Macroeconomic Adjustments and Oil Revenue Fluctuations:
The Case of Iran 1960-1990

By

Sayyed Aziz Arman
(B.A., M.Sc.)

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Abstract

In an oil exporting developing country the issue of how to stabilise the domestic economy from oil market volatilities has been a big concern for both scholars and policy makers during the last two decades. Modelling the behaviour of key arguments involved in the transmission mechanism of oil revenues into the domestic economy is a necessary introduction to dealing with this problem.

On the specification point of view, previous empirical works in this area show little concern over a process that takes the variables back to their steady state positions. This leaves long run equilibrium values of the variables involved in this processes undefined.

This thesis attempts to provide a careful analysis with empirical evidence of the issue of the macroeconomic effects of oil revenue fluctuations on key economic variables such as domestic and foreign prices, money demand equation, exchange rates and non-oil gdp growth set in a *Dutch Disease* framework for the Iranian economy during 1960-1990 period. The analysis, using annual data, employs modern econometric techniques (such as cointegration and error correction) to examine dynamics (short run) and static (long run) components of:these variables in connection with oil revenue fluctuations. Two modified versions of the *Purchasing Power Parity* and *conventional money demand* relationships are used to model black market exchange rate and monetary aspects of oil revenue changes, respectively. To model domestic price movements, we experiment with 2 long run equilibrium positions, inverted money demand function and reversed PPP relationship.

PPP appears as a valid model of the long run black market exchange rate and domestic prices determination. We also find strong supportive evidence for conventional model of real money balances.

The main conclusions are: increases in oil revenue **(i)** depress black market exchange rate asymmetrically; **(ii)** suppress domestic inflation directly and then pull it up indirectly through higher foreign inflation and a more depressed exchange rate; **(iii)** have a contractionary effect on non-oil real gdp growth; and **(iv)** change real money balances with a small elasticity.

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1. Introduction

Many problems of oil-exporting developing countries (OEDCs) can be seen as issues relating to managing the economic rent stemming from oil production. Oil revenues aside, many of the oil exporters are still characterised by the major features of less developed countries (LDCs): insufficient infrastructure, limited endowments of skilled labour, inadequate developmental institutions, widespread illiteracy, and a large proportion of the population in economic sectors where productivity remains low. Oil revenues remove only one constraint to development, the financial one.

A massive petroleum boom represents opportunities[1] for accelerated development of the domestic economy on one hand, and serious problems of adjustment on the other hand.

Acquiring large amounts of foreign exchange revenues from oil exports is a considerable economic opportunity to remove financial obstructions. However, it also tends to reduce the urgency of motivating and expanding non-oil export industries - the industries that inevitably have to take the responsibility of providing the foreign exchange if oil revenue falls in the future - and so these industries often stagnate.

Keeping an 'artificially' overvalued exchange rate is usually used as an essential instrument to encourage the import of capital and intermediate goods 'and also to keep food prices down in the politically sensitive urban centres' (Pesaran, 1982 p. 510).

[1]The oil industry is important in development programmes of these countries largely because it provides a source of easily controlled and easily mobilised revenue for government and a supply of foreign exchange greatly in excess of what the indigenous industries could possibly earn, and not because it transmits its dynamism directly to the rest of the economy.

Sluggishness in the rate of expansion of the traditional and agriculture sectors and also in small -scale and self-employed activities are expected to be the likely disadvantages of such policy. The persistence of an overvalued exchange rate, which is more feasible in an oil-exporting country can also destroy any chances for non-oil economic sectors (including industrial sector itself) to gain access to international markets to export their products, a problem which is rarely felt in an oil-exporting country. This is one of the reasons why the effect of oil income in an oil-exporting country is treated as paradoxical in some parts of literature (Karshenas, 1990 and Karshenas and Pesaran 1995).

For a country with a volatile and out of control source of foreign revenues finding a stable economic situation in domestic and foreign markets deserves an overwhelming task. Identifying, specifying and evaluating the behaviour of the leading arguments involved in the main stream of the economic process is at least a worthy introduction to such a task.

The argument of how an OEDC can get rid of oil market shocks or eliminate the ensuing effects resulted from those shocks, is and has been frequently put forward by policy makers and scholars in such countries.[2]

In this study we intend to investigate some aspects of ***Iranian economy***, as one of the most important oil exporter developing country among 12 major OEDCs,[3] in connection with oil revenue fluctuations during 1960-1990 period.

The role played by boom sector in Iranian economy is both straightforward and complicated. It is straightforward in that any random investigation of the historical record readily shows that oil exports is the most dominant item in the country's export sector. Equally, revenues from oil dominate the government's fiscal resources. The modern history of development planning in Iran is largely an analysis of the utilisation of oil revenues and any credits that could be raised for the creation of new assets.

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[2] 'Independent - of - oil economy' is a repeated doctrine in these countries, especially when they face a considerable crash in the oil market.

[3]The 12 major oil exporting countries are Algeria, Indonesia, Iran, Iraq, Kuwait, Nigeria, Oman, Qatar, Saudi Arabia, Libya, the United Arab Emirates, and Venezuela. (IFS)

Drawing general conclusions about the sector's impact on the overall economy is much harder to judge, however. Many links that may exist between the boom sector and the rest of the economy are not generally as perceptible.

Quantification of the nature and degree of the petroleum sector's impact on the economy should provide some help toward an understanding of the mechanisms underlying developments which have occurred in Iranian economy during last decades.

The main questions addressed in this thesis are: (a) What have been the likely effects of the oil fluctuations on exchange market and how the short and long-term behaviours of exchange rates could be explained in the whole period under consideration and in pre and post-revolutionary periods separately? (b) Has oil laid a basis for self-sustaining growth at a higher rate than would otherwise have been possible? This appears to have been the main goal of all oil producer governments. Or, have the difficulties of economic management through fluctuating income severely reduced the benefits of oil windfalls, and resulted in increased oil dependence. Monetary and inflationary aspects of oil windfalls should also be discussed.

Our aim is not to provide a detailed and comprehensive picture, an objective which, in the light of deficiencies of the data available seems very hard to attain, but to focus upon those features which can help us to understand the main forces and players attributed to this process.

Such works have been discussed, mostly analytically, in the context of ***Dutch Disease*** (DD) theory.

The DD full employment model of adjustment predicts several consequences of an oil-led boost in the domestic economy. First, real exchange rates will appreciate. Secondly, this is associated, in the medium run at least, with a shift in production structure towards the non-traded sectors, and leading to greater dependence on oil for foreign exchange. Thirdly, increased domestic investment should raise growth.

Massive and excessive incomes from oil exports usually gives the false sign of a more favourable balance-of-payment position than would otherwise be possible, and an 'equilibrium' rate of exchange valued at a much higher level than would otherwise be the case. This unwarranted and spurious feeling of well-being discourages non-oil exports, encourages imports and foreign dependent domestic production, and stimulates capital exports, instead of promoting internal investment. As a consequence, the economy becomes more volatile in the short run as oil prices fluctuate beyond the country's control in the global market. In the longer run, as oil is gradually depleted, the country is unlikely to be able to finance its accustomed levels of consumption because of the paucity of income-generating investments and the dwindling supplies of foreign exchange.

In this context, the issue of how to deal with and manage the fluctuations of oil rent is an important point. More precisely, it can be said that DD sheds light on the difficulty the government has in managing short-term oil rents which arise from the export boom, without losing consistency with its long-term objective of promoting economic development through the expansion of non-oil tradable sector. Government policies in the face of the oil boom, therefore, are crucial.

A number of reasons may make an oil economy deviate from these stylised patterns. Price controls and import liberalisation can limit the appreciation of the real exchange rate by deflecting demand onto imports. Next, if traded sectors are able to respond strongly to investments financed by oil revenues, product market pulls towards the non-traded sectors may be counterbalanced, particularly if labour markets are slack so that expanding non-traded sectors do not draw labour from the traded sectors. Finally, the overall impact of higher public spending on growth may be low if the quality of investment projects declines with accelerating spending, or if subsidies and other expenditures drain resources from the public investment programme[4].

The level of ***exchange rate*** can affect the range of a country's export sector, expanding it when the exchange rate depreciates and contracting it when it appreciates. Concern with the structure of exports, especially with increasing the share and maintaining the competitiveness of non-oil exports, makes the exchange rate particularly important for the oil exporting country's development prospects. In this sense, the right equilibrium exchange rate is a necessary, though not a sufficient,

[4] The results of Gelb (1986)'s studies suggest that the impact of expanded investment on growth of non oil GDP has been unsatisfactory during the (oil boom of) 1972-81 compared with 1967-72. (see Gelb, 1986, p. 79)

condition for export diversification. We will discuss exchange rate behaviour in connection with oil revenues fluctuations in detail in this thesis.

Although changes in nominal exchange rate is the first step in this procedure, the final outcome is, however, conditioned by its final effects on real exchange rate. Any attempt to expand expenditure beyond the economy's short-run absorptive capacity (which is usually encouraged by the 'excess' available oil revenue) will simply give rise to relative and general ***price level*** effects that will reinforce appreciation. So dealing with the movement of domestic inflation rate is a necessary task in this discussion.

Purchasing Power Parity (PPP) or 'inflation theory of exchange rate' (Dornbusch, 1987) is usually used as a basic framework to evaluate exchange rate and price level movements. In fact, we should see the PPP theory as a model of exchange rates and/or prices.

In many oil exporting countries, the process of adjustment initiated by the rise in oil revenues has been accompanied by a deterioration in their non-oil current accounts, domestic inflation, a rise in the prices of non-traded goods relative to those of traded goods, and a tendency toward corresponding changes in the structure of ***domestic production***. These developments have been very important in bringing about balance of payments adjustment on current account. At the same time, however, they have also been regarded as interfering with the efforts of these countries to create a more diversified base of non-oil production.

Monetary aspects of the boom are parallel forces by which the boom revenue is accommodated into the domestic economy (Edwards, 1986), and which reinforce the real effects. If this revenue accrues to the government and is deposited in the central bank there will be no increase in the domestic money supply unless the government spends at home out of the increased revenues or domestic credit to the private sector is increased[5]. In the absence of any increase in public spending, the increase in net foreign assets of the central bank is exactly offset by the reduction in net domestic credit to the government (reduction in budget deficit or debt of government to the central bank). So

[5] In the case that this revenue accrued to the private sector and be deposited in the commercial banks, the domestic money supply will increase.

the money supply will increase as government domestic spending *monetises* the boom revenue. In fact, the extent of ***change in the domestic money supply*** depends on the extent of foreign exchange receipts from oil exports and the extent to which the monetary authorities sterilise these proceeds to neutralise their effect on the domestic money supply (Noorbakhsh, 1990). We will discuss the monetary effects of oil revenue in an appropriate framework of modelling money market.

Although theoretical models have been discussed to evaluate the macro-economic problems associated with a boom sector mostly in the context of DD literature, empirical examinations of such models are not frequently conducted. Yet, most of accomplished empirical works in this area have used an illustrative method (see for example Forsyth and Kay, 1981). The research that used a more comprehensive and efficient framework to discuss DD phenomenon preceded new econometric methods now available. On the specification point of view, a little concern has been maintained over a process which take the variables to their steady state positions. This leaves long-run equilibrium values of the variables (prices, exchange rates, money) undefined (see Edwards 1986 for instance). Inclusion of an *error feedback factor* would help to make the analyses more clear and improve the qualifications of the other estimates.

Karshenas (1990) argues that the main source of structural imbalances in the Iranian economy over recent decades was not the 'crowding out' of the traded goods sectors by non-traded sectors, as is expounded in the recent literature in 'booming sector economies'. The basic assumption of such theory is full employment equilibrium with given technology, the situation which is far from that of most OEDCs.

In the light of data deficiencies (quantity and quality) and the problem of rapid structural change common in most less-developed countries (see Morgan 1979) and compatible with Iranian case during recent decades, applicability of any econometric method and interpretation of its results should be taken with adequate caution.

Chapter 2 presents a brief review of the nature and complexities of the Iranian economy in which the study is being conducted. This chapter considers the general consequences of oil boom era, and discusses post revolution stagnation.

The development of the Iranian economy between 1959 and 1974 had been marked by the growth of oil production, and the decline of agriculture and the rural population and boom and bust in this sector afterwards. Post-revolution period (until 1990) is characterised mainly by oil revenue crash, war and economic stagnation.

Chapter 3 critically examines the literature relating to the Dutch Disease phenomenon, whereby a booming resource sector is presumed to lead to a contraction of the non-boom tradable sectors, via the loss of competitiveness, due to the appreciation of the domestic currency. The DD theory would be approached in the light of oil export boom and the consequential effects on other tradable sectors. The extension and applicability of the concepts of the core model of the DD phenomenon to an oil exporting developing country, then, will be discussed.

Because of the complexity of the process there is not a unique interpretation of this mechanism: several alternative models analytically or numerically have been discussed in the literature during the past few decades based on different scenarios: whether the resource of the boom is privately or publicly owned; how the authorities spend the revenues, gradually or immediately; the fiscal and monetary policies conducted after the boom, the structure of the economy under consideration and so on. For example, while in a core model of Dutch Disease, manufacturing sector is considered as the non-boom tradable (lagged) sector which would be squeezed after a boom (*de-industrialisation* phenomenon), in some cases it is the (export-oriented) agriculture sector which is buffeted by the boom repercussions (see Pinto, 1987, where the agriculture sector is taken as the main non oil tradable sector in Indonesia and Nigeria).

In ***chapter 4*** some of the most relevant concepts and ideas in econometric modelling and time series estimation by which our research will be conducted are reviewed.

There are models which make use of dynamic adjustments (short run movements) to steady targets (long run solution), in the form of error correction terms.

Throughout this thesis we have used modern econometric techniques to investigate static and dynamic components of the processes under consideration. These methods of modelling usually are more sensible from the economic point of view and less problematic from the econometric point of view. Since many economic time series appear to be non-stationary processes, this kind of modelling prevents some of the problems which potentially could appear when traditional method is applied. Johansen's method will be used to search for cointegrating vectors among variables under consideration. Where we find cointegration relationship(s), we try to test for any theoretically sensible restriction applicable on them. But because of data restriction, which lower the performance of Johansen's method, a *general non-linear model* are used to specify the final model.

Chapter 5 deals with exchange rates performance in the literature theoretically and empirically, and then applies an appropriate exchange rate model to our data. In *section one* of this chapter main aspects of the PPP theory and its later developments will be reviewed and discussed. *Section 2* reviews, selectively and briefly, the empirical works on PPP revealed in the literature.

Empirical work on PPP during recent decades shows that several methods have been used to test the validity of this theory. The econometric methods applied in these works have been chosen as a criteria to categorise this review[6].

Section 3 of ***chapter 5*** assesses the results obtained from applying different versions of PPP relation on our data, official and black market exchange rates. First part of this section considers the relevance of simple economic models to the determination of the official and black market Rial/Dollar exchange rate. This part also considers how the behaviour of these exchange rates differed before and after the revolution.

For many years a free market for foreign exchange has existed alongside the official market for foreign exchange in Iran. The official exchange rate has been fixed[7] and subject to infrequent changes of nominal value. Sometimes the free market has been almost dormant, at such times the premium that could be earned in the free market has been almost zero. But at other times, most notably since the revolution of 1979, the free market has been the dominant source of foreign exchange. The social and political

[6] Abuaf and Jourin (1990) believe that ' the negative results obtained in previous empirical research reflect the poor power of the test rather than evidence against PPP.' (p. 157)

[7] In February 1975, the pegging of the rial to the dollar was abrogated in order to reduce the rial's sensitivity to fluctuations in the value of the us. dollar *vis-à-vis* the other major currencies, and an SDR peg was adopted at a par value of 82.2 Rials for SDR. In addition, the commercial rate was allowed to float within a ± 2.25 percent band. The US dollar, nevertheless, remained as the currency of intervention by the central bank. Throughout this period the parallel market exchange rate floated closely above the official exchange rate.

unrest starting shortly before the revolution began a rapid depreciation of the black market exchange rate as the demand for foreign currency exceeded the official supply. In the post-revolution period, the premium on foreign currency sold in the black market over currency sold in official markets has been rapidly increasing, from near to zero shortly before the revolution to over 2000% by 1990. The purpose of this chapter is to see if Purchasing Power Parity has influenced either the black market or official exchange rates. We then proceed to examine the relationship between the exchange rate and oil revenue, and obtain an exchange rate equation that can be used to simulate the effect of oil on the economy. There is some evidence found in support of **PPP** as a relevant model of both, official and black market, exchange rates in pre-Revolutionary period. In the whole period an adjusted version of PPP is found a valid model.

