978 and in 1979 than in 1977 while OPEC production fell slightly in 1978 relative to 1977 but came back to the 1977 level in the following year (1979). Finally, Adelman's interpretation seems at odds with Saudi Arabia's well-known attempts to hold down the oil price throughout 1979 and 1980 producing at full technical capacity and competing with other OPEC and non-OPEC producers which were willing to follow the spot market price increases. (For a detailed presentation of this period's price and production decisions within and outside OPEC and the individual producers' motives see Roberts (1984)).

A more subtle approach in support of the "OPEC is a cartel" view is to argue that OPEC did not cause the price rises

but acted in such a way as to sustain them. Let us examine this argument considering the two price shocks separately.

(a) The period following the 1973-74 shock. World oil consumption did not decline by very much in the aftermath of the first oil price shock. In 1975, world oil consumption was only 2.6 per cent below its 1973 level (see Table 5), and in 1976 it rose again to a new peak. Hence, there was almost no consumption cut against which OPEC had to sustain the higher oil price (a similar argument has been made by Gately (1984)). As mentioned before, OPEC had no explicit production sharing agreement prior to March 1982. We also argued that the evidence supports neither the assumption that OPEC operated as a two-part cartel, nor the assumption that Saudi Arabia (or the Gulf countries) was the dominant producer who supported the higher oil price in these years. (For other arguments explaining why OPEC did not act as a

Table 5: World Oil Consumption. 1973-1984. Million Barrels/Day

Year	Consumption	Year	Consumption
1973	57.0	1979	64.1
1974	56.4	1980	61.6
1975	55.7	1981	59.9
1976	59.2	1982	58.4
1977	61.2	1983	58.0
1978	63.1	1984	58.9

Source: BP (ibid)

cartel during this period see, among others, Teece (1982), Moran (1982), Mac Avoy (1982) and Robinson (1983)).

(b) The period following the 1979-81 shock. This period was rather different. World oil consumption fell substantially and OPEC's production fell even further because of increased output from non-OPEC sources (mainly from Mexico, Alaska, the United Kingdom and the Soviet Union). The asymmetry in the market response after the first and the second oil price shocks is an interesting issue but a detailed analysis is rather outside the scope of this paper. The main reasons for this asymmetry can be found in a) the effects of policy-induced oil conservation (the response of the governments of oil-consuming countries was much more effective after the second rather than the first oil price shock); b) the lasting recession in the OECD countries after the second oil price shock; and c) the presence of time-lags. Although non-OPEC producers invested in oil producing capacity in the early 1970s, oil production from these sources came on stream in the late 1970s and early 1980s: the same applies to oil conservation efforts.

In the face of oil consumption cuts and production increases from non-OPEC sources, OPEC attempted to control the oil market by introducing production quotas at its Vienna meeting in March 1982. However, this attempt failed because the agreement was rejected by some member countries. In the face of continuously falling spot market prices OPEC, at its London meeting in March 1983, took the historic step of reducing the official marker crude (Arabian Light) price to the then ruling spot price of $29/b and adjusted price differentials accordingly.

In addition, it decided to impose an overall production ceiling of 17.5 mb/d (a quantity corresponding to the level of demand at the new price according to the producers' conjectures) and to allocate production quotas to all member countries with the exception of Saudi Arabia. The latter undertook to play the role of the "swing" producer in order to balance the (expost) demand for OPEC oil with the OPEC supply calculated on the basis of the (exante) demand conjecture of 17.5 mb/d. In 1982 Saudi Arabia began to behave in a way which conformed to the dominant producer hypothesis: its oil market share fell sharply from 17.1 per cent (1981) to 12.0 per cent (1982), 9.5 per cent (1983) and to 8.5 per cent in 1984. This has to be contrasted with Saudi Arabia's behaviour between 1973 and 1981, a period during which her market share increased from 13.1 per cent (1973) to 17.1 per cent (1981).

Whether this sellers' agreement will continue to hold is not easy to tell. The factors that work against it are, not surprisingly, demand uncertainty and cheating, given that OPEC does not have mechanisms either for detecting cheating[10] or for punishing it. For instance, it is not known to what extent the continuing spot market weakness (which, in effect, led to the cut in the official Norwegian and British oil prices and the subsequent OPEC meeting in Geneva in October 1984 where a new production ceiling of 16 mb/d was agreed to support the $29/b official marker crude price) was due to a wrong estimate of OPEC demand at the time of the London agreement (which, in turn, could be attributed to a mistake in the estimate of world oil demand

and/or about the intentions of non-OPEC producers) and to what extent it is due to cheating among the OPEC members.

In the presence of these factors (and as recent events have shown) it is mainly the willingness of Saudi Arabia to absorb the cuts in OPEC demand that has prevented the nominal official marker crude price from falling even further. (The real oil price has, nevertheless, fallen substantially: see Figure 2). In this context a price decline might occur either as a result of Saudi Arabia's inability to continue acting as a swing producer in the face of falling demand for OPEC oil or as a deliberate attempt to force the other oil exporters (not only OPEC members) to observe some rules of co-operative behaviour.[11]

B. Market Failures and the Oil Price

We have argued in the previous section that the view which attributes the oil market events since 1970 to the cartelization of the market by OPEC is not convincing. In this section we shall examine a number of arguments according to which the reversal of the oil price trend in 1970, as well as the two oil price shocks of 1973-74 and 1979-80, can be attributed to the underlying competitive forces and to a number of market failures other than oligopolistic behaviour.

Although these arguments are complementary to each other, they have so far been presented by different authors as separate explanations. This is unsatisfactory as it leaves many questions unanswered. In this section we shall attempt to provide a unified explanation by tying these arguments together and by supplementing them with other propositions arising from

our own research in this subject.

As mentioned before the real price of oil declined between 1950 and 1970 though oil consumption was rising at an average compound rate of 7.0 per cent a year. At the beginning of the 1970s it became evident that oil production capacity was not keeping pace with the rise in oil consumption. The reason may relate to oil companies' uncertainty about their property rights in the Middle East following the host countries' demands for equity participation in the concessions which were made in the late 1960s (Mabro (1984)). In fact, the spot market had become very tight and spot oil prices had risen well above official prices in the months preceding the 1973-74 oil events.

The Arab-Israeli conflict in October 1973 explains the timing of the first oil price shock. This shock occurred during a very short period extending between October and December 1973 as a result of politically motivated production cuts imposed by Arab oil-exporting countries in an oil market characterised by inelastic demand (short-run) and dominated by expectations of further disruptions. In other words, the first oil price shock occurred as a result of panic and rapid stock accumulation (Robinson (1983)).

This only tells us what happened at the time of the oil price shock and does not provide a complete explanation of the behaviour of oil prices in terms of competitive behaviour. The fact that oil prices did not return to their previous level after the panic was over has not been accounted for. There are four arguments which explain why the oil price did not fall after the 1973-74 events. We have already referred to one of them when we