The process by which a resource boom affects the economy are complex and messy, and depend upon such things as the ownership of the resource, how state revenues are used, and the structure of the economy in question. Given these considerations, it is not surprising that there is a broad range of models of 'Dutch Disease'. The purpose of ***chapter 6*** is to examine how oil booms and slumps have affected the Iranian economy, in particular *growth of the non-oil sector* and *inflation.* Estimation of the full system is infeasible given the shortage of data[8]. Rather, we proceed by estimating single equations. Even with the single equations it is not possible to apply Hendry's general-to-specific approach to modelling[9]. Reasonably we must try alternative specifications and settle on those which appear to best correspond to general economic theory whilst having acceptable statistical properties. We then test the best equations for shifts in the slope parameters since the revolution, and then test any cross equation restrictions before settling on our preferred specifications. Oil revenue restrains domestic inflation in early stages, in a longer horizon two other opposite forces, foreign inflation and exchange rate depreciation generated by oil boom dominate. Massive political and economic shocks that dominated on Iran in recent decades may have given rise to a

[8] A system of all equations except money equation is, however, estimated and the obtained results are reported in chapter 7. These results are then used to simulate key indigenous variables.

[9] However, where applicable this method was chosen as the strategy of the estimation.

drastic change on the pattern of our variables particularly real gdp. Perhaps this reason accompanied with inefficiency in our data should be blamed for preventing us to get a convincing result on non-oil gdp growth. A long lag contractionary effect of oil revenue changes on non-oil gdp growth should therefore be accepted with caution. There is strong evidence found in support of conventional model of real money balances with a small oil revenue elasticity.

In ***chapter*** *7* the complete model as a *system* was estimated using SUR (seemingly unrestricted regression) method to get more efficient results. These results, then, were chosen to undertake the simulation exercise. The simulation results plus plots for selected key variables are presented in the following subsections and in the appendix. The exercise considers several scenarios by various assumptions on oil revenue changes (and its related oil prices) *within* and *out of sample*. The examination of the model performance in tracking the historical data is then presented. We also proceeded to examine the response of our endogenous variables to different time paths for our exogenous variables, oil revenue and oil prices. Obtained results reflect mainly the same trends dedicated from our previous chapters that is indicative of a reasonable stability in our estimations.

Chapter 8 puts the main findings altogether, discusses them and concludes accordingly. Generally, the conclusions are: increases in oil revenue **(i)** depress black market exchange rate asymmetrically; **(ii)** suppress domestic inflation directly and then pull it up indirectly through higher foreign inflation and a more depressed exchange rate; **(iii)** have a contractionary effect on non-oil real gdp growth; and **(iv)** change real money balances with a small elasticity.

2

2. Iranian Economy (An Overview)

2.1 Introduction

The Iranian economy can be divided into three sectors: the Oil sector, and the modern and traditional sectors in industry, agriculture and services. The oil industry mainly produces crude oil for the world market and provides part of the capital and a majority of the foreign exchange for the modern sector, both private and public. The oil industry's linkages to other economic sectors are limited , due to its capital-intensive nature and the underdeveloped state of the modern sector in Iran's capital goods industries. The modern sector relies on the traditional sector for labour and part of its raw material and sells much of its output to the traditional sector and the rest to itself. Of course, the relative importance of the traditional sector has declined due to migration to towns and the expansion of the modern sector.

National income data starts statistically from 1959, when GDP stood at $3.69 bn, with agricultural making up 27 per cent of the total and oil a mere 11 per cent. After a period of economic stagnation in the early 1960s, a period of sustained economic expansion began during 1964 that lasted through to 1973. Indeed, the rate of growth accelerated steadily from an average 9.6 per cent in the 1962-68 plan period to 11.8 per cent in the 1968-73 period as oil became the leading sector. The negative aspects of the "boom" years hold clearly in growth between 1973 and 1978, which dropped to an annual average of 6.9 per cent. The decline came mainly from the poor performance of the oil industry. After a protracted period of economic stagnation, the rate of real GDP growth rose to an official estimated 10.1 per cent in 1990/1991.

Recent trends in capital formation show that, other than during the brief boom in 1983/84, there was a major decline on this account in most years since the mid-1970s (EIU 1992/93).

2.2 Pre Revolutionary Period (1960s & 1970s)

2.2.1 Economic Steps

In the inter world war period the main role of the government had been the mobilisation of the economic surplus within a principally agrarian economy through the control of trade. In the post-1953 period the state had direct control of a substantial share of the national income in the form of oil revenues, and so faced the duty of distribution and allocation of the already centralised economic surplus[1]. After the 1953 coup, the Iranian economy was subjected to a massive inflow of external finance. During the five year period of 1956-60 government oil revenues amounted to $ 1228 m, compared to $ 483 m during the entire thirty-six year period of 1913-49. Furthermore, there were also substantial inflows of foreign capital in the form of official aid and grants during this period. Between 1953-1960, the Iranian government received more than $ 890 m in the form of aid and grants from the US government alone. The most notable aspect of these new conditions was the considerable rise in oil revenues and easy access to foreign capital in the post-1953 period. With the rapid growth of oil revenues and increasing reliance on foreign borrowing (equivalent to mortgaging the future oil revenues), the state (through Plan Organisation) increasingly assumed a central role in Capital accumulation during this period. The market intervention of the state during the post-1953 period was largely indirect, mainly in the form of foreign trade and exchange regulations, credit rationing, indirect taxes and tariffs, with a view to the protection/subsidisation of particular sectors of the economy rather than revenue-raising motives. Between 1953 and 1955 the nominal exchange rate was revalued by about 15 percent (Table 2-1).

This was not due to the automatic response of the foreign exchange market, but it rather resulted from deliberate policy by the government which maintained strict exchange controls in this period.

[1]The 1950-53 period could be regarded as the period of oil and political crisis. In 1953 the last king of Iran (Mohammed Reza Shah) was restored via a coup d'état supported by US against the popular Prime Minister M. Mossadegh.

Inflationary pressures resulting from the investment boom[2], together with government's implementation of revaluation of the exchange rate did in fact result in a noticeable revaluation of the real exchange rate- as is signified by the opposite movements of the domestic prices and that of imported commodities (Table 2-1). As this table shows, while the wholesale price of imported goods declined by about 20 percent between 1953 and 1960, the general index rose by more than 15 percent over the same period[3].

Table 2-1 Exchange rates and price movements 1953-60

			WPI 1953=100	
Year	Nominal Exchange rate[a]	Real Exchange Rate (1)/(2)	Imported goods (1)	General Index (2)
1953	90.5	1.0	100.0	100.0
1954	84.5	0.96	106.1	110.7
1955	76.5	0.92	97.8	106.8
1956	76.5	0.79	91.0	115.1
1957	76.5	0.72	81.6	112.9
1958	76.5	0.72	80.0	111.6
1959	76.5	0.72	81.3	113.6
1960	76.5	0.71	82.8	115.9

Source: Karshenas, (1990, p. 118). .[a] Rial per US dollar.

The unparalleled growth of investment and incomes in this period, which resulted in a substantial divergence between the structure of demand and supply in the domestic economy, gave rise to the balance of payment crisis of the early 1960s. The economic recession of the early 1960s (up to mid 1963), following the 1955-59 boom, created strong internal and external political pressures for social reform and change of the economic strategy of the government.

[2] In the Dutch Disease literature this phenomenon is considered as the 'expending effect'. (see Corden, 1984, among others, for more details. Also see chapter 3)

[3] This real exchange rate appreciation damaged the non-oil exports during the following years.

The new period (1960-62) was in fact a period of political crisis for the regime leading to the breaking of its connections with the powerful traditional established classes. The period witnessed a rapid decline in the rate of investment particularly in the private sector, following the Stabilisation Programme of the government and the political uncertainties which characterised the period.

The third phase (1963-77) formed the longest period of sustained accumulation in recorded economic history of Iran, with a real annual rate of growth of 18.9 per cent for gross fixed investment. The share of gross fixed investment in non-oil GDP rose from 16.9 per cent in 1962-3 to 30.9 per cent in 1971-2, and reached the phenomenal rate of 50.7 per cent in the post-1973 oil boom years. After the 1973-oil boom an over-expansion of investment could be distinguished (with a domestic investment growth rate of 20 per cent between 1974 and 1975) and the over-heating problems which it gave rise to.

During 1963-77 period, the share of oil revenues in financing government expenditure was growing while that of tax revenue was weak. In fact one of the negative effects of unsustainable oil revenue is that it diverts the financing of public expenditure from sustainable tax revenue to exhaustible oil revenue. Karshenas (1990, 171-2) has shown that the (annual) elasticity of real public sector investment with respect to government oil revenues are 0.3 in the short term and 1.0 in the long-term, with variations in oil revenues explaining more than 98 per cent of variations in government investment.

The share of oil revenues in total government revenue increased from about 50 per cent during the 1963-67 (third plan) period to more than 75 per cent over the 1973-77 (fifth plan) period, while domestic taxes remained generally below 10 per cent of GNP (Table 2-2). As can be seen in table 2-3 despite a more than four-fold increase in real per-capita GNP, central government tax revenues remained relatively low in relation to national income. While non-oil and oil income show the same contribution to total public income during the 1963-67 period, the former declined to less than one-third as much as the oil income during the 1973-77 period (Table 2-2). This shows that the expenditure policy of the government had a much more important bearing on income distribution than its taxation policy.

A fifth plan was prepared for the period 1973-78. It was designed to reinforce all the major industrial projects and infrustructural investments begun during the previous plan. Total investment was set at $ 36.5 bn and there was fear that this would be too demanding for an undeveloped physical and commercial infrastructure. Planners were also concerned by doubts about growing inflation and a lack of innovative projects both for agriculture and for genuine small-scale entrepreneurship in industry. Planned investments were almost doubled to $ 70 bn but increased spending on defence, prestige construction projects and a range of additional schemes taken on at random made the plan itself almost irrelevant.

Table 2-2 Aggregated public sector accounts 1963-77 (Per cent of GNP)

	1963-67	1968-72	1973-77
Total income from which:	16.7	21.5	41.0
Oil income	8.5	11.8	31.0
Non-oil income	8.2	9.7	10.0
Public sector deficit (excluding oil income)	2.5 (10.6)	5.0 (16.8)	0.7 (32.3)

Source: Karshenas (1990), p. 189.

During the years 1973-78 there were constant shifts in government policy in reaction to gross overheating of the economy in the mid-1970s and to sharp falls in revenue later on. There was severe inflation, a massive stream of population to the towns, a marked down turn in agricultural development, competition for scarce resources and a predictable failure of the infrastructure to cope with the rate of expansion in what was essentially an import led boom (EIU 1992/93).

A higher rate of growth of the industrial sector on a sustained basis would not only lead to higher productivity growth in the sector itself but is also expected to create the conditions favourable for growth of the economy as a whole by absorbing the surplus labour and providing the goods necessary to raise productivity and incomes in the other sectors of the economy. What normally handicaps the generation of such dynamic processes in the underdeveloped economies is the limited market for the manufacturing sector and shortages of foreign exchange both of which are related to the inefficiency of the manufacturing sector and its inability to export in the early stages of the industrialisation. If a country could pass this stage of development process successfully and access the international market in order to supply part of its industrial production, then those two sensitive bottlenecks (domestic market limitation and exchange shortage) could be gradually overcome. Furthermore, by accessing the international markets the existing inefficiency in industrial sector (which is usual in the early stage of industrialisation process) would be progressively removed (through 'learning' by exporting).

Table 2-3 Real per -capita income and central government tax revenues 1963-77

	Per-capita income[1] (000 Rials)	Total Taxes[2]
1963	14.8	8.0
1964	15.2	7.1
1965	16.6	8.1
1966	17.6	8.5
1967	19.2	9.1
1968	21.0	9.3
1969	22.3	9.3
1970	24.4	10.0
1971	28.5	9.9
1972	30.6	9.7
1973	41.3	7.9
1974	53.8	6.0
1975	54.0	9.5
1976	58.7	9.6
1977	58.1	10.6

Source: Karshenas (1990), p. 190.

[1] At real 1959 prices.

[2] Per cent of GNP.

In an oil-exporting country such as Iran in this period for which almost all the foreign exchange needed for industrial sector has been easily provided by oil exports, the exports of industrial production do not to achieve a significant level and therefore the efficiency of this sector did not improve. Table 2-4 shows the role of oil and non-oil exports in financing import expenditures during the 1959-72 period.

Table 2-4 Foreign Exchange providers for imports.

		As percentages of imports		
Year	Value of imports[a] ($ m)	Non-oil exports[b]	Oil sector's net earnings	Total external resources[c]
1959	572.9	27.8	58.9	72.2
1960	597.3	28.3	60.1	71.7
1961	565.4	26.1	69.2	73.9
1962	527.3	25.1	80.3	74.9
1963	547.9	27.0	85.9	73.0
1964	758.9	19.2	73.2	80.8
1965	931.8	22.5	65.2	77.5
1966	1088.0	20.7	65.8	79.3
1967	1342.3	21.7	63.2	78.3
1968	1804.7	20.3	54.3	79.7
1969	2072.2	20.3	53.0	79.7
1970	2365.1	17.6	53.9	82.4
1971	3013.8	19.4	71.3	80.6
1972	3502.4	21.1	74.2	78.9

Source: Karshenas (1990), p. 212.

[a]-Imports of goods (c.i.f.) and services.

[b]-Exports of goods (f.o.b.) and services.

[c]-Equals oil sector exchange earnings plus the current account deficit.

The real annual average growth rates of imports and non-oil exports of Iran compared with some middle-income economies are shown in table 2-5.

As can be distinguished from this table the rank of the growth rate of Iran's commodity imports is sixth, while that of non oil exports is 22nd.

Table 2-5: Growth rates of real GDP, imports and non-oil exports (1960-1970)

	Real annual average rates		
	Iran	Upper quartile of middle-income economies[a]	No. of countries above Iran
GDP[b]	8.8	6.2	1
Commodity imports	11.4	9.0	5
Commodity exports (non oil)	7.1	9.2	21

Source: Karshenas (1990), p. 211.

a-58 countries according to the World Bank classifications, excluding the high-income oil-exporting countries.

b-Refers to non-oil GDP for the case of Iran.

Although the growth performance of the Iranian economy during the 1959-72 period was very impressive and forceful, amongst the highest in the world this growth performance was , however, heavily financed by *external resources* in the form of oil revenues and foreign borrowing. Oil revenue on average grew by the phenomenal rate of 17.9 per cent per annum in real terms (deflated by the import price index) during this period. In addition about 10 percent of gross investment during this period was on average financed by foreign borrowing. As Karshenas (1990) argues, the external resources (oil income and foreign borrowing) in fact have had a dual contribution in the domestic economy. On one hand they contributed to the process of growth by covering the gap in the non-oil current account of the balance of payments (see table 2-4, share of imports financed by external resources). On the other hand external resources contributed to the financing of domestic investment (Table 2-6).

Given this picture of the Iranian economy during this period, it is clear that the long-run viability of the growth path after the exhaustion of oil resources could not be guaranteed, since in the long-run the success of the import substitution strategy depends on the ability to export.

Table 2-6 Gross Investment: values and growth rates (1959-72)			
		Percentage of Gross investment	
Year	Gross investment (bn Rials)	non-oil savings[a]	Total external resources
1959	52.7	47.6	52.4
1960	57.8	42.9	57.1
1961	54.3	51.2	48.8
1962	47.4	61.2	38.8
1963	51.5	58.6	41.4
1964	63.2	38.8	61.7
1965	85.5	32.7	67.3
1966	90.0	36.8	63.2
1967	119.3	37.7	62.3
1968	136.5	31.7	68.3
1969	156.4	27.4	72.6
1970	167.3	29.0	71.0
1971	216.3	28.9	71.1
1972	287.4	30.8	69.2

Source: Karshenas (1990), p. 213.

[a]-non-oil savings are derived as the residuals of gross domestic savings and the net contribution of the oil sector (oil revenues of central government).

Despite considerable reductions in import ratios[4] in sub groups of production, there was an increase in the import ratio of the manufacturing sector as a whole, and in particular in capital goods sector. The process of import substitution, therefore, appears to have led to an increased import penetration as measured by the import ratio (31.7; 33.6; and 32.8 for 1963, 1967 and 1972 respectively).

Comparing the ratio of import to total supplies for different manufacturing branches in Iran with the international norms for a country with similar levels of income and

[4] Import ratio has been defined as $100*M_i/D_i$, where M_i= imports of commodity i, and D_i=home demand = $Q_i + M_i - X_i$. Q_i and X_i indicate to sector i's total domestic output and exports of i's product respectively (for details see Karshenas (1990 p. 222)

population, it is clear that in almost all intermediate and capital goods industries (old ISIC 25-28), import coefficients were by far higher than the international norms. (see Karshenas, 1990, p. 223)

Though the Iranian economy achieved high growth rates and rapid structural change, growth was financed by 'excessive' reliance on external resources[5]. In an import substitution strategy, therefore, the main problems from a medium term point of view could be the rapid rate of growth of imports; while the main problem in long run appears as the relatively slow rates of growth of manufacturing exports. Excessive import dependence, to the extent that it could be regarded as 'undesirable', arises because of the combination of high rates of protection of the domestic market and high subsidies given to the imported intermediate and capital goods.

The structural balance of payments problems which arise during the growth process are thus largely blamed on the price distortions which the import substitution strategy itself creates. Devaluation of the exchange rate and a free trade policy are advocated as the main instruments for restructuring the economy through a better use of pricing mechanism.

It should be noted that the accusation of overvaluation of the exchange rate (usually made about oil-exporting countries experiencing perverse growth) is basically correct. But this is a problem which can not be relieved by the devaluation of the exchange rate alone. Depending on the income generating policies of the government, a nominal devaluation of the exchange rate could even have the paradoxical results of leading to an even higher exchange rate in real terms[6].

The ease of access to external resources, i.e. oil income and foreign borrowing, allowed the rapid acceleration of the rate of growth of investment and government expenditure without the need to restrict the income and consumption of higher income groups.

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[5] 'excessive' in the sense that in the medium term the economy was prone to severe balance of payments crises and in long-run, given the continuation of the existing pattern of structural change, the economy could not sustain itself after the exhaustion of the oil reserves.

[6] That is, it is possible that any devaluation policy in these countries not only create a deep negative effects in short run (J curve effect), but also it is not expected any improvement will happen in the long run; unless some other complementary and contractionary fiscal and monetary policies are implemented simultaneously.

Generally, three five-year plans were implemented during 1963/64 to 1977/78. Development plans represent the longest period of sustained growth of per capita real income that the Iranian economy has experienced and is likely to experience for some time. During this period the per capita income rose from about $ 176 to $ 2160 at current prices and the country's GDP grew in real terms by an average annual rate of around 9.3 percent, ranking Iran as one of the fastest growing developing countries in the world. The real non-oil GDP grew by an average annual rate of 10.8 percent over the 1963/64-1977/78 period (Table 2-8), which was 1.5 percentage points higher than the annual rate of growth of GDP with oil, indicating a considerably broader base of development than is normally realised.

The share of agriculture sector in the total GDP, which in 1962/63 stood at about 28 percent, declined steadily over the whole period, and by 1977/78 it was no more than 9.3 percent of the country's domestic product at current prices (Table 2-13).

Such a sustained, though unbalanced, growth performance was achieved by following the import-substitution industrialisation strategy backed by rising oil revenues and a stable political environment[7].

2.2.2 Import Substitution Strategy

The industrialisation strategy of import substitution backed by the stream of oil revenues, that was implemented in Iran during 1960s and 1970s, had it's own social costs and unfavourable economic consequences. Some general reasons could be attributed for such outcomes. (see Pesaran, 1982)

- A high wall of protection policies (through high tariffs, tax relief policies and abundant investment incentive schemes), regarded as essential to a successful implementation of the import-substitution strategy, usually results in constituting some inefficient, although partially successful, industrial firms.

[7] Political stability during this period was brought about not through increased participation, reconciliation, and political tolerance but by the harassment, imprisonment, and torture of political opponents of the regime (Pesaran 1982, p. 505).

- Such firms, provided with an excessive protection from domestic and foreign competition, will spoil any possibilities of "forward" and "backward" linkages with the rest of the economy.

- Keeping an 'artificially' overvalued exchange rate is usually used as an essential instrument to encourage the import of capital and intermediate goods 'and also to keep food prices down in the politically sensitive urban centres' (Pesaran, 1982 p. 510). Sluggishness in the rate of expansion of the traditional and agriculture sectors and also in small -scale and self-employed activities are expected to be the likely disadvantages of such policy. The persistence of an overvalued exchange rate, which is more feasible in an oil-exporting country like Iran, can also destroy any chances for non-oil economic sectors (including industrial sector itself) to gain access to international markets to export their products, problem which is rarely felt in an oil-exporting country. This is one of the reasons why the effect of oil income in an oil-exporting country appears paradoxical.

The strategy typically involves the replacement of imported manufactured goods by domestically produced commodities and basically relies upon tariffs and import quotas and the granting of all kinds of tax and investment incentives to local industrialists and their foreign partners. This growth strategy was based on the false assumption that the benefits of high rates of growth would somehow automatically "trickle down" from the rich to the low income groups, and on the erroneous belief that the magnitude of GDP , particularly in a major oil-exporting country like Iran, can be regarded as a satisfactory yardstick of the economy's development and progress. But the benefits of rising real income were not enough to improve or even stop the unfavourable trend in the distribution of income and wealth among householders and geographical regions, or between rural and urban areas that existed in the early 1960s. Consequently, this growth strategy which was implemented basically on a stream of oil income, with little "backward" and "forward" linkages with the rest of the economy, finally badly affected the structure of the economy and widened the socio-economic gap between rural and urban societies. All these adverse trends took on new dimensions when oil prices more than quadrupled in 1973/74. In spite of this tremendous price increase, no attempt was made by the Iranian government to reduce the level of oil exports, and as a result revenues from oil exports rose from $ 4.9 billion in 1973/74 to $ 18.7 billion in 1974/75. On the basis of this unprecedented rise in oil revenues and the apparent overflow of foreign exchange reserves, government expenditure was more than doubled, all foreign exchange controls were lifted, and selective liberalisation of foreign trade was implemented. In spite of trade liberalisation policies, heavy government subsidies on essential foodstuffs, and the unpopular anti profiteering campaigns, the trend rate of increase of consumer prices not only did not fall but started rising even faster (Table 2-7). Such an inflationary movement, which is a disadvantage of oil boom[8], spoiled the *competitiveness* of Industries. Many industrialists who found themselves faced with a greater degree of foreign competition preferred to invest in safe financial assets abroad or become importers rather than undertake risky new domestic investments. Although the exact figures are open to debate, the capital outflow during 1978/79 are estimated about £ 4 to 6 billion (Pesaran, 1982, p. 509).

One of the features of import-substitution strategy is to keep the exchange rate overvalued in order to encourage the imports of capital and intermediate goods necessary for domestic (especially industrial) production. This policy was financed by the large oil revenues of this period. The consequences of such a policy are usually greater capital intensity of production techniques and a slowdown in the rate of expansion of the traditional and agriculture sectors (Table 2-9). The Rial was revalued against the dollar in February 1973. The overvaluation of the Rial also penalised small-scale producers and the self-employed at the expense of providing greater benefits to the large local enterprises and their foreign partners.

Whilst acquiring large amounts of foreign exchange revenues from oil exports is a considerable economic opportunity to remove financial obstructions, however, it tends to reduce the urgency of motivating and expanding non-oil export industries; the industries that inevitably have to take the responsibility of providing the foreign exchange when oil is depleted in the future and so these industries often stagnate.

[8] See chapter 3 for more details. Big jumps revealed in earnings of construction workers could be indicative of a strong effect of oil boom in non tradable sectors of the domestic economy (Table 2-7).

Table 2-7 Annual Rates of Price Increases in Iranian Economy (in percent)

Year	Retail prices	Wholesale prices	Earnings of construction workers
1962/63	0.9	1.4	-5.0
1963/64	1.0	0.4	-2.3
1964/65	4.5	5.4	7.4
1965/66	0.3	0.9	3.6
1966/67	0.8	-0.5	1.3
1967/68	0.8	0.2	5.8
1968/69	1.6	0.7	11.5
1969/70	3.5	4.0	14.1
1970/71	1.5	3.4	3.5
1971/72	5.5	7.1	2.8
1972/73	6.3	5.7	17.5
1973/74	11.2	13.1	21.6
1974/75	15.5	16.9	28.9
1975/76	9.9	5.3	47.12
1976/77	16.6	13.5	39.4
1977/78	25.1	14.6	34.4

Source: Pesaran (1982)

The structure of government's revenues which is enormously dependent on oil revenues shows another adverse effect of the oil windfall. The availability of non-tax government revenues weakens the government's desire to implement badly needed but unpopular reforms of the taxation system.

2.3 Post Revolutionary Period (1980s)

In the two decades prior to the revolution, a strict import substitution strategy accompanied by a highly protected domestic economy was the policy followed by Iranian government. Although producing rapid growth rates in this period, the paradoxical result of this strategy was to make the economy increasingly dependent on oil export revenues to finance the growing needs of the industrial sector for imported intermediate and capital goods (see previous section). From the mid-1970s, however, when reserves obtained from the 1973 oil boom were exhausted the growth rate decreased.

In this section the economic developments in the aftermath of the 1979 revolution are overviewed with special attention given to foreign trade and exchange rate movements in this period. The economic goals of the revolution include:

The redistribution of wealth and income; political and economic independence from the West and East; increased economic self-sufficiency; and policies favourable to the agricultural sector (which was thought consistent with the income redistribution aim)[9].

The relative oil recovery during 1981-1985 was reflected in an annual growth rate of about 8 percent in real GDP. Similarly, the significant weakness in the oil sector two years later was the main cause of the downturn in real GDP of about 10 percent. This arrangement was followed again in 1989, when the economy grew by 4.3 percent as production and exports of oil recovered. It is worth showing how much this growth was related to oil by showing growth rates in *non-oil* GDP. Non-oil GDP increased by 26.7% over 1981-85, decreased by -14.6% in 1985-88 and again increased by 23.2% in 1988-91[10]. In fact among the various sectors of the economy, the industrial sector performed least satisfactorily. As already mentioned in the previous section, although high growth rates were achieved by this sector during the two decades before the revolution, the overall degree of import dependency of the industrial sector increased; contrary to the principal aim of the import substitution strategy. The nationalisation of

[9]The 32.1 (1977/78) percent of population in activities related to the agriculture sector received only 8.5 percent of GDP, while the 33.4 percent in industrial sector, 0.6 percent in oil sector and 31.0 percent in services sector had 18.7, 32.5, and 40.3 percent of GDP respectively.(see Amuzegar, 1993, 339 for these details)

[10] Calculated based on Table 2-8.

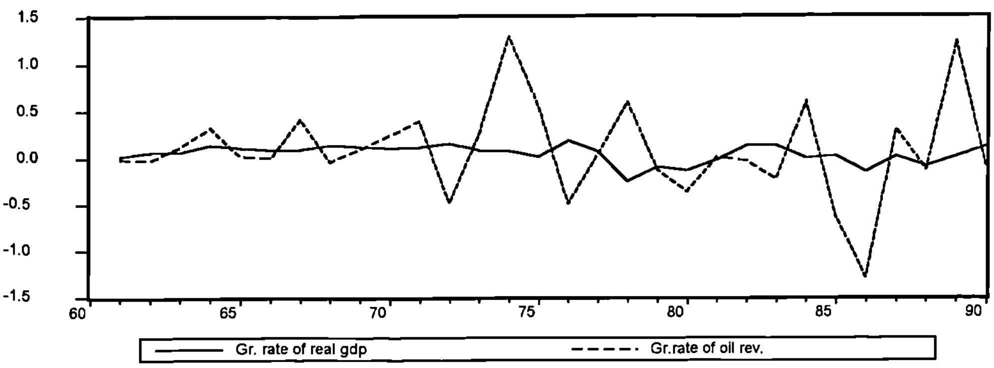
Table 2-8 Growth rates of oil revenue and real non-oil gdp (log difference)

obs	non-oil gdp[a]	oil revenue
1960	NA	NA
1961	0.026	-0.002
1962	0.068	-0.022
1963	0.064	0.123
1964	0.144	0.328
1965	0.116	0.026
1966	0.096	0.009
1967	0.105	0.420
1968	0.141	-0.035
1969	0.122	0.095
1970	0.100	0.239
1971	0.114	0.393
1972	0.155	-0.480
1973	0.081	0.258
1974	0.071	1.287
1975	0.014	0.548
1976	0.184	-0.489
1977	0.066	0.036
1978	-0.250	0.593
1979	-0.097	-0.122
1980	-0.143	-0.365
1981	-0.026	0.006
1982	0.127	-0.034
1983	0.132	-0.226
1984	-0.006	0.595
1985	0.018	-0.639
1986	-0.152	-1.290
1987	0.010	0.301
1988	-0.091	-0.132
1989	0.016	1.232
1990	0.116	-0.106

[a] Defined as real gdp - oil revenue. Real gdp obtained from Economic Report and Balance Sheet, Central Bank of Islamic Republic of Iran, several issues. Oil revenues obtained from IFS, several issues.

a big portion of the industries, the destructive effects of war, and the uncertainties caused by the political and economic sanctions are other factors in this story.

Figure 2-1 Growth rates of oil revenue and real non oil gdp



Overall, the Iranian economy showed an asymmetric growth trend in the 1980s. Since the mid-1970s, the oil sector (as the main provider of the foreign exchange necessary for production process) has played an expected and crucial role in the economic irregularity (See Ghasimi, 1992).

2.3.1.1 Immediate changes

During the post-revolutionary period some immediate changes in economic policies were introduced by the Provisional Government. The most important changes, in particular, were: the nationalisation of foreign trade (as part of a severe import-restriction); extension of full public ownership and control over the oil sector; a move toward the establishment of Islamic, interest-free banking system (see Amuzegar 1993 p. 45)[11]. In many cases the nationalisation of large scale modern industries (originally

[11]Principle 44 of Constitution of Islamic Republic of Iran (perhaps the most important economic principle) summarises the country's economic system as follows: " The Economic system of the Islamic Republic of Iran consists of three sectors: governmental, co-operative and private, with systematic and sound planning.
The governmental sector consists of all major industries, foreign trade, major moneys, banking, insurance, power production, dams and major watercarrying networks, radio and television, postal, telegraph and telephone system, air, sea, land and railroad transportation, and others similar to the above, which in the form of public ownership are at the disposal of the government.
The co-operative sector establishes and assigns the co-operative companies and organisations which have been created in the cities and villages in accordance with Islamic regulations.
The private sector consist of those portions of agriculture, animal husbandry, industry, trade, and services which supplement the activities of the governmental and co-operative sectors.

owned by major businessmen associated with the Pahlavi family) was imposed on the government as the owners and managers of factories had left the country and some enterprises were on the edge of breakdown. The Iranian economy in the aftermath of the 1979 revolution has been subjected to a number of adverse external and internal shocks. The revolution, the lengthy and costly war with Iraq, the freezing of Iranian assets, the economic isolation of the country, and the downward oil price shocks of the 1980s all have taken their toll on the economy (Karshenas, 1995).

The Islamic Republic of Iran imposed exchange controls to initially stop the post-revolutionary capital flight . However, exchange controls then became one of the main economic devices to allocate limited foreign exchange as foreign exchange became increasingly scarce.

The outbreak of the war with Iraq, which could be regarded as the beginning of a new period, provided a new framework through which the government could impose a collection of new restrictions and regulations. Quantitative constraints on foreign trade (particularly imports) to conserve foreign exchange (external balance); the rational distribution of basic necessities, foreign exchange allocation (to restrain capital flight), and wage-price controls (to retain internal balance). The constraints imposed by war, the freezing of assets, western economic sanctions, and oil market volatility, interrupted the development of a sustainable and coherent economic system[12].