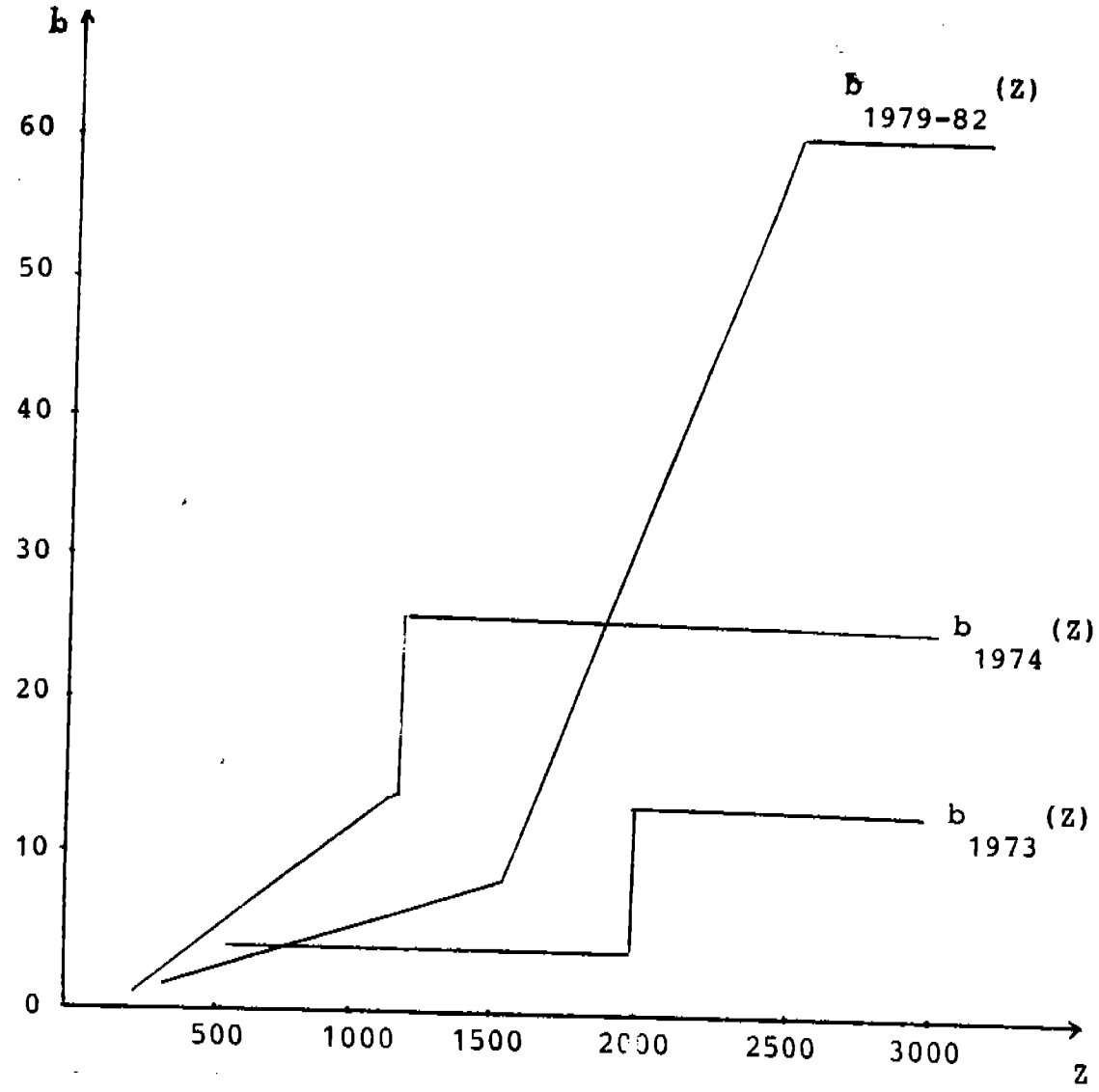
noted that investment in oil production capacity was not sufficient to support the 7 per cent annual growth rate in oil consumption (see also Mac Avoy (1982), Lichtblau (1982)).

The second argument stresses the changes in perceptions about long-term resource availability that occurred in the 1970s (Roumasset, Isaak and Fesharaki (1983), Odell and Rosing (1983)). Figure 6 shows the revision of the industry's expectations concerning the long-term oil extraction costs and the costs of substitute technologies. Until 1973 it was firmly believed by the industry (see Roumasset, Isaak and Fesharaki (1983)) that up to 2000 billion barrels of conventional oil could be extracted at a cost of less than $5/b (in 1981 dollars) and that a substitute technology could then take over and provide a very large ("infinite") amount of oil equivalent at a production cost of $12/b. This is shown by the function $b_{73}(Z)$ in Figure 7. Subsequently, oil companies and government agencies re-estimated the size of the resource base and revised their expectations about costs. This is shown by the functions $b_{74}(Z)$ and $b_{79-82}(Z)$.

The weakness of this argument is that it does not explain the process through which expectations about long-term scarcity have been formed and revised. In fact the three time-dependent functions in Figure 6 have been constructed from data published after a substantial time-lag and do not tell us why industry's expectations changed. In our opinion it was the loss of the oil companies' property rights in the Middle East in 1972-74 which forced them to undertake the necessary investment in searching for oil elsewhere and in alternative technologies. As

Figure 6

Revision of Expectations about Long-Term Oil Extraction Costs



b: Oil Extraction Cost in 1981 $ terms.

Z: Billion Barrels of Cumulative Quantity of Oil Extracted.

Source: Roumasset, J., Isaak, D. and Fesharaki, F., Energy Economics, July 1983

the results achieved were relatively disappointing they re-evaluated the size of the resource base. This still leaves unanswered the question of why companies and governments had underestimated the costs of (unextracted) oil prior to 1973. Odell and Rosing (1983), as mentioned before, attribute this underestimation to the fact that the oil companies tended to extrapolate their past experience from oil exploration and discovery in the prolific Middle Eastern fields to other (as yet unexplored) areas and far into the future.

The third argument stresses the changes in the ownership and control of oil production activities in the Middle East (Johany (1978), Mead (1979)). It was said that the governments which took over control from the international oil companies (concessionaires) were willing to cut oil production because they were using a lower discount rate in evaluating their revenues from oil production than the oil companies.