The necessity of pursuing a year-to-year *managed* strategy -dependent on the oil fortune- resulted in a public mode of action and policy formulation based on what may be called ' expedient discrimination '. This strategy manifested itself in : establishing a dozen different exchange rates for different categories of imports; granting various types and amounts of subsidies to domestic social-economic procedures; setting up different foreign exchange quotas for various industries, activities and institutions;

Ownership in these three sectors shall be protected by the laws of the Islamic Republic as long as this ownership is in conformance with the other essentials of this chapter, does not depart from Islamic precepts, promotes economic growth and development for the country, and does not harm the society. The details regarding the standards, procedures, and conditions for all three of these sectors will be determined by law."(Middle East Journal, 34, 1980, 184-204)
Although the private sector has appeared weak and 'supplementary' in this principle, in principle 43, however, ' a strong warning is given against "turning the government into a major absolute employer" '(Pesaran, 1982).

[12] A five-year plan that was worked out in great detail in 1982-1983 but never got off the ground at that time.

designating different rates and volumes of foreign exchange surrender obligations for non-oil exports; offering different price subsidies to essential consumer goods; allowing different permissions to certain privileged business operators; and guaranteeing arbitrary protection of property rights belonging to different groups and individuals.

The most outstanding feature of this period was the regime's extraordinary flexibility in seeking, sorting , interpreting and justifying pragmatic, ad hoc solutions.

The third period, which began after the cease-fire in 1988, continued, more or less, till now. During this period the dominant economic policies are mainly: emphasising domestic private enterprise; price de-control; trade liberalisation; business deregulation; export promotion; attraction of foreign private investment, and repatriation of Iranian Capital, management and entrepreneurship, speedy exchange rate adjustment; and wholesale privatisation of non-defence industries.

2.3.2 Economic Steps

The first period of decline actually began in 1978/79 with nation wide strikes, street demonstrations, physical damage to property, and other revolutionary events that cut down productive economic activity. The negative trend continued in the first year of the revolution, and was accelerated in the second year due to a significant fall in oil revenue, flight of capital and skilled labour, the war with Iraq and a sharp overall drop in investment. Economic activity in the second half of 1978/79 showed a sudden decline, followed by an equally drastic fall in oil exports, industrial activity, construction, and government revenues. Only the agricultural sector showed notable growth. Real GDP at factor cost experienced a decline of 10.9 percent during 1978/79, followed by another 5.2 percent fall in 1979/80. Again, agriculture was the only area to show growth, along with the services sector. The *oil sector*, on the other hand, experienced a 19.4 percent decline (on top of a 28.7 percent fall in the previous year), and industry showed a 15.7 percent drop. The fall in industrial output (combined with the smaller than expected rise in farm output and reduced imports due to trade sanctions) caused both unemployment and inflation to rise. Industries dependence on imports of raw materials and spare parts at a time of foreign exchange shortage caused industrial output to decline below the already depressed level of 1979/80.

In 1980/81 the oil sector showed a drastic 65.8 (Table 2-9) percent drop in value from the year before, causing real GDP to take another 14.9 percent decline. The Iraqi invasion of Iran in 1980/81 caused enormous damage to main parts of industry and resulted in a drastic drop in capacity utilisation. This event caused government revenues to decline and government expenditure to increase, and so the budget deficit increased. During the four-year recession 1978-81, the decline in real output amounted to about 33 percent, bringing the real 1981/82 GDP to the same levels as those of the early 1970s. As could be expected, the most negatively affected sector after oil was manufacturing, where among others, the shortage of foreign exchange, and severe difficulties in obtaining raw materials from either domestic or foreign suppliers played havoc with the normal production process. Almost 12 percent of the labour force were officially out of the work in 1981/82.

The deterioration in oil exports caused by the oil industry strike before the victory of revolution and the devastation of the war reduced the foreign exchange available in the market, whilst demand was increasing. From the mid-1980s this process led to a policy of import compression and strict foreign exchange controls and rationing which heightened inflationary pressures in the economy.

Table 2-9 The Sectoral Composition of GDP (1977-1991) (B. Rials; 1982 prices)						
	Agriculture	Oil[2]	Industry	Services	GDP[1]	Non-oil GDP[3]
1977	1640.4	4408.3	2330.0	4817.3	12851.3	8443.0 -
1978	1747.2	3144.0	2104.3	4841.1	11440.9	8296.9 (-1.7)%
1979	1851.2	2535.2	1773.7	4964.4	10841.3	8306.1 (0.11)
1980	1914.9	866.1	1874.4	4855.0	9228.4	8362.3 (.07)
1981	1952.7	882.6	1875.1	4507.2	9031.7	8149.1 (-2.5)
1982	2091.4	1947.7	1884.0	4543.4	10335.4	8387.7 (2.9)
1983	2193.0	2006.3	2254.6	5135.6	11517.6	9511.3 (13.4)
1984	2353.7	1625.6	2364.3	5260.5	11522.1	9896.5 (4.0)
1985	2537.6	1644.4	2232.2	5373.2	11723.6	10079.2 (1.9)
1986	2650.5	1403.0	2032.7	4654.7	10692.5	9289.5 (-7.8)
1987	2715.8	1598.7	2084.1	4340.5	10736.2	9137.5 (-1.6)
1988	2648.0	1745.0	1978.1	4030.2	10360.6	8606.6 (-5.8)
1989	2746.0	1889.5	2109.1	4100.9	10799.9	8910.4 (3.5)
1990	2967.5	2264.7	2391.8	4499.6	12045.2	9780.5 (9.8)
1991	3118.8	2488.8	2834.3	4738.9	13090.6	10601.8 (8.4)

[1] Factor cost, adjusted for Imputed service charges. [2] Includes oil extraction and refining. [3] =GDP -Oil sector; Average growth rate 1979-1991=%2.02.

Source: Bank Markazi: Iran's National Accounts 1974/75-1987/88; Iran's National Accounts 1988/89-1990/91; and annual Review 1991/92.

With the partial restoration of political stability and a gradual return of public certainty, real output resumed its pre-revolution growth trend in 1982/83. The ensuing four-year recovery period was largely underwritten by the resumption of oil exports, and particularly by the relatively firm prices of crude oil. Rising oil revenues enabled the government to finance larger imports of industrial inputs and other raw materials needed for industrial growth. For the four-year period, the average annual real GDP and non-oil GDP growth rates were as considerable as 6.8% and 5.6% respectively.

The favourable growth cycle was reversed in 1986/87 through to 1988/89, as a result of a drastic fall in the price of oil, and the loss of oil exports caused by attacks on oil facilities and oil tankers in the Persian Gulf. High war expenditures, the fall in oil income, and exhausted foreign exchange resources, brought almost all foreign-exchange dependent domestic economic activities to a pause. Real GDP dropped by 8.8 percent in 1986/87 when capacity utilisation in industry fell as low as 30 percent in certain activities, and other sectors also experienced large declines. A drop in farm output in 1988/89, combined with the sluggish recession in the industry and services sectors contributed to form another negative growth rate of 3.6 percent in that year.

With the launching of a new five-year plan in 1989/90, and a distinct shift in the government's priorities and policies, substantial resources released from war efforts, and a noteworthy improvement in oil production and exports helped the 1989/90 GDP realise a 4.2 percent rise in real terms. The growth picked up speed in 1990/91 when the oil and industry sectors took the lead and pushed GDP up by 11.5 percent (Table 2-9). The positive growth rates continued through the Plan-years (although with a diminishing trend).

Overall, despite the presence of some destructive events such as war, political shocks and frequent oil shocks, by the end of 1991/92, real GDP had reached a level around 2 percent above that of 1977/78. But, because of a high population growth, per capita real GDP was only about 62 percent of the level achieved before the revolution (Table 2-10) (see Amuzegar, 1993 , table 4.2 and 4.3 for more details).

Broadly speaking, the developments in the Iranian economy over the period after revolution have been shaped by the policy response of the government, within the constraints set by the pre-existing structures of the Iranian economy and the newly emerging post-revolutionary institutions.

Table 2-10 Trend of gross domestic product[a]

	1985/86	1986/87	1987/88	1988/89	1989/90
Total (IR bn)					
At current prices	16556	18126	21270	23588	28122
At constant (1985/86) prices	16556	15163	14994	14270	...
Real change (%)	4.2	-8.4	-1.1	-4.8	...
Per head (IR)[b]					
At current account	34621	36663	41641	44912	51886
At constant (1985/86) prices	34621	30669	29354	27171	...
Real change (%)	0.1	-11.4	-4.3	-7.4	...

[a] Years beginning March 21. [b] Calculated using IMF population estimates.

Source: EIU Country Profile 1992-93.

2.3.3 Oil : A Free Gift?

The oil sector in an oil exporting developing country is usually regarded as an alien sector; that is alien in its ownership, control, management, production, pricing, marketing and downstream operations (Amuzegar, 1983)

The modern history of development planning in Iran is largely an analysis of the utilisation of oil revenues and any credits that could be raised for the creation of new assets. Success came late and was relatively brief, being restricted to the period 1964/65 to 1972/73.

The 1979 revolution brought about significant changes in the structure and policy direction of Iran's hydrocarbon sector, particularly the petroleum industry. In fact, no other sector of the Iranian economy was as thoroughly affected by the 1979 revolution, and subject to so many conflicting internal policies. Similarly, no other factor influenced the behaviour and performance of the domestic economy as much as petroleum output and exports. The industry had to also bear the burst of the war;

absorb the new policies imposed by the new regime and adjust to a global oil market that went from boom to bust , and bust to boom. Within a 14-year period after the revolution, crude oil prices tripled during the first year of the revolution, fell to one-fifth of the early peak in 1986, and shot up again to near the early 1980 level after the Persian Gulf war, before settling down to a mid-range between the two extremes.

The share of the oil sector in GDP declined sharply from more than 30 per cent in 1977/78 to about 8 per cent in 1991/92[13]. Responsible for this volatile swing were such diverse factors as the early decision by the Islamic Republic to 'save' oil by cutting down output[14], foreign economic sanctions, damage inflicted by war, wild fluctuations in world prices for crude oil, and poor maintenance of oil wells.

Revolutionary turmoil, strikes, and oil workers' demands reduced Iran's oil output from a peak of 6.1 mb/d in September 1978 to 1.4 mb/d in the first part of November, and by December. 1978 oil exports totally ceased , and were only partially resumed in March 1979. The war with Iraq after Sept. 1980, continuous wrangling within OPEC, and Iran's need for foreign exchange, subsequently determined the oil industry's level of output and export.

The strikes by oil workers during the last months of the Shah's regime with their crippling effect upon industries and urban life brought the country's oil production to a complete termination and as a result the average daily crude output in 1978/79 declined by about 24 percent and amounted to 4.25 million b/d. The oil output recovered quite slowly after the revolution, but because of some economic and political problems started to decline again and fell from the average daily rate of 3.9 million b/d in the first quarter of 1978/79 to 2.4 million b/d in the last quarter of that year. The export of oil also fell very sharply during these years, but thanks to the doubling of Iran's crude oil (light 34^0 A.P.I.) prices from $ 16.57 per barrel in April 1979 to $ 32.50 per barrel in February 1980, Iran's revenues from oil and gas exports amounted to $ 19.4 billion in 1979/80 (7.2 percent above the figure for 1978/79).

[13] It should be remembered that the oil revenues have been converted into domestic currency at the (overvalued) official exchange rate. So, the decline of the share of oil revenues in GDP could to some extent be due to this fact.

[14] By mid-January 1979, daily output was cut to only 700,000 barrels or below domestic consumption-compared with 5.7 mb/d of production and 4.9 mb/d of exports as late as October 1978.(Amuzegar,1993)

The increase in oil revenues in 1979/80 coupled with lower imports of goods and services resulted in an impressive net current account surplus of $ 6.1 billion, which in turn meant an addition of $ 5.8 billion to the country's foreign exchange reserves (Pesaran, 1982). Furthermore, the share of oil and gas revenues in total foreign exchange receipts , which had stood at about 80 percent in 1977/78, increased even further to 86 percent in 1979/80.

The doubling of the oil price in 1979 and 1980 reduced the demand for OPEC oil from 30m b/d in 1979 to about 23m b/d in 1981. This affected Iran's oil exports more than other OPEC countries. Responsible for this were a complex of political factors and the higher-oil price policy of Iran as well (see Fesharaki, 1985).

Iran has found adjustment to a declining international market for oil since 1982 difficult. Deterioration in the income generated by the oil and gas industry was intensified by a cut in gas exports to the former USSR in the immediate aftermath of the revolution. With the exception of a brief period of recovery during 1982-1983, Iran's main economic prop -oil revenue- was gradually whittled away by events mainly outside its control. By the time of oil price crash of 1986 the country was already suffering acutely from economic contraction.

Although there was a recovery in the international oil price after 1989, the impact on Iranian revenues was minor because export volumes remained depressed and costs of crude exports remained abnormally high. These high costs are a legacy of the damage done in the revolution and Iran-Iraq war and the inadequate maintenance undertaken since 1979.

Table 2-11: Oil performance in economy

	Average annual growth rate			**Oil Portions**		
	1959-64	**1964-72**	**1959-72**	**1959**	**1964**	**1972**
Total Output	5.1	11.7	9.1	100	100	100
Oil Sector	12.2	10.9	11.4	10.4	12.2	27.4
Total Employment:	2.4	2.7	2.6	100	100	100
Employment in Oil sector	5.9	2.8	4.1	0.5	0.6	0.4

Source: Karshenas (1990), p. 210

2.3.3.1 Government revenue and oil income

The expenditure effect of oil revenues is the main impact of these revenues on domestic economy in oil exporting counties (see Corden, 1984). The organisations which are responsible for distributing oil revenues among various economic sections (investment, consumption, ...) are usually, directly or indirectly, under the state control[15]. Therefore, the role of government in these countries may be very different to what it would otherwise has been in the absence of oil. Any boom or bust in the oil sector could affect the state's fiscal and monetary policies, including tax and money supply arrangements. It is sometimes even believed that the big size of the government in these countries is, in fact, an essential requirement in order to smooth the oil-induced economic fluctuations and inflexibility in the supply side of their economy (Karshenas 1990).

Usually referred to as the 'Dutch Disease', massive and excessive incomes from oil exports have given the false sign of a more favourable balance-of-payment position than would otherwise have been possible, and an 'equilibrium' rate of exchange valued at a much higher level than would otherwise have been the case. This unwarranted and spurious feeling of well-being has discouraged non-oil exports, encouraged imports and foreign dependent domestic production, and stimulated capital exports, instead of promoting internal investment. As a consequence, the economy has become more volatile in the short run as oil prices have fluctuated beyond the country's control in the global market. In the longer run, as oil is gradually depleted, the country is unlikely to be able to finance its accustomed levels of consumption because of the paucity of income-generating investments and the dwindling supplies of foreign exchange.

Table 2-12 shows the performance of the government in Iranian economy during the pre revolutionary period. The government's total revenue is derived from three main sources: oil and gas revenues; non-oil revenues; and special revenues. Oil and gas

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[15] In most of oil exporting developing countries, like Iran, oil revenue accrues directly to the government. Whereas, in oil exporting developed countries like UK the government imposes a high tax rate on the oil companies which acquire oil revenues.

income accrued from the export of crude oil and natural gas. Non-oil revenues consist of tax receipts and non-tax earnings. It is clear that along with any increase in oil revenue (row 2), the rate of growth of the government revenue shows an increase (row 1). While the share of oil revenue in total government revenue stood at 58.4 percent for pre oil boom period (1971-1973), this portion reached its peak at 83.1 percent in 1974 and then again diminished to 75.5 percent in the post boom years. Annual government revenues gradually increased from 24.4 percent of GDP in 1971-73 to 38.8 percent of GDP in 1974 and then 43.1 percent of GDP in 1975-78.

Table 2-12 **Growth and Structure of Government Revenues**

	1971-73	1974	1975-78
Annual Rate of Growth of Total Government revenues (% p.a.)	33.5	171.4	19.1
Annual Rate of Growth of Oil revenue (% p.a.)	41.8	258.1	35.2
Share of Major Revenue Components in Total Government Revenues:			
Non-Oil Tax Revenue	30.7	12.8	18.5
Oil revenue	58.4	83.1	75.5
Ratio of Total Government Revenues to GDP	24.4	38.8	43.1
Ratio of Non-Oil tax to Non-Oil GDP	9.9	9.2	12.8

Source: Amuzegar (1983, P.44-45)

The importance of oil revenues from oil and gas accounted for 72 percent of the government's total revenues in 1979/80 as compared with the figure of 74 percent in 1977/78 (see Pesaran 1982).

After revolution annual government revenues gradually declined from more than 34 percent of GDP (at market prices) in 1977/78 to about 10.5 percent of GDP in 1988/89, before turning up again to about 31 percent in 1992/1993. A sharp drop in oil and gas revenues, as the main part of government revenues were to blame. The fall in oil revenue was partly due to the limited volume of crude exports caused by the war-related damage to the oil facilities and the depressed prices of oil in some years. But the main reason for the declining oil-GDP ratio was the government's deliberate policy of calculating the value of its petrodollars at an artificially overvalued official rate of IR 70=$ 1. (Amuzegar, 1983)

Since the government budget deficit is usually financed through borrowing from the country's banking system, in the case of a decline in oil revenue this borrowing must increase[16]. In other words, any increase in trade deficit must usually be compensated for by a budget deficit to provide the necessary funds for investment or other part of public expenditure.

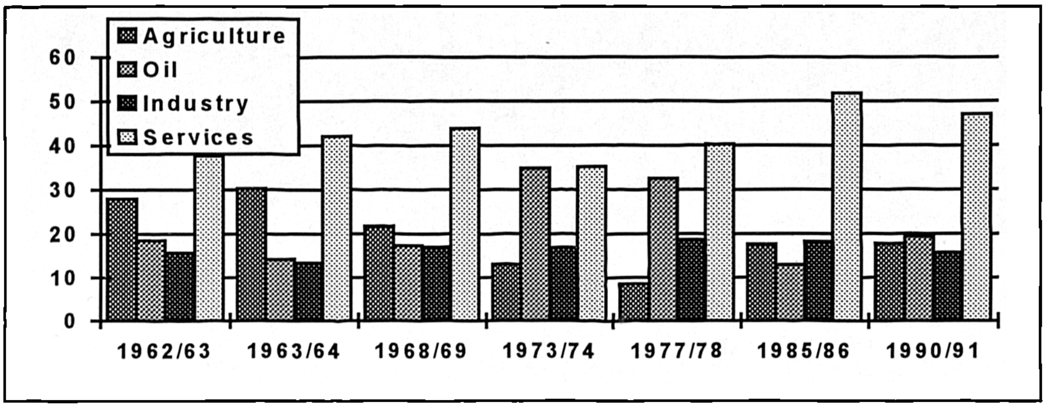
Table 2-13 GDP by Sectoral Origin (Percentage share in total)[a]

	1962/63[d]	1963/64	1968/69	1973/74	1977/78	1985/86	1990/91
Agriculture	27.9	30.3	21.8	13.1	8.5	17.6	17.8
Oil	18.6	14.3	17.3	34.9	32.5	12.9	19.4
Industry	15.8	13.4	17.1	16.9	18.7	18.2[b]	15.8[b]
Services	37.7	42.0	43.8	35.1	40.3	51.8[c]	47.0
GDP	100	100	100	100	100	100	100

a. Sources: 1963/64-1977/78 from Amuzegar (1993, pp.339) and thereafter from EIU Country Profile 1992/93 (pp. 20) (Years beginning March 21)
b. including mines.
c. Including -0.5% imputed bank service change.
[d] Data in this column have been taken from Pesaran (1982, p.506).

[16]Dailami (1979) examined the extent of contribution of foreign reserves to the supply of the monetary base in Iran. He concluded that this contribution fluctuated from value of -9 percent in the 1970 to a maximum value of 163 percent in 1974, while it exhibited a rather stable pattern contributing on the average 48 percent (p. 17).

Figure 2-2 Percentage share in total GDP



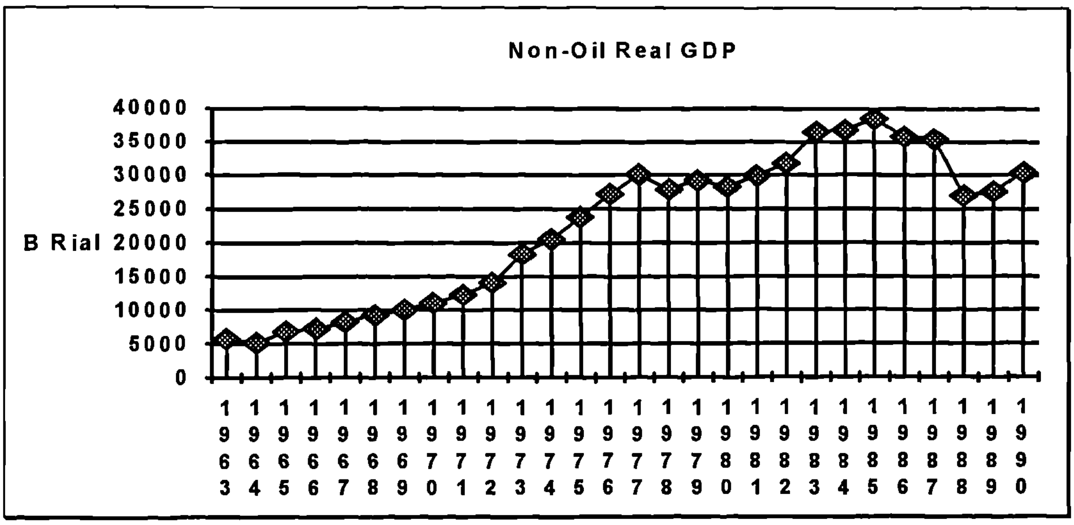
2.3.4 Non-oil GDP and the growth of economic sectors

To show a more clear picture of the economy it is more convenient to investigate the growth trend of the economic sectors separately in pre and post boom years (Table 2-13 and

Figure 2-2). The agricultural sector shows a rapid decline from 27.9 percent of GDP in 1962/63 to 8.5 percent of GDP in 1977/78. In this period "while services, construction and manufacturing enjoyed a high and increasing share of the allocation of resources, agriculture was disproportionately downgraded and starved of funds. These 'backwash effects'-of oil and the state- for agriculture became circular and cumulative, while the potential 'spread effects'-through market expansion, etc.- did not materialise because the gates were open to agricultural imports and urban food subsidies. " (Katouzian, 1978, p. 355 and 367). Contrary to the agricultural sector, the services sector has been the most fortunate inheritor of oil resources in the whole period under investigation. The share of this sector which shows 37.7 percent of GDP in 1962/63 took its peak of 47 percent of GDP in 1990/91.

Figure 2-3 shows the non-oil real GDP from 1963 to 1990 in billions of Rial. As can be seen there was an increasing trend up to 1977. From 1977 when the oil revenue started to decline non-oil GDP became depressed. The next increase in non-oil GDP form the early 1980s is due partly to the relative establishment of revolutionary regime and partly due to the increase in oil revenue in these years. A considerable oil depression happened in 1985 and again affected the trend of non-oil GDP after that year.

Figure 2-3 Non-oil Real GDP[17] (B. Rials)



2.3.5 Inflation

During 1960s Iranian economy enjoyed a stable price level. The annual rates of increase in the average level of consumer prices ranged from 1 to 6 percent during 1968-72. All corresponding inflation rates after this period jumped to two digits values amounting to as much as 27 percent in 1977. As Looney (1982) argues, 'injection of oil revenues beyond a certain level, that is annual absorptive capacity, only led to higher inflationary pressures with little or no corresponding increase in output resulting from this expenditure.' (p. 141). International inflationary pressure which expanded after 1973/74 oil shock is also partly responsible for intensification of domestic inflation process since that year.

A comparison of the rate of increase in the money supply and that of the major inflation indexes indicates that in the post-1973 period the Iranian economy had

[17]Source: Economic Report and Balance Sheet; Bank Markazi Iran, several issues (CPI were used to convert the different-base raw data to 1990's base year)

advanced beyond its absorptive capacity, in the sense of finding the complementary factors of production (such as human skills and infrastructure) to be put to work alongside the rapid increase in financial resources. Apparently, injections of oil revenues beyond a certain level (annual level of capacity absorb) only led to higher inflationary pressures with little or no corresponding increase in output resulting from this expenditure.

During 1974 and 1975 almost all exporting developing countries implemented four major types of fiscal policies to avoid inflationary pressure in their countries: (1) direct subsidy payments on a wide range of goods and services. (2) indirect subsidy payments through the pricing policies of public enterprises like electricity and water and energy. (3) tax elimination or reduction on several categories of domestic goods and services; and (4) the abolition of user prices for public services of health, education, and other areas. (Morgan, 1979)

Table 2-14 Inflation Rates

	1960-67	**1968-73**	**1974-77**
Average annual rate of Inflation (%)	2.5	3.7	15.5

Source: Amuzagar (1993, p. 6)

After oil price increasing in 1973, Fifth Five Year Economic Plan was dramatically revised. Total investment was doubled and social welfare and subsidy programs were strongly supported through allocating of huge amounts to them. Government's expenditures grew 200% between 1973-1974. From total budget in 1974, 28% went to fixed capital formation, and 72% to current or semi-current expenditures. Such a great expansion in government expenditure made its necessary increase in money supply and hence caused a massive increase in effective demand. To reply to this excess demand, producers and traders tried to provide the needed production factors and material from domestic and foreign markets. Although the availability of foreign exchange made it possible to import part of needed goods and services, the existed bottlenecks and limitations in domestic facilities (like skilled workers and infrastructure capacity) and the rigidity of supply side of the domestic economy exerted a considerable inflationary pressure on non-tradable sectors. This inflationary pressure , then, spilled over into other economic sectors, plus imported inflation mentioned above built up a range of higher inflation rates during post-1973 oil shock.

The increase in the rate of inflation in the first half of the 1970s together with the government's seeming inability to stabilise the price level dramatised the need for a deeper understanding of the country's inflation process. Something of a debate concerning the precise cause of the rapidly accelerating price level transpired during this period. In particular the role of money and monetary policy in controlling increase in domestic price was a commonly debated topic in planning areas[18].

The officially announced price index increased by an average 19.2 percent annually from 1977 to 1982. In 1983, due to a short-run improvement in the economy's macroeconomics performance, the rate of inflation slowed down. Also in 1984, the rate of inflation was reduced to some extent, but this time it was due to an anti-inflationary credit policy of the government and the decline of aggregate demand. Since 1985, aggregate supply has also decreased, increasing rates of inflation and unemployment. By 1988 inflation rate reached a value higher than 20 percent and continued to rise until 1988 when the Iraq-Iran war seized. Since then inflation rate was decreasing and in 1990 reached 7.7 percent[19].

Despite the downward bias in official data, price developments over the years since the revolution can still show reasonably clear trends.

Figures supplied by Bank Markazi (central bank of Iran) for all post revolution years point to a persistently upward inflationary movement, albeit at different and irregular annual rates.

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[18] One generalisation of the inflation process in Iranian economy relies on monetary view of inflation. Defenders of this theory argues that given the proper monetary and fiscal policies, a steady rates of economic growth accompanied with price stability would appeared. Another analysis of sources of inflation treats the existed constraints in socio-economic structure of the country as the most important responsible factor for the inflation. Structuralists argue that even with a proper monetary and fiscal policies, given the existed institutional and socio-political bottlenecks in the economy, inflation would be an inevitable phenomenon, especially when a sudden and large demand capacity set upon domestic markets. (for more discussion on this topic see Karshenas, 1990; Noorbakhsh, 1990, Looney, 1982 and 1985).

[19] Construction programmes conducted since post-war years started a new stream of inflationary pressure in the Iranian economy and emerges some exceptional and historical values since then.

Budgetary deficit that increase demand for goods and services, combined with structural supply rigidities, leads to a chronic excess demand that merely knocked up prices, leads to higher inflation and restrains the expansion of output, during post-revolutionary period (1980-1990), this problem has been aggravated by the fall in output which has given rise to a rare stagflation.

During 1978 1979 the overall consumer price inflation was held down to less than 11% on average. In 1980, CPI shows 23.5% and growth in WPI (wholesale price index) rose from 19.85 in previous year to 30.5%. Outbreak of war with Iraq in September 1980, a devastating decline in oil production and revenues (which resulted in a significant reduction in imports of consumer goods and industrial inputs) accelerated inflationary pressure in this year. In 1981 by introducing some proper distribution policies such as war-induced rationing policy, the inflation rates decreased to 22.8% (CPI) and 19.4% (WPI). These indices again reduced in 1982 to 19.2% and 13.7% respectively. In 1983 because of some improvements in industrial sector on one hand and introducing a more stringent distribution policy on the other hand, inflation rates reduced to 15% (CPI) and 8% (WPI). A decline in current and public investment expenditures resulted in a reduction in budget deficit, accompanied with a reduction in private sector liquidity, resulted in a fall in aggregate demand. These developments together with simultaneous improvements in supply side (agriculture and industry) gave rise to further reduction in inflation and produced 10.4% (CPI) and 7.6% (WPI) in 1984 and 6.9% and 7.3% in 1985. A considerable reduction in public sector investment plus continued government subsidisation on basic necessities and a fall in circulation of money supply, were the major causes. In 1986 an unprecedented rise in the government budget deficit (due to a sharp decline in oil revenues) intensified the inflationary pressure. In this year CPI and WPI rose by 23.7% and 22.1% respectively. Inflationary spiral continued in subsequent year (1987) and reached the rates of 27.7% (CPI) and 29.7% (WPI). Another reduction in oil price in 1988 affected public revenues and raised budget deficit to 50% of total public expenditures and resulted in 28.9% and 22% inflation in CPI and WPI respectively. Cease-fire in August 1988 eased military expenditure and subsequently reduced the Rial cost of certain import items (because of an appreciation occurring in free market exchange rate). This situation continued, more or less, in two subsequent years, 1989 and 1990. In 1989

CPI rose by 17.4%, and by 18.4% while the corresponding rates in 1990 show 9% and 23.9% respectively. With acceleration of peacetime economic activities particularly growing demand for construction materials, basic commodities, industrial parts, and skilled labour in 1991, CPI inflated by an estimated of 19.6 percent and WPI by 28.1%.

The clearest linkage between the fall in exchange revenues and the rise in prices is apparent in the increase in liquidity resulting from budget insufficiency and the consequent extra money creation.

2.3.6 Exchange Rate Movements

The Rial is the basic unit of currency in Iran. With the exception of only a few years, Iran has had an official market for currency and a parallel market for foreign exchange. (Mazarei, 1995)

Performance of the Iranian Rial has been highly variable in last decades. It officially stood at IR 70=$ 1 during much of the 1970s but began a protracted and at the same times spectacular collapse in 1981/82. An arbitrary revaluation steadied the official rate in 1984/85.

A dual exchange rate system based on the use of export certificates was in effect until a unified exchange rate system was put into place in March 1956. Up to May 1957, foreign reserves (including gold and IMF accounts) were converted at the old principal import rate which was 32.5 Rls per US dollar. In May 1957 foreign reserves were converted at the new unified rate of 75.5. It should be noted that this unification of the exchange rate did not amount to a devaluation of the exchange rate as far as the private sector traders were concerned. The rate applicable to them before March 1957, including the export certificates rate, was 76.5. The main effect of this act was in the public sector by more than doubling the Rial value of government oil export revenues, and turning the hidden subsidies on the import of essential goods into open subsidies (see Karshenas, 1990, p. 98 foot. 16).

Prior to the oil boom of the early 1970s, Iran operated a fixed exchange rate system under which the Rial was pegged to the US dollar. Between January 1974 and

November 1978, Iran officially had a dual foreign exchange rate system comprising a fixed commercial and a 'free' commercial rate. However, the central bank intervened frequently in support of the Rial in the 'free market', and the country operated under a *virtually unified* exchange rate system. In February 1975, the pegging of the Rial to the dollar was abrogated in order to reduce the rial's sensitivity to fluctuations in the value of the US dollar *vis-à-vis* the other major currencies, and an SDR peg was adopted at a par value of 82.2 Rials for SDR. In addition, the commercial rate was allowed to float within a ± 2.25 percent band. The US dollar, nevertheless, remained as the currency of intervention by the central bank. Throughout this period the parallel market exchange rate floated closely above the official exchange rate.