Although this argument has been used to explain the oil price shock, we think that it is more relevant to the issue of why the oil price was sustained at the higher level after the shock. The argument does not explain the price increases of 1973-74 because it implies that the production cuts of that period were due to economic factors (the change of behaviour following a transfer of property rights) when they were plainly induced by political objectives. Secondly, the transfer of oil property rights from companies to governments was a lengthy process which did not coincide exactly with the shock. As already argued, uncertainty about the oil concessionaires' property rights during the late 1960s led to over-exploitation of

the existing fields and to restraint in investment in oil production capacity. Thirdly, a glance at Middle East oil production data (see Table 6) reveals that the production decline of 1975 was followed by production increases in subsequent years: it was only after 1979 that Middle East oil production fell below the 1973 level.

One needs to explain why the governments of oil-exporting countries might use lower discount rates than the oil companies. We have suggested before that uncertainty about

Table 6: Oil Production. Middle East. 1973-1984. Million Barrels/Day

Year	Production	Year	Production
1973	21.3	1979	21.9
1974	21.9	1980	18.8
1975	19.7	1981	16.0
1976	22.3	1982	13.2
1977	22.5	1983	12.1
1978	21.4	1984	11.7

Source: BP (ibid)

property rights leads oil companies to deplete faster. An additional important reason is that a number of oil-exporting countries are characterised by limited absorptive capacity. This points to the existence of some capital market imperfections. Due to limited opportunities for domestic investment and

consumption in a number of countries with substantial oil reserves (e.g. the Gulf countries) and to restricted access to international capital markets, there are limited opportunities for the profitable investment of the oil export revenue, under which circumstances the conservation of oil reserves by producers becomes a relatively attractive investment.

This argument requires an explanation of why access to international capital markets is restricted. One reason is that the oil exporters' rate of return is negatively affected by the size of their savings. The windfall gains from the oil price rise presented the oil exporters with the unfamiliar problem of managing an enormous financial surplus. Hence it is natural to expect, given managerial constraints and lack of expertise, the rate of return on their foreign investment to be negatively affected by the volume of their surpluses. In addition oil exporters were (and still are) prevented by legal constraints from investing in a number of profitable industries in OECD countries (Amuzegar (1983)). In fact, the (realized) average real rate of return on the oil exporters' foreign savings during the crucial 1974-1980 period was very small, if not negative (Amuzegar (1983)).

Furthermore a number of oil exporters were (and still are) hostile to the ideal of a "coupon clipping" rentier society living on profits from capital invested abroad. This argument would not be valid in a politically and ideologically homogeneous world, but since the real world does not display these characteristics we believe that most oil-exporting countries

which are also net savers actually think in these terms. These considerations mean that, even in a perfect capital market, the world rate of return overestimates the oil exporters' social marginal value of their foreign capital with the implication that oil extraction becomes more conservationist (Stournaras (1984,c)).

The fourth argument which may explain why oil extraction policy has become more conservationist during the 1970s (and hence explain the reversal of oil price trends) is as follows. Since the beginning of the 1970s and with the transfer of the oil sector's property rights, a number of rich capital- and oil-exporting countries (e.g. Saudi Arabia) have embarked on an industrialization policy based on the transformation of crude oil into a number of oil products and petrochemicals. Because of limited absorptive capacity and partly because of technical considerations, investments in oil refining and petrochemicals have long gestation periods. This has an important implication for oil depletion policy. Since associated gas (also an exhaustible resource) is an important input to the production of petrochemicals with almost no opportunity cost, optimal oil extraction policy during the period preceding investment in petrochemicals has to take into account the amount of associated gas which is flared. The social value of the marginal barrel of crude oil is the world price of oil reduced by the shadow price of the associated gas which is equal to the present value of its (future) marginal product. For a rigorous analysis of this case see Stournaras (1984,c).

Finally, there is another argument proposed by Teece

(1982) which explains the 1973-74 events and their aftermath with the use of a backward-bending oil supply curve. According to this argument oil production decisions in a number of oil-exporting countries are not being made with a view to maximizing oil wealth, but with reference to domestic budgetary requirements. These requirements are determined by absorptive capacity, a term used to define the revenue required to finance internal economic development. Oil-producing countries set a revenue target and choose the level of production which will satisfy it, taking into account the relevant oil demand curve. If the world oil price increases and revenue targets remain stationary, oil production falls. If there are many countries with such backward-bending oil supply curves (the assumption is justified on the grounds that oil production capacity and reserves are concentrated in a small number of countries of low-absorptive capacity, namely the Gulf States) the market supply curve will also be backward bending. As a result, and depending on whether the world oil demand curve is inelastic or not, we might get two market equilibria (one stable, one unstable) or one stable market equilibrium. In both cases however, small (random) shifts in the demand curve will produce large changes in the price.