Since the advent of the Iranian revolution in 1979, the Iranian Rial has depreciated against the US dollar by more than 30 times. In 1978 the nominal parallel exchange rate between the Rial and the dollar was about 77 Rials per dollar (in the same year the official exchange rate was almost 70.5 Rials per dollar).

With the expansion of domestic political tensions and of capital flight, the Central Bank of Iran *discontinued its support* of the Rial in the free market in November 1978. In May 1979, the commercial and the non commercial rates were replaced by two fixed exchange rates: an 'official' and a devalued 'unofficial' rates.

Furthermore, surrender requirements on foreign transactions were reinstated. In May 1980, the official rate was devalued from 82.2 Rials/SDR to 92.3 Rial/SDR and became characterised by a multiplicity of exchange rates. The exchange system was further modified during the 1980s in response to domestic and external shocks. In some years, Iran operated under a system of over ten exchange rates. However, the actual structure and coverage of these rates had not been officially sanctioned.

As a result, after the revolution, the previously relatively liberal exchange system[20] became restrictive, bilateral, complex and inefficient. Trade became vastly restricted and regulated, and the exchange system became multiple and controlled. Imports became a virtual state monopoly for most of the 1980s.

[20]In this period the availability of huge amounts of oil revenues, the regime's access to international financial market and the external and internal political silence had provided a necessary situation to keep relative stability in the foreign exchange market.

The twenty fold increase in premium during 1980s in the parallel exchange markets was indicative of the extensive subsidies which the government was providing to those institutions and individuals which benefited from the government's foreign exchange rationing system (Karshenas, 1995).

Iran's exchange and trade system was partly liberalised following the end of the war with Iraq in 1988. In January 1991, the foreign exchange regime was drastically simplified and the existing seven exchange rates were replaced by three rates. The three rates included: the official rate (92.3 Rials/SDR ≈ 70 Rials/US dollar), the 'competitive' rate (600 Rials/US $), and a floating exchange rate. To complete this step, the government reduced drastically the extent of exchange and trade restrictions. Numerous import items were moved from the official to the competitive rate and surrender requirements on *non-oil* exports were abolished. Furthermore, foreign exchange receipts from non-oil exports were made convertible under the floating rate. After much anticipation, the multiple exchange rate system was virtually unified in March 1993 (1540 Rials/US $). However, the unification was reversed in December 1993. (Mazarei, 1995)

The level of the exchange rate can affect the range of a country's export sector, expanding it when the exchange rate depreciates and contracting it when it appreciates. Concern with the structure of exports, especially with increasing the share and maintaining the competitiveness of non-oil exports, makes the exchange rate particularly important for the oil exporting country's development prospects. In this sense, the right equilibrium exchange rate is a necessary, though not a sufficient, condition for export diversification.

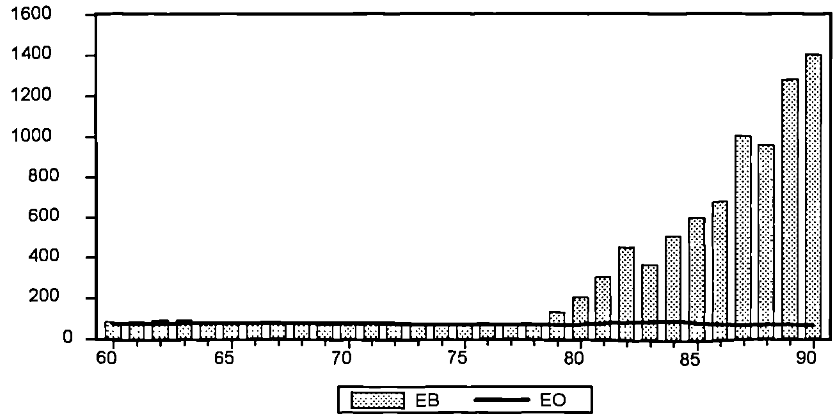
Although changes in nominal exchange rate is the first step toward the diversification objective in exports sector, the success of exchange rate policy, however, is conditioned by its final effects on real exchange rate. In oil-exporting developing countries, expressly, such a policy could be useful to improve the competitive position of their non-oil exports only if the depreciation is supported by other complementary and consistent monetary and fiscal policies. Any attempt to expand expenditure beyond

Table 2-15 Official and Black Market Exchange Rates

year	Official	Black Market
1960	75.75	80.142
1961	75.75	86.604
1962	75.75	91.666
1963	75.75	91.542
1964	75.75	82.166
1965	75.75	80.792
1966	75.75	78.863
1967	75.25	76.454
1968	75.9	76.412
1969	76.38	77.771
1970	76.38	79.213
1971	76.38	79.179
1972	76.38	77.333
1973	67.63	71.3
1974	67.63	68.354
1975	69.28	67.758
1976	70.63	72.104
1977	70.48	74.588
1978	70.48	76.925
1979	70.48	127.875
1980	72.32	200.75
1981	79.49	302.917
1982	83.43	452.083
1983	88.16	366.083
1984	93.99	509.125
1985	84.23	598.288
1986	75.64	678.166
1987	65.62	1000.4
1988	68.59	957
1989	70.24	1275
1990	65.31	1400

Source: IFS, various issues for official rates; World Currency Yearbook various issues for black rates.

Figure 2-4 Official and Black Market Exchange Rates (1960-90)



the economy's short-run absorptive capacity (which is usually encouraged by the 'excess' available oil revenue) will simply give rise to relative and general price level effects that will blur the relative price and expenditure-reducing effects of the depreciation. Behdad (1988) asserts that the devaluation policy 'is not an effective instrument in the case of an oil-exporting country with a heavily import-dependent industrial sector' (p.16). An effective devaluation is expected to lead to an improvement in the balance of payments through reducing imports and encouraging exports. In oil exporting developing countries imports react to devaluation very sluggishly. On the other hand, more than 90% of their exports (oil) is determined exogeneously, that is, independent of exchange rate devaluation.

In many oil exporting countries, the process of adjustment initiated by the rise in oil revenues has been accompanied by a *deterioration in their non-oil current accounts, domestic inflation, a rise in the prices of non-oil traded goods relative to those of traded goods, and a tendency toward corresponding changes in the structure of domestic production.* These developments have been very important in bringing about balance of payments adjustment on current account. At the same time, however, they have also been regarded as interfering with the efforts of these countries to create a more diversified base of non-oil production.

The question of what is the correct exchange rate policy for the oil exporting countries to follow under these circumstances does not have a simple answer. Normally, a country with a persistent balance of payments surplus would be expected to consider an appreciation element in a mix of corrective policies. In some oil exporting countries, the structure of domestic production is determined largely by government decisions without regard to market incentives. In these instances, the effects of exchange rate changes likely to be much smaller than in most non-oil developing countries. (IMF (1980) Annual Report of the Executive Board, p.51-52)

Nevertheless, in a number of oil exporting countries the market plays a significant role; and in these countries another objection is raised against a policy that results in an appreciation of the national currency, namely, that it discourages diversification of the non-oil traded goods sector. The desirability of encouraging the growth of this sector, and the correct timing of such encouragement, varies considerably among economies, depending on the projected time span and size of oil earnings, as well as on the immediate development needs of each country.

Where encouragement of the non-oil traded goods sector is desired, suitable incentives may include special government assistance to certain activities and changes in the structure of taxes and subsidies. The use of exchange rate policy to faster a more diversified non-oil sector, as has sometimes been suggested, would in general be a less effective way of encouraging this development than would policies aimed directly at reducing the growth of consumption expenditure or at augmenting the share of expenditure devoted to investment. This is especially so in countries that already have large balance of payments surplus, since in these circumstances exchange rate depreciation tends to result in increases in wages, prices, and money supplies that offset the initial effect of the depreciation on relative prices and domestic expenditure.

2.3.7 Foreign Trade

As I have noted before, owing to the large inflow of foreign exchange (and large balance of payment surpluses in some oil exporting developing countries), there has been a tendency for the domestic currency to appreciate (in nominal, or real senses), with a harmful impact on the competitiveness of domestic production and the objective of diversification.

Following the 1973-74 oil boom, a real appreciation was come about in some countries by nominal appreciation accompanied by domestic inflation. In other countries where the nominal exchange rate was fixed, the real appreciation was achieved through higher domestic inflation. The major effect of this appreciation was to reduce the attractiveness of non-oil tradable sector.

In the face of the distortions created by the shift in relative prices, and real appreciation, most oil exporting developing countries preferred fiscal and trade policies. The trade policies in most oil exporting countries vary significantly from one to another. However, the same objective has been followed by them. That is, all high-absorbing countries aimed at supplementing the domestic market with needed imports and protecting domestic import-substitution industries[21].

Iran is essentially an oil based economy, a peculiarity that shows up clearly in the country's trade figures (Table 2-16). Oil normally accounts for more than 90 percent of all exports. Other exports are mainly traditional items-fruits , carpets, leather and caviar. Cotton, which closely rivalled carpets as an export in the 1970s, has been badly damaged and exports since 1980 have been negligible. Carpet exports declined throughout the war years. In the same way manufactures, which were gradually gaining a foothold in foreign markets before the revolution, have fallen back markedly in recent years.

[21] Only Indonesia attempted to correct the situation with the exchange rate, devaluing the rupiah by 34 per cent in November 1978. However, after 1978, while the nominal effective exchange rate remained relatively stable, the real effective exchange rate appreciated by about 15 per cent.(see Amuzegar, 1983, p. 43)

Table 2-16 **The structure of foreign trade 1959-72**			
	Percentage shares		**Real annual growth rates**
	1959-61	**1970-2**	**1959-72**
Non-oil exports (f.o.b.)			
Primary products	75.8	60.5	6.1
Manufacturing products	24.2	39.5	15.9
Total	100	100	
Total value (m$)	96.3	328.2	9.1
Imports			
Consumer goods	28.0	12.5	1.4
Intermediate goods	49.9	63.6	11.7
Capital goods	22.1	23.9	11.4
Total	100	100	
Total value (m$)	493.7	2516.0	9.8

Source: Karshenas (1990).

Table 2-17 Main non-oil exports by type[a] ($mn)						
	1983	**1984**	**1985**	**1986**	**1987**	**1988**
Agricultural goods	**318.1**	**295.0**	**371.0**	**780.7**	**990.7**	**880.3**
of which:						
fruit	125.5	79.8	113.3	272.4	271.7	252.6
leather	34.6	48.7	60.5	60.6	103.0	78.2
caviar	19.0	21.9	19.8	15.7	33.9	43.5
carpets[b]	88.9	89.8	115.1	272.4	271.7	252.6
Metal ores	**12.5**	**38.8**	**30.0**	**24.9**	**38.3**	**32.8**
Industrial goods	**26.0**	**27.3**	**64.0**	**109.9**	**131.8**	**232.7**
of which:						
chemicals	0.1	1.4	4.5	11.0	17.4	32.6
textiles	10.0	14.3	8.8	15.4	9.9	6.9
construction materials	3.1	1.1	08	3.3	10.2	4.5
refined copper	-	-	29.0	80.8	41.8	143.5

[a] Years beginning March 21.
Source: EIU Country Profile 1992-93. [b] It is not obvious that why this item-which in fact belongs to the manufacturing products- has been accounted as a part of agricultural sector.

The revolution brought a major shift in the type of goods imported. A significant decline took place in capital goods imports, and there was also a sharp cut in consumer goods imports, especially in those categories assessed to be luxury goods. Food imports rose rapidly throughout the early 1980s despite the government's emphasis on agricultural development. The underlying trend in food imports is upwards despite reversals in years of good rainfall.

Table 2-18 Main imports by type[a] (£ mn cif)						
	1983	**1984**	**1985**	**1986**	**1987**	**1988**
Food & live animals	2368	2070	1538	1039	1466	1374
Beverages & tobacco	90	82	99	109	107	47
Chemicals & pharmaceuticals	2084	1768	1163	1369	1428	1304
Iron, steel & manufactures	5326	3561	3356	2258	1952	1623
Road vehicles & machinery	6317	5452	3896	3315	3066	2804
Total include others	**18103**	**14494**	**11989**	**9355**	**9369**	**8177**

[a] Years beginning march 21.
Source: EIU Country Profile 1992-93.

Under the Shah's regime West Germany, the USA and the UK were traditionally Iran's major suppliers. However, after the revolution trade ties with the USA were severed while the UK declined in importance. Germany and Japan are currently Iran's major suppliers of manufactures (Table 2-22). Japan is a significant market for oil. Barter agreements, mainly with the former Eastern bloc countries, increased in importance during the 1980s although political change and the current economic crisis in these states throws the future of this kind of trade into doubt.

Table 2-19 Main imports by Sectoral destination[a] ($ mn c.i.f.)			
	1986/87	**1987/88**	**1988/89**
Raw materials & intermediate goods	**5461**	**5498**	**4829**
Industrial & mines	4017	4161	3492
Construction	405	407	424
Agriculture & livestock	724	644	596
Capital goods	**2199**	**2209**	**1869**
Industries & mines	1190	1223	1128
Services	887	954	665
Agriculture	122	32	76
Consumer goods	**1695**	**1662**	**1479**
Total	**9355**	**9369**	**8177**

[a] Years beginning March 21.
Source: EIU Country Profile 1992-93.

Table 2-20 Imports and Exports (1977-90) (M. $US)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Imports:	**14626**	**10372**	**9695**	**10850**	**13515**	**11845**	**18103**	**14494**	**11408**	**9355**	**9396**	**8177**	**12807**	**18722**
Raw material and processed goods	7910	5350	5301	6207	8225	6861	10840	8310	7411	5461	5498	4829	7548	11854
Capital goods	4019	9208	1835	1738	2149	2308	4352	3867	2421	2199	2209	1869	2915	4363
Consumer goods	2697	2114	2559	2905	3141	2676	2911	2318	1576	1695	1662	1479	2344	2505
Exports[a]:	**625**	**543**	**812**	**645**	**339**	**283**	**357**	**361**	**465**	**915**	**1161**	**1036**	**1044**	**1373**
Raw material and processed goods	273	297	217	122	111	100	84	145	195	240	325	389	308	307
Capital goods	49	28	23	2	-	-	4	2	1	2	3	6	4	6
Consumer goods	303	218	572	521	228	183	269	213	269	673	833	641	733	1060
Memorandum items:														
	1977-1990		**1979-1990**											
Average Growth rate of Consumer Goods (%)	1.74		3.7											

[a] Excluding oil and gas.

Source: Amuzegar (1993), P. 365

Table 2-21 Balance of Payment (In M. of US dollar)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Export	**21429**	**18533**	**19829**	**12338**	**11831**	**20452**	**21507**	**17087**	**14175**	**7171**	**11916**	**10709**	**13081**	**19035**	**18415**
Oil and gas	20905	18116	19386	11693	11491	20168	21150	16726	13710	6255	10755	9673	12037	17993	15802
Non-oil exports	524	417	443	645	340	284	357	361	465	916	1161	1036	1044	1312	2613
Imports	**16553**	**13551**	**11545**	**10888**	**13138**	**12552**	**18027**	**14729**	**12005**	**10585**	**12005**	**10608**	**13448**	**18330**	**24975**
Trade Balance[1]	***4876***	***4982***	***8284***	***1450***	***-1307***	***7900***	***3480***	***2358***	***2169***	***-3414***	***-89***	***101***	***-367***	***975***	***-6560***
Services[2]	-3781	-5483	-2175	-3885	-2139	-2167	-3122	-2772	-2645	-1741	-2001	-1970	-2324	-3148	-3849
Current account	1095	-501	6109	-2435	-3446	5733	358	-414	-476	-5155	-2090	-1869	-191	327	-7909
Capital account	1505	316	-110	-8238	1441	-1847	-2474	-2818	544	3127	1711	441	3207	354	5530
Overall balance[3]	**2014**	**-579**	**5651**	**-9228**	**-260**	**4938**	**-1252**	**-4138**	**617**	**-1172**	**-186**	**-956**	**2334**	**-300**	**-2097**
Official Exchange Rate (Rials/$)	70.62	70.48	70.48	70.62	78.33	83.60	86.36	90.03	91.05	78.76	71.46	68.68	72.02	68.10	67.51

[1] Exports-Imports. [2] Receipts - payments. [3] Adjusted for Errors and omissions.

Source: Amuzegar (1993), p. 368.

Table 2-22: Main trading partners (% of total by dollar value)					
	1986	**1987**	**1988**	**1989**	**1990**
Exports to:					
Japan	15.8	12.9	12.8	13.7	20.8
Italy	9.7	8.6	6.1	6.2	9.5
France	4.0	5.2	1.4	8.0	8.2
Netherlands	4.8	7.9	11.5	7.9	6.1
Brazil	0.9	3.1	2.3	2.9	6.1
Belgium/Luxembourg	2.0	3.1	6.4	8.3	5.8
Imports from:					
Germany*	18.7	20.0	20.8	15.3	19.8
Japan	14.4	13.3	10.2	10.4	12.4
Italy	8.1	6.4	4.7	6.3	8.5
UK	7.3	6.4	5.6	4.8	5.3
France	1.2	2.3	2.5	4.1	4.6
Turkey	7.0	5.6	6.9	6.2	4.3

* Includes former East Germany from July 1990.
Source: EIU Country Profile 1992-93

Iran enjoyed a surplus on trade throughout the 1960s, 1970s and most of the early 1980s. But since 1984 the trade balance has shown wide fluctuations, mainly reflecting trends in the volume of oil exports and international oil prices (Tables 2-20 and 2-21).

Import spending has also fluctuated mainly in response to oil trends. The total was rapidly reduced from the heady $ 19.4 bn of 1978 down to $9.7 bn in 1979. A slow recovery then set in with 1982 and 1983 as the peak years, when oil revenues were relatively high and commercial confidence was returning. An import boom began in 1991 associated with the liberalisation of trade and an increase in oil and other revenues.

Table 2-23: Foreign trade ($ mn)

	1985	1986	1987	1988	1989	1990[a]
Exports f.o.b. of which:	13328	8322	11685	9084	13600[a]	18800
Petroleum (crude oil & products)	13115	7183	10515	8170	12500	17300
non-petroleum	213	1139	1170	914	1100[a]	1500
Imports (c.i.f.)	-11635	-10521	-9570	-11800[a]	-14500[a]	-18000
Balance	**1639**	**-2199**	**2115**	**-2716**	**-900**[a]	**800**

[a] OPEC estimates.
Source: EIU Country Profile 1992-93

Iran's current account has mainly followed oil income developments. With the collapse of oil prices in 1986, Iran's current deficit increased more than tenfold to $ 5.2 bn, reflecting the shift of the trade balance from healthy surplus to $ 3.4 bn deficit. The situation began to recover in 1987 with the deficits on trade and current account closing to $ 89 mn and $ 2.1 bn respectively. Subsequently, Iran's external position is believed to have surged during and immediately following the 1990 Persian Gulf crisis.

Iran enjoyed a considerable surplus in foreign exchange during the mid-1970s, entirely on account of oil revenues. The boom began to collapse in 1976 and the government was forced to raise import controls in 1978. After 1979 the revolutionary government imposed severe restrictions on luxury imports. Other adverse factors were also inherited by the new government: Iran had developed as a major long-term lender during the 1970s but had , later in the decade, become a short-term borrower, often at disadvantageous rates. Foreign debts were frowned upon by the revolutionary government and consistent and successful efforts were made to reduce foreign indebtedness. Moreover, repossessing the funds owed to Iran by foreign suppliers, commercial partners and debtors proved a long and difficult business.

2.4 Conclusion

As oil prices (and revenues) are extremely volatile, careful government planning is needed to insulate the economy in the short run from the resulting instability of foreign exchange revenues from oil-exports. The evidence regarding pre-Revolutionary Iran, however, suggests that, despite the existence of medium-term planning, short-term fluctuations in oil export revenues were very quickly translated into government investment, with rather short adjustment lags (Karshenas & Pesaran, 1995). The overall growth rate in real GDP increased from 9% in 1960-1972 to 13% in 1973-79, but the domestic inflation jumped from 2% to 13% during the same periods (see Aghevli and Sassanpour, 1982). Imports also show a rapid growth during this period. The public sector deficit (excluding oil income) changed from 10.6% of GNP in 1963-67 to 32.3% in 1973-77 (see Table 2-2).

The role of oil has remained critical in Iran's economic structure, peaking at some 50 per cent of GDP during the first oil shock of 1973/74. Oil and services combined contributed approximately 70-75 per cent of GDP in the second half of the 1970s.

The accrual of substantial revenues from the oil sector to the government in a country like Iran inevitably casts an important role on the state in the process of development. These same revenues also can lead to over-centralising tendencies in economic decision making, with the government monopolising the key allocation decisions.

By the end of 1970s the Iranian economy was as an 'excessively' import-dependent economy operating in an 'excessively' protected environment financed through oil revenues accruing to the state. Iran, therefore, at the end of the shah's reign, was more dependent on oil than it had been at the beginning.

The developments in the Iranian economy over the period since the revolution have been shaped by the policy response of the government, within the constraints set by the pre-existing structures of the Iranian economy and the newly emerging post-revolutionary institutions.

The main influences on the economy after revolution arose from political factors, principally the continuing adverse effects after the Iran-Iraq war and 1991 Persian Gulf war. During 1980-1988 the authorities had been preoccupied with the war effort, and allocations of available financial and real resources were influenced strongly by the claims of military. In most ways the country had a full scale war economy. Effects of the war have been made more damaging by the losses sustained during the revolution. The effects of the revolution and the impact of the war have been sufficient to prevent management of the economy on any systematic and medium-term basis. The effects of disinvestment brought on by eight years of economic dislocation were apparent in low and sluggish rates of growth, especially in industry and even the oil sector. The departure of trained Iranians and the problems of using emmigrant labour have combined to create an adverse impact through constraining the availability of skilled managerial and technical personnel. The basic endogenous sector, agriculture, has yet to recover from the damage done to it during the years when the oil economy was rapidly developing between 1970-80 and the uncertainties surrounding the revolutionary government's policies toward the sector after the 1980 land reform.

The black market which had been virtually dormant since the end of the balance of payments crisis of the 1960s, re-emerged on account of political developments in early 1978 and became one of the most important features of Iran's post-revolutionary economy.

3

3. Oil Revenue and Domestic Economy: Concepts and Evidence

3.1 Introductory Concepts

The impact of a considerable and exhaustible revenue earned from a single commodity export on the rest of the domestic economy is usually argued in the 'Dutch Disease' framework. This term, which appears in the economic literature over last two decades (see Corden, 1984), refers to the transmission mechanism and the ensuing effects of boom sector revenues in connection with other economic sectors including non-oil traded sector (Lagged sector) and non-traded sector.

The role played by boom sector in economy under consideration is both straightforward and complex. It is straightforward in that any random examination of the historical record easily shows that the exports of the boom commodity is the most dominant item in the country's export sector. Likewise, for the oil exporting developing countries, revenues from boom sector dominate the government's fiscal resources. Drawing general conclusions about the sector's impact on the overall economy is much harder to judge, however. Many links that may exist between boom sector and the rest of the economy are not generally as perceptible.

Because of the complexity of the process there is not a unique interpretation of this mechanism: several alternative models analytically or numerically have been discussed in the literature during the past few decades based on different scenarios: whether the resource of the boom is privately or publicly owned; how the authorities spend the revenues, gradually or immediately; the fiscal and monetary policies conducted after the boom, the structure of the economy under consideration[1]and so on. For example, while in a core model of Dutch Disease, manufacturing sector is considered as the non-boom tradables (lagged) sector which would be squeezed after a boom (*de-industrialisation* phenomenon), in some cases it is the (export-oriented) agriculture sector which is buffeted by the boom repercussions (see Pinto, 1987, where the agriculture sector is taken as the main non oil tradables sector in Indonesia and Nigeria).

Despite the diversities on this subject, a simple core model can be exposed as follows:

Two different effects are usually distinguished in the related literature:

1. *Resource Movement Effect*: According to the core model of Dutch Disease, because of profitability increasing in the boom sector following the boom, the mobile productive factor (for instance labour) is drawn away from the rest of the economy, namely the non-oil tradables and the non-tradables sectors, tending to reduce the output in these sectors. The marginal product of labour rises in the boom sector as a result of the boom, so that, at a constant wage in terms of tradable goods, the demand for labour in the boom sector rises, and this induces a movement of labour out of the non-boom traded and non-traded sectors. This is called *direct de-industrialisation* which comes from the *resource movement effect* of the boom.(see Corden 1984 and Neary, 1985 for more details).

2. *Spending Effect*: As the boom raises the economy's real income, so the demand for both (lagged) tradables and non-tradables would be raised[2]. Add to this the excess demand from the resource movement effect in these sectors. But only the price of non-tradables rises, given that the lagged sector price is fixed by the world trade[3], thus the *real exchange rate appreciates*. This is called the *spending effect* of the boom. Increasing the price of the non-tradable sector provides a more profitable situation for this sector and leads to an output recovery in this sector (the

[1] The adjustment problem could be very different if the case under consideration is a ' desert economy' like Abu Dhabi ; an economy with a medium-size industrial sector, like, Indonesia, Nigeria or Iran; or a developed economy with a strong industrial sector, like UK (see Hague's discussion in Neary, 1985).

[2] Assuming that all goods are normal.

[3] This later assumption could be questionable when we are considering an oil boom brought about by an oil price shock. There is considerable evidence (including our own in this paper) supporting a direct relation between oil price shock and world prices.

magnitude of this recovery, however, depends on the related elasticities operating on this process: the income-elasticity of demand for non-traded goods, output-elasticity of supply with respect to the real wage and so on). It will draw resources out of the boom and non-boom tradable (Lagged) sectors into the non-tradable sector; as well as shifting demand away from non-tradables towards the boom and lagged sectors[4].

From this general simple model of the Dutch Disease, there are some alternative channels through which a boom can be accommodated. First, if the boom sector does not show a strong participation in the domestic factor market, the *resource movement effect* would not be effective (see for example, Buiter and Purvis, 1983; Fardmanesh, 1991c van Wijnbergen, 1981 and Neary, 1985). The oil sector in the oil exporting developing countries, for instance, is considered as an 'enclave' (Pinto, 1987, for instance) with capital-intensive and hyper-technologic features (with minimum competition with the non-oil economy) and so this sector does not exert a considerable resource movement effect in such economies[5]. The key mechanism of resource reallocation is the real appreciation. Providing spending on non-tradables goes up initially, output of the non-traded sector must finally be higher than in the pre-boom situation.

Another point which should be put forward is that the term ' de-industrialisation' is not a precise concept and can not entirely cover all cases under consideration. As Corden (1984) points out the lagging sector can produce both non-boom (oil) exportables and importables, and it need not consist only of manufacturing industry. In some oil exporting developing countries one can in fact recognise 'de-agriculturalisation' rather than de-industrialisation (p., 363).

Furthermore, non-traded goods are not the only products that are physically impossible to trade; but there are also the products that are subject to binding quantitative restrictions, for which the prices are determined only in the domestic market, and should then be treated as non-tradable goods even though they are potentially tradable.

[4] Real appreciation could happen, either because of nominal appreciation, high domestic inflation, or both.

[5] See also McKinnon (1976) for supporting the 'enclave nature' of the oil sector in oil-exporting developing countries.

Fardmansh (1991) argues that some oil exporting developing countries observed a growth in non-oil traded (manufacturing) goods during the oil boom, the opposite of what simple Dutch Disease model predicts. Instead it was the agriculture sector which faced a considerable reduction in its share in GDP. He explains that although the *spending effect* could worsen the trade balance, a rise in the world price of manufactured goods relative to agricultural products (*the world price effect*) following the oil boom may dominate the negative effect mentioned above and lead to an expansion in manufactured output. The observed expansion of the non-oil traded sector in most oil-exporting developing countries has been explained by other authors in different ways. For example, Neary and van Wijnberg (1986) consider this sector in these countries as a protected sector and so put that sector under the non-traded category. Benjamin, *et. al.* (1989) attributed this unexpected phenomenon to the ' imperfect substitutability between domestic and foreign goods as well as to their linkages with the rest of the economy.' (p.90). Gelb (1986) in a comparative study of this issue, pointed out that Indonesia has been successful in using oil revenues to expand the non-oil tradable sector (industries and agriculture sectors). Usui (1996) confirms that the 1978 devaluation undertaken in Indonesia has been instrumental in this achievement.

Neary (1985) discusses a model of Dutch Disease where there may be both *de-industrialisation* and *real depreciation* (instead of real appreciation implied in the core model). But he stressed that nobody has yet presented a plausible model which simultaneously had an increase in manufacturing output and a depreciation in the real exchange rate following a boom.

Monetary aspects of the boom are parallel forces by which the boom revenue is accommodated into the domestic economy (Edwards, 1986b), and which reinforce the real effects. If this revenue accrues to the government and is deposited in the central bank there will be no increase in the domestic money supply unless the government spends at home out of the increased revenues or domestic credit to the private sector is increased[6]. In the absence of any increase in public spending, the increase in net foreign assets of the central bank is exactly offset by the reduction in net domestic credit to the

[6] In the case that this revenue accrued to the private sector and be deposited in the commercial banks, the domestic money supply will increase.

government (reduction in budget deficit or debt of government to the central bank). So the money supply will increase as government domestic spending *monetises* the boom revenue. In fact, the extent of change in the domestic money supply depends on the extent of foreign exchange receipts from oil exports and the extent to which the monetary authorities sterilise these proceeds to neutralise their effect on the domestic money supply (Noorbakhsh, 1990).

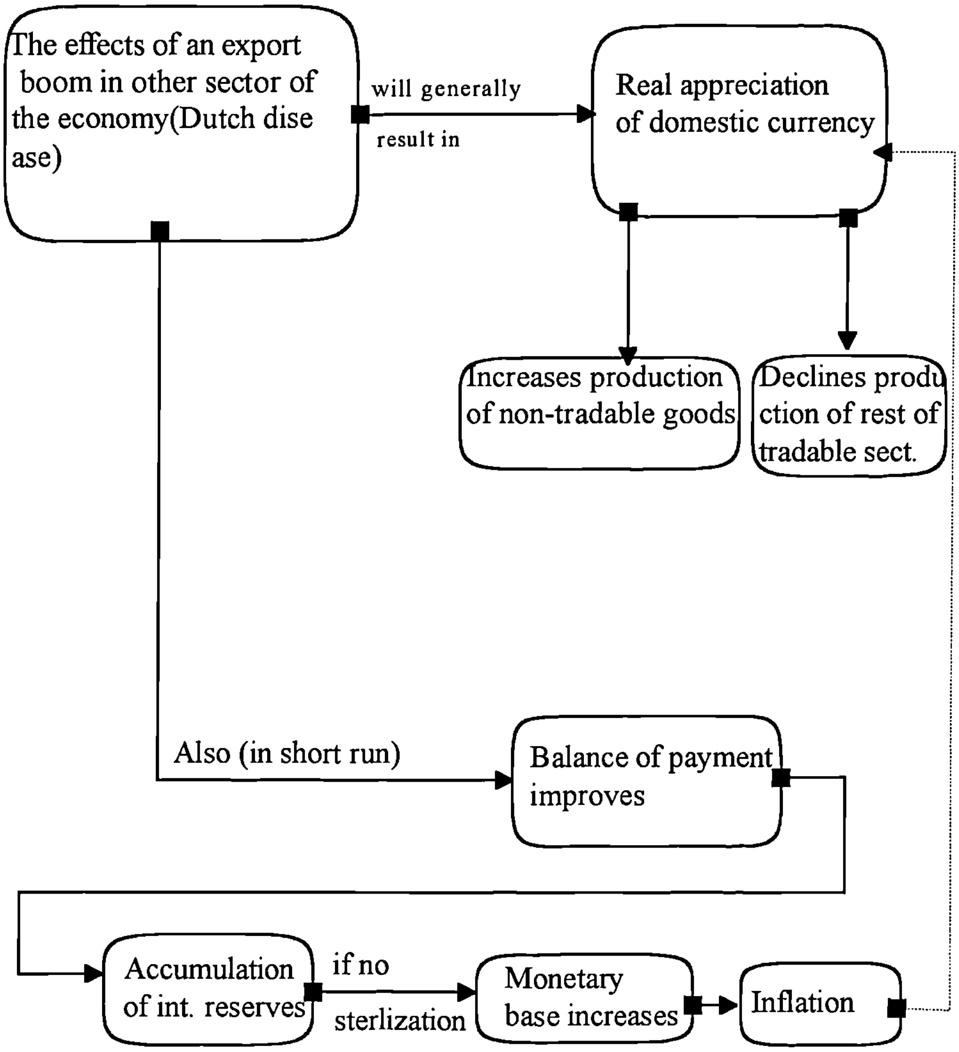
Change in Monetary Base = **Change in Domestic Credit** + **Change in Foreign Reserves**

Change in foreign receipts earned from oil exports (Foreign Reserves) would change the second term in the right hand side of the monetary base expression above. The net monetary effect of oil revenues depends on how much the first term (Domestic Credit) would be affected by oil revenue, and the authorities' decision to accommodate the monetary effect.[7]

The transformation mechanism of oil revenue into the domestic economy, including its monetary effects, consistent with the Edward's model, is shown in the chart below (see an outline of the empirical results of the Edward's model in the appendix). Altogether, once the oil boom has settled down in the domestic economy, we expect an expansion in the non-traded goods and a stagnation in the lagged sectors (agriculture and traditional manufacturing in oil exporting developing countries and non-oil industry in oil exporting developed countries). The overall effect on non-oil gdp, however, is ambiguous and can not be identified beforehand.