We have two serious objections to this view. The first is that it ignores the possibility of investing in foreign assets. The point, which we have ourselves already made, that OPEC low-absorptive producers consider foreign investment unattractive because of low returns and political risks does not

mean that they do not seek the maximization of their wealth. It only means that these countries face a foreign rate of return which is a (negative) function of their savings and/or that their discount rate is lower than the world rate of return because of a risk element. Hoel (1980) has shown that the first case has serious implications for the theory of exhaustible resources. If an oil-producing country faces a foreign rate of return which is negatively related to its own savings and is also constrained in its investments at home then the optimal oil price path could be negatively sloped (the oil price starts at very high levels and declines over time). The second case is compatible with wealth maximization but will make oil policy more conservationist than otherwise.

Our second objection is that there is no evidence that oil production decisions are being taken with reference to domestic budgetary requirements. Evidence used by Teece himself (1982, page 84, Table 3.5) shows that government expenditure in most oil-exporting countries has grown almost as fast as oil revenues. This suggests that the notion of a producer choosing an output level to satisfy a revenue target is of a rather ambiguous analytical validity, since the target itself could be explained by the growth in oil reserves.

Having developed and criticized the different theories that explain the 1973-74 events and their aftermath in terms of the underlying competitive forces, we can now proceed to examine those theories which explain the second oil price shock on a similar basis.

The second oil price shock also coincided with

political events, namely the events before and during the Iranian revolution. From December 1978 to the last quarter of 1981 the official price of Arab Light increased from $12.7/b to $34/b.

According to those who stress the significance of underlying competitive forces, this shock occurred in a period during which perceptions of long-term scarcity had, once again, become pessimistic (Roumasset, Isaak and Fesharaki (1983), Gately (1984), Odell and Rosing (1983)). The point is illustrated in Figure 6 which shows a substantial revision of the long-term oil extraction cost curve and the cost of substitute technologies during the 1979-82 period.

However this does not explain the oil price shock since we do not know how this revision took place and how it may have affected the market.

Another version sees the second oil price shock as a short-term competitive response to a supply disruption (the production cuts during the Iranian revolution) in a market characterized by a short-term demand elasticity and expectations of further disruptions. These expectations were formed during the highly uncertain and extensive period which followed first the Iranian revolution and then the beginning of the Iran-Iraq war (Robinson (1984), Mac Avoy (1982)). Another important factor which contributed to the aggressive stockpiling policies of oil companies and oil-consuming governments (and thus to the size of the competitive response) was the structural break that occurred in the oil market during this period. The Iranian revolution had a particularly large effect on some major oil companies. BP lost

almost 1.4 mb/d, Exxon 400,000 b/d and Socal 300,000 b/d: all three of them had to declare "force majeure" on a large number of their long-term contract customers (Roberts (1984)). This sharp reduction in the flow of crude oil to the Third Party Market sent a number of refiners, which traditionally obtained crude oil through long-term contracts, either to the spot market or to the oil producers themselves. The loss of long-term contracts increased governments' concern about security of supplies (mainly the Japanese government and some European ones). Refiners or national oil companies, with the backing of their governments, were willing to pay a premium to obtain crude oil from the spot market or directly from the oil producers themselves, thus bidding up the crude oil price to higher levels than would have obtained otherwise.

Apart from the shift from long to short-term contracts at the time of the Iranian disruption which explains a "temporary" price rise there were also other, more permanent, effects. Robinson (1984) suggests that oil has tended to become like an ordinary commodity with inventory cycles explained by some version of the well-known multiplier-accelerator principle. This raises some important questions regarding the stability of these cycles and the role of expectations, which we have attempted to answer in Stournaras (1984,a,b). In addition, the behaviour of oil producers regarding their depletion policies is expected to be affected as well. Most of the oil-exporting countries are heavily dependent on crude oil revenues. Therefore, in the absence of perfect capital markets, unexpected fluctuations in the current demand for crude oil cause unexpected

fluctuations in those countries' National Income. If oil exporters are risk averse (this seems to be a reasonable assumption in this context) they will delay oil extraction (i.e. their depletion policy will become more conservationist) for the following two reasons. First, since the theory of exhaustible resources predicts that the (expected) price of oil will be rising and the demand for oil falling, oil exporters will be less dependent on oil in the future than in the present. Therefore, they will be willing to transfer the sale of the marginal barrel of oil from the present to the future. Secondly, as the process of revenue diversification in the oil-exporting countries develops, fluctuations in crude oil revenue will be less harmful to these countries' national economies in the future than in the present. Therefore it will be beneficial for them to transfer the marginal barrel of oil from the present to the future. (For a rigorous derivation of these results see Stournaras (1984,c)).

As we have already noticed, in the period which followed the 1979-81 events OPEC has tried to control the oil market through a system of production quotas with Saudi Arabia playing the role of the dominant producer. Since this is clearly evidence in favour of (some form of) the cartel hypothesis (only relevant to the post-1981 period) it might be useful to examine whether this entails any efficiency losses. In fact many separate issues are involved. First, we may notice that what, in effect, OPEC is attempting to do is to control the rate of decline of the real oil price. Despite Saudi Arabia's efforts to act as a dominant producer and despite OPEC's oil production

ceiling and quotas since 1982, the price of oil has fallen in both nominal and real terms (see Figure 2). If we contrast this with Saudi Arabia's efforts during the pre-1981 period to moderate the oil price increases in a tight market by producing in excess of its maximum "allowable" (see Roberts (1984)), it will not be easy to separate the efficiency losses due to cartel behaviour from the efficiency gains due to Saudi Arabia's buffer stock role. Secondly, it has been shown that, from a theoretical point of view, the efficiency losses in exhaustible resource markets due to cartelization may not be significant. This is because the owner of an exhaustible resource who decides to exploit his market power by keeping more oil in the ground now will be forced to sell more oil in the future accepting a lower price than otherwise. In fact, it has been shown that if the (price) elasticity of demand for the resource is constant and higher than unity and extraction costs are negligible, monopolistic and competitive oil extraction paths will coincide (Stiglitz (1976), Heal (1981)). In a way, this argument says that, in the long run, the structure of an exhaustible resource market may not play a significant role. This seems to be confirmed by the results of a number of forecasting models concerning future oil prices: most forecasters agree that in the long run (that is in the 1990s and beyond) the real price of oil will be higher than its 1980 level; and although the future price is quite sensitive to market fundamentals such as the elasticity of demand, the size of the resource base and GNP growth, it appears to be much less sensitive to different assumptions about the market structure (Gately (1984)).

Thirdly, there is the issue of "countervailing" power. Whatever market power OPEC might possess, it is constrained by the market power of crude oil buyers. Most of the major international oil companies are now net buyers of crude oil and therefore, their interests are in conflict with those of OPEC. Also, the oligopsonistic power and political leverage of the USA, and that of other oil-importing countries should not be underestimated. Oil importers have their own co-ordinating organisation, the International Energy Agency, which was created immediately after the first oil price shock with the aim of reducing crude oil consumption in the OECD countries. Although a thorough empirical investigation is required in order to substantiate this argument, casual empirical observation suggests that the current structure of the oil market resembles that of a multilateral oligopoly rather than a sellers' cartel versus a competitive fringe. Under these circumstances, the emphasis put on OPEC's market power is rather exaggerated.

Finally we ought to examine the oil extraction policies of non-OPEC producers. Since several non-OPEC producers are either countries with large populations facing borrowing constraints in the (imperfect) world financial markets or oil companies facing uncertain property rights, it is likely that non-OPEC oil extraction rates are higher than those which would prevail in the absence of these distortions.[12] Hence, even if OPEC's production is lower than that would prevail under a competitive market structure this might be desirable in the second-best real world environment in which decisions are being made.

The movements of oil prices can only be understood in the context of market distortions, structural changes and political events. There is no single explanation for these movements as the "dominant" distortion changed from time to time. Hence, models which attempt to simulate (or even predict) oil prices on the basis of a single factor (e.g. market cartelization) are likely to miss a lot of other important explanatory variables.

To attempt to provide a formal model of the oil market incorporating all the relevant factors is a Herculean task. However, it is possible to provide qualitative explanations for the past movements of oil prices by identifying the most important distortions which influenced the oil market during the period under consideration. We have done this in considerable detail in the main text. Here, and for the sake of summarizing the arguments, we will attempt to classify these distortions and explain very briefly how they influenced the oil market.

(a) Imperfect Information. In the absence of perfect information, market participants form estimates about certain parameters of the economy which may turn out to be incorrect. We have argued that imperfect information about the size and extraction costs of the world's resource base and the way the oil industry formed estimates about these parameters during the period which followed the large Middle East oil discoveries are the main factors explaining the falling oil prices in the 1950s and 1960s. The revision of these estimates started in the late 1960s and early 1970s and can partly explain the reversal of oil

prices. The timing of the revising process can be explained by another distortion/structural change: this was uncertainty about (and, ultimately, the loss of) the oil companies' oil property rights in the Middle East which forced them to invest in re-evaluating the world's resource base. Also their relatively disappointing results forced them to revise their initial estimates of the world's resource base.