[7] For instance, authorities may decide implement an open market policy and sell public bonds to reduce money supply. On the other hand any increase in oil revenue usually leads to a decrease in budget deficit of the government which in turn diminish the domestic credit.

A general view of the mechanism of the effects of a commodity export boom on economy



In the short run, possibly, increase in the rate of inflation to exceed what is required to bring about the equilibrium real appreciation generated by the expo rt boom; in this case, the real exchange rate will appreciate in the short run by more than what real factors only would indicate.

3.2 Developed and Developing Countries: Different Effects

In oil exporting developed countries (like UK) the oil sector usually affects the non-oil economy mostly in an indirect way, through expenditure and exchange rate effects[8]. More oil revenue provides more taxes to finance government expenditure. In a developing country, however, the government is often the only direct receiver and distributor of the oil revenue in the domestic economy. The inefficiencies in resource utilisation in such economies is usually attributed to this character of such economies. In fact, the extra revenue provides the opportunity for the government to increase production subsidies to inefficient producers, which can considerably delay the Learning by Doing experience and improvements in their competitiveness (see van Wijnbergen, 1984).

Moreover, increased oil revenue in oil exporting developing countries may lead to serious problems in building up a *diversified export base* because of real wage pressures (see Wijnbergen 1984). Developing countries with only a limited range of exports (typically primary products) face greater oscillations in their terms of trade than more diversified advanced economies. Diversification in exports is now a very important objective which economic planners in oil exporting developing countries are seeking. This goal has been badly affected by oil shocks (boom or bust) in past decades. The ability to export non-oil goods in international market would not only lead to an improvement in the base of the balance of payments but would also enable the 'utilising the "Learning by Doing" induced technical progress' (Wijnbergen 1984, p. 41), and so gain efficiency through competition. Furthermore, The ease of access to external resources (oil income) allows a rapid acceleration in the rate of investment and government expenditures without the need to restrain the income and consumption of higher income groups. This can gradually cause a very serious damage to the tax system and eventually worsen social inequality in these countries.

The immediate contribution of oil income to growth in these economies comes from alleviating the constraints on the growth process. For instance, the supply-demand gap

[8] In the UK for instance following the great appreciation of sterling in 1979 and 1980, when the oil price increased significantly, many economic models considered the oil component as an explanatory factor in their models (see Brooks *et. al.*., 1986 for a brief survey).

which often arises during the growth process can be moderated by foreign exchange earned from oil revenue.

In next sections of this chapter we describe some indications of oil effects on several parts of Iranian economy[9]. During 1970-79, Iran which ranked an overall second in oil exporting developing countries included in its investment programme 108 projects averaging over one billion dollars each. The total capital cost was equivalent to over one and a half times its 1977 GNP (Gelb, 1986). After the (1979) revolution the Iranian share in providing the world's crude oil declined, and changed from 17.1% and 14.2% in 1974 and 1977 to 2.7% and 7.2% in 1980 and 1982 respectively(Gelb, 1986, table 2-2).

3.3 Evidence: Dutch Disease Investigation

According to the standard model of Dutch Disease some outcomes are predictable:

- Real exchange rate appreciates.
- A shift towards the non-tradables sectors.
- Increased domestic investment should raise growth, accompanied with a change in composition of non-oil GDP.

Number of reasons may make oil economy deviate from these stylised patterns. Price controls and import liberalisation can limit appreciation of the real exchange rate by deflecting demand onto imports. Next, if traded sectors are able to respond strongly to investments financed by oil revenues, product market pulls towards the non-traded sectors may be counterbalanced, particularly if labour markets are slack so that expanding non-traded sectors do not draw labour from the traded sectors. Finally, the overall impact of higher public spending on growth may be low if the quality of investment projects declines with accelerating spending, or if subsidies and other expenditures drain resources from the public investment programme[10].

---

[9] Oil was discovered in 1908 and was nationalised in 1951.

[10] The results of Gelb (1986)'s studies suggest that the impact of expanded investment on growth of non oil GDP has been less satisfactory during the (oil boom of) 1972-81 compare with 1967-72. (see Gelb, 1986, p. 79)

3.3.1 Iran in 1950s

Between 1953 and 1955 the nominal exchange rate was revalued by about 15 percent[11].

Table 3-1 Exchange rates and price movements 1953-60

		WPI 1953=100	
Year	Nominal Exchange rate[a]	Imported goods	General Index
1953	90.5	100.0	100.0
1954	84.5	106.1	110.7
1955	76.5	97.8	106.8
1956	76.5	91.0	115.1
1957	76.5	81.6	112.9
1958	76.5	80.0	111.6
1959	76.5	81.3	113.6
1960	76.5	82.8	115.9

Source: Karshenas, (1990, p. 118).
[a] Rial per US dollar.

The 15 per cent nominal revaluation when added to the 5 percent decline in foreign currency prices of imported goods should in time have led to 20 percent fall in the domestic prices of imported goods.

In fact the general price index rose by more than 15 percent over the same period. This happened mostly because of the 'spending effect' of oil revenue in the form of public expenditure and an increase in the money supply at that time[12]. These opposite (and theoretically unexpected) movements of the nominal exchange rate and domestic

[11] Essential imports, however, were subjected to the preferential official exchange rate of 32.5 Rls per dollar and were excluded from this revaluation.
[12] Edwards (1986) discusses the monetary aspects of the Dutch disease in details.

prices[13] together constitute around 35 percent real exchange rate appreciation. This strange phenomenon which seems to be related to the interconnections between oil revenue and government on one hand and private economic behaviour on the other hand, is a very important character in oil exporting developing countries. 'On an aggregate basis, therefore, it appears that the textbook predictions [of Dutch Disease effects] hold (Karshenas, 1990, p. 117).

The economic movements outlined above reveal that the 'spending effect' directed by real revaluation of the exchange rate has worked strongly in the period 1953-55; though the 'resource movements effect' has not been observed in that situation. In fact the resource market (labour, finance...) has not been in full employment (which is an initial condition for 'resource movement' effect in Dutch Disease theory) and, hence, there was no evidence of a general insufficiency of labour. The potential inadequacy of the supply of finance as a resource, (regarded as a sustainable problem in a developing externally induced boom economy) can be alleviated by government intervention and minor modifications to the banking system (Karshenas 1990). So, the labour movement from traded goods sector to the non-traded sector after a boom, discussed in original Dutch Disease theory, is not a necessary result in an oil exporting country like Iran[14].

3.3.2 Boom and 1980s Oscillations

The effects of an oil boom depends on how the government allocates the extra revenue. The greater the extent to which the government increases expenditure either directly by increasing its own expenditure or indirectly by reducing the non-oil tax (see chapter 2 for this discussion) on private agencies, the greater will be the effect on the non-oil sector.

[13] According to PPP theory the change in price deferential and the nominal exchange rate should roughly be equivalent (see chapter 5 for more details).

[14]Looney (1982) discusses that since farming methods with several exceptions were primitive, levels of income in rural areas remained very low. As a result, most of the economy imposed few demands on the oil industry, and responded little if at all to increases in the supply of oil or to the demands for skilled labour and other inputs generated by that industry. (p.19)

After oil price increasing in 1973, Fifth Five Year Economic Plan was dramatically revised. Government's expenditures grew 200% between 1973-1974. From total budget in 1974, 28% went to fixed capital formation, and 72% to current or semi-current expenditures. Resulting in an increase of 189 per cent in planned investment expenditure. Moreover, the shares in planned expenditure of agriculture, industry, oil and gas declined while the housing and transport (non-traded) sectors had an increasing share.

Government capital formation on machinery and construction constitutes on average something about 26.2 percent of non-oil GDP in 1974-78 period. This portion decreased in post-revolution period to 9 percent (see appendix 2, Table A.3-2).

Public consumption expenditures (including military and consumption subsidies) rose from the equivalent of US$ 6.3 bn in 1973 to US$ 9.2 bn in 1974 (Bank Markazi Iran 1975/76). During 1973-1978 period public and private consumption expenditure in real values increased 12.2 and 10 percent respectively.

Domestic prices during this period inflated on average by something around 12.8 per cent. Given the low price of imported goods, partly because of low external inflation and partly because of paying a very heavy subsidies on some imported goods, the real exchange rate appreciated by 35.3 per cent during the period under consideration.

Prices of domestic goods and services consumed in rural regions rose on average 19 percent in 1974-79 (see appendix 2, Table A.3-1). In the same period the average of inflation of imported goods appeared 10 percent. So the real exchange rate appreciated around 23 percent in this period[15]. Domestic inflation and imports goods inflation rose to 47 and 11 percent respectively in 1980-1990 in average. The related appreciation of real exchange rate is 60 percent. One reason for such huge appreciation, despite a big reductions in oil revenues in this period, is the decision of authorities on keeping an overvalued official exchange rate. As mentioned in chapter 2, the revolution brought about significant changes in the structure and policy direction of Iran's hydrocarbon section. This sector had to tolerate the distruction caused by the eight-year war with Iraq, alongside with the fluctuations occurred in global oil market. Crude oil prices

[15] Real exchange rate was calculated by dividing index of imports prices over index of domestic prices (see table 1 in appendix).

tripled during the first year of the revolution, one-fifth of the early peak in 1986, and raised again to near the early 1980 level after the Persian Gulf war. The volume of production and exports of oil changed also dramatically because of the new policy of revolutionary regime and the war and so do not necessarily show the same direction of oil prices. Average of oil revenues during 1974-1979 is 1194 B. rials at constant 1982 prices while in 1980-1990 decreased to 423 B. rials (see appendix 2, Table A.3-1). The share of oil sector in nominal GDP fell to its least value, 4.1%, in 1986 and increased to 10.6% in 1990 (Iran Statistical Yearbook 1371). While oil sector's real value added shows about 68 percent of non-oil real GDP in 1974/79 on average, this portion declined to 19% in 1980/90 period (see appendix 2, Table A.3-2). Real value added of construction declined from 1150 B rials in 1976 to 438 in 1990 (Iran Statistical Yearbook 1371, p. 601). With little direct linkage between oil sector and the rest of a developing economy the fluctuations in relative oil-value added were mainly reflected in fiscal revenues. Such a considerable discount in oil sector mostly affected capital expenditure of the government. Share of capital expenditures in total public expenditures declined from 35% in 1976 to 19% in 1988, while share of current expenditures increased from 65% in 1976 to 81% in 1988 (Table 3-2).

Table 3-3 exhibits the cumulative and annual average changes in the GDP deflator (1962/72) and implicit prices (1974/79 and 1980/90) for the main sectors of non-oil GDP before and after the oil booms.

As can be seen through this table, the prices of all sectors inflated around two times in post-revolution period (1980/1990) related to those of post-boom period (1974/79). Construction sector (non-traded) is the only sector in which the inflation rate decreased from 52.2 during boom period to 36.2 in post-revolution one. This finding is consistent with the prediction of Dutch Disease hypothesis. On the other hand, inflation in industry (non-oil traded) sector is the least inflation related to all other sectors in 1974/79 period. It is difficult to isolate a number of effects in 1980/1990 including oil crash, war and revolution effects. So, while some Dutch Disease effects are perceptible in 1974/79, we could not judge on these effects in post-revolution period.

Table 3-2 ***Public Expenditure/Revenues (B. Rials)***

	Public Expenditure			**Public Revenues**		
	Current exp.	Capital Exp. (share in total%)	Total	Oil sector (share in total%)	Foreign exchange sales	Total
1976	1084	592 (35)	1675	1329 (76)	0 (0)	1744
1980	2032	675 (25)	2707	938 (55)	0 (0)	1703
1986	2410	747 (24)	3157	417 (23)	18 (1)	1782
1988	3394	816 (19)	4211	668 (32)	142 (7)	2099
1989	3385	932 (22)	4317	771 (24)	744 (23)	3181
1990	4285	1766 (29)	6051	1118 (20)	2257 (40)	5637
1991	5564	2527 (31)	8091	1039 (15)	2511 (36)	7004

Source: Iran Statistical Yearbook 1371, table 23-4 (p.573).

Table 3-3 Cumulative percentage price change of main sectors

	1962/72		**1974/79**		**1980/1990**	
	Cumul.	*Avr.*	*Cumul.*	*Avr.*	*Cumul.*	*Avr.*
Agriculture	37.7	3.77	100	20	366	36.6
Industry	22.4	2.24	58	11.6	322	32.2
Construction	70.0	7	261	**52.2**	362	36.2
Public services	10.5	1	96	19.2	419	41.9
Transportation & Communication	-	-	127	25.4	437	43.7
Real non-oil GDP	-	-	89	17.6	467	46.7
Real GDP	-	-	96	19.2	386	38.8

Source: For 1974-1979 and 1980-1990 periods calculated based on: National Accounts of Iran (1353- 1366) and (1367-1369), Bank Markazi Iran. For 1962-72 period calculated based on Bank Markazi Iran (Central Bank of Iran), annual reports, several issues.

3.4 Crowding out: Oil and Non-oil exports

Crowding out of the non-oil exports by oil exports is one of the most important structural changes that has happened in oil exporting developing countries during oil booms. This process happens, after a boom, partly through the changes of real exchange rate (through inflation and/or nominal appreciation) and partly through the direct spending effect which causes an increase in domestic demand for non-oil potentially exportable goods.

The contribution of non-oil exports to financing commodity imports declined from 50 percent in the late 1940s to below 28 percent in 1959 and 21 percent in 1972. The dollar value of non-oil exports after a 50 percent increase over the 1948-55 period, remained stagnant over the period of the economic boom (see Table 3-4).

As this table shows during the period 1959-63, while oil export was increasing significantly, the non-oil exports were stationary. After three decades, 1959-1989, non oil exports decreased from 29% of imports to only 8% (see Table 3-4 and Table 3-5).

One can argue, of course, that this is an efficient response to the increase in income from oil production, the oil exporter simply should move into oil derived industries and non-traded goods and forget about their non-oil tradable sectors (manufacturing, agriculture) until oil revenues are exhausted. As Wijnbergen (1984) pointed out, almost all successful economic development during the post war II involve, without exception, countries that promoted their traded goods sector strenuously. Technical progress is usually considered a result of Learning by Doing process which is largely restricted to the traded goods sector[16]. Thus, it is in fact desirable not to focus narrowly on the exports of one sector.

[16] In fact, the development process is much better explained by human resources and technological progress rather than capital accumulation.

Table 3-4: Foreign Exchange providers for imports.

		As percentages of imports		
Year	*Value of imports[a] ($ m)*	*Non-oil exports[b]*	*Oil sector's net earnings