(b) **Uncertainty about property rights.** One of the effects of property rights uncertainty is to reduce investment, including investment in oil conservation. Towards the end of the 1960s oil companies started to feel uncertain about their property rights in the Middle East, following the demands for participation in the oil concessions by the host, oil-producing countries. As a result their investment in oil-producing capacity did not keep up with (rising) oil consumption. This can also explain the "tightness" of the spot oil market and the reversal of oil prices in the beginning of the 1970s.

(c) **Unexpected political events and their consequences on the oil market.** The timing of two oil price shocks can be explained by political events (the Arab-Israeli war in 1973-74, the Iranian revolution and the beginning of the Iran-Iraq war in 1980). Although the oil production cuts due to these two events were very small, the oil price increased dramatically due to expectations of further disruptions (which led to aggressive stockpiling policies) and the small short-term price elasticity of oil demand.

(d) **Transfer of property rights and capital market imperfections.** The transfer of oil property rights from producers using high

discount rates in evaluating future oil revenues (oil companies worrying about their property rights) to producers using low discount rates ("low absorptive" oil-exporting countries, facing restrictions in their foreign investment and being averse to foreign capital) can partly explain why the oil price did not fall after the first oil price shock. Of course, this is not the only explanation: oil consumption did not respond much to the first oil price increase.

(e) **The presence of market power.** While it is firmly believed that the reversal of the oil prices in the 1970s was the result of market cartelization by OPEC, we have argued that OPEC has attempted to act as a cartel only in the aftermath of the second oil price shock and in a "weak" market. Despite OPEC's efforts to cartelize the market by introducing production quotas, the real oil price continues to fall: this is mainly because some members of OPEC are not observing the cartel rules (cartel instability). Having presented and criticized the various arguments we will now attempt to retrieve those factors which explain the movements in oil prices since 1950.

4. CRUDE OIL PRICE MOVEMENTS : 1950-1984 AN ATTEMPT AT EXPLANATION

The movements in crude oil prices since 1950 can only be understood in the context of uncertainty, imperfect information and a number of other market failures. The falling real crude oil price from 1950 to 1970 mainly reflected a common contemporary perception that oil's scarcity value (rent) was falling. Following the establishment of the major international oil companies in the prolific Middle Eastern oilfields after the Second World War, the oil industry entered the era of increasing returns to oil exploration and discovery. In the absence of perfect information about the size and extraction costs of the world's ultimately recoverable oil reserves the oil industry was extrapolating its immediate post-war experience from oil exploration and discovery in the Middle East far into the future. In other words, the era of low and even declining average oil discovery costs, an index that can be used as a surrogate for oil scarcity, was expected to continue far into the future either as a result of substantial oil discoveries and/or continuous technical progress.

There are also some other explanations for the falling real oil price from 1950 to 1970 (e.g. entry of independent oil

companies) but, as we have argued in the text, these can only be considered as supplementary explanations to the one presented above.

The reversal of the real oil price trend in 1970 was the result of underlying competitive forces, revision of expectations concerning the world's resource base and structural changes. Towards the end of the 1960s, it became clear that the existing oil-producing capacity in the oil exporting areas (Middle East) could not sustain the underlying oil consumption growth. The main explanation of why investment in oil-producing capacity did not keep up with the growth in oil consumption can be found in the oil companies' (concessionaires) uncertainty about their property rights in the Middle East following the host countries' demands for participation in the late 1960s. In fact, the transfer of oil property rights from the oil companies to the host countries took place over a relatively long period of time and can explain, along with some other factors, why the oil price was more or less sustained at the level achieved during the first oil price shock in 1973-74.

The quadrupling of the oil price during the price shock of 1973-74 was an unanticipated event. It was a competitive response to a very small production cut which was not dictated by profit maximization (i.e. it was not a collusive act aiming at increasing OPEC's profits) but was the result of purely political events in the context of the Arab-Israeli war. The large price increase that occurred as a result of the small and short-lived oil production cut can be explained by the small short-term elasticity of oil demand and by expectations of further

disruptions which led to the rapid accumulation of oil inventories.

Apart from their impact on the current oil price, the 1973-74 events had other serious implications which can also explain why the price was sustained at the higher level. First, this period witnessed a substantial shift of oil property rights from producers using a high discount rate in evaluating their future oil revenues (oil companies worrying about their property rights) to producers using a low discount rate ("low absorptive", oil-producing countries). Secondly, and perhaps as a result of the loss of their upstream assets in the Middle East, the oil companies and the governments of oil consuming countries re-evaluated the size and recovery costs of the world resource base and the costs of (potential) substitute technologies, and produced substantially revised, much more pessimistic, estimates relative to those that they had used in the 1950s and 1960s.

Since there is almost no evidence that in the aftermath of the 1973-74 events OPEC acted as a collusive cartel to sustain the higher price of oil (in fact there was almost no consumption cut against which OPEC had to sustain the higher oil price) we are led to the conclusion that the higher oil price was sustained from 1973-74 to 1978, not as a result of cartelization as it is usually said, but because of the underlying (dynamic) competitive forces and structural changes described above.

The second oil price shock (1979-1981) followed a period of stable oil prices (in fact the real oil price fell slightly between the first and the second oil price shocks). As

in the first oil price shock, this was an unanticipated price increase which occurred as a competitive response to a small supply disruption caused by a political event (oil production cuts during the Iranian revolution) in a market characterised by a short-term demand elasticity and aggressive stockpiling led by expectations of further disruptions. These expectations were formed during the highly uncertain and extensive period which followed first the Iranian revolution and then the beginning of the Iran-Iraq war. This period also witnessed an important structural change which contributed to the uncertainty which prevailed at that time: the shift from long to short-term oil supply contracts.

In the period which followed the second oil price shock, world oil consumption fell substantially. In the face of falling oil consumption and increasing oil production from non-OPEC sources, OPEC attempted to act as a cartel adopting a system of production quotas in order to sustain the oil price. However, this arrangement has not prevented the oil price from falling either because some members of OPEC have not been observing the cartel rules and/or as a result of their overestimating the demand for OPEC oil.

NOTES

1. This was founded by the famous article of H. Hotelling (1931). After the first oil price shock in 1973-4, economists became strongly interested in this theory. See, among others, Solow (1974), Dasgupta and Heal (1979) and the list of references at the end of this paper.

2. Adelman (1972) for instance, who is probably the most important source of evidence for the pre-1973 period, has written (p.40): "But this (the problem of the optimum rate of production) is not an interesting or important problem nor is user cost a helpful concept because it assumes the unknown we should be solving: the future price, which itself depends on future incremental cost." Anyone who is aware of the recent developments of the theory of exhaustible resources would probably realize that the above statement is neither a proper criticism of the theory, nor a justification for neglecting it.

3. See, among others, Heal (1981).

4. See Odell and Rosing (1983), ch. 1.

5. This does not necessarily imply that the major oil companies' profits were also declining, as some authors have argued, since the system of "double tax" concessions allowed the oil companies to reduce their tax liabilities at home by the amount of their tax payments to the host oil-producing countries.

6. The theory predicts that if a previously competitive exhaustible resource market is cartelized there will be an upward jump in the price trajectory due to a reduction in current extraction rates. The price trajectory will generally vary according to the equilibrium concept used. For instance, the Nash-Cournot equilibrium price path will generally differ from the Stackelberg equilibrium price path. There are also cases where the Stackelberg equilibrium is not dynamically consistent (see Newbery (1981)).

7. According to Ibbotson and Sinquefield (1979) the long-run market rate of return is 5-6 per cent.

8. Table 4 also reveals that OPEC's share of world oil was declining during the period in question. This fact has been used in support of the "OPEC is a cartel" hypothesis, the argument being that the decline in share is a sign of a voluntary production cut. However, since OPEC is not a single producer and since there is no evidence of co-operation on output among its members (in 1973-1981), this argument is incorrect. In our view the decline in OPEC's share can be attributed partly to differences in discount rates between OPEC and non-OPEC producers and partly to some other factors.

9. In other words the production cuts would have happened irrespective of the market structure.

10. At the December 1984 meeting in Geneva, OPEC members considered a proposition to establish a policing committee to monitor the individual members' production levels.

11. Since the evidence supports the hypothesis of dominant producer after 1981 it is useful to have a discussion on the possible efficiency losses in the oil market due to such a behaviour. We will postpone this discussion until the end of the paper in order to discuss certain other issues related to it first.

12. The difference in interest rates between OPEC and non-OPEC producers can also explain the fall in OPEC's oil market share since 1973.

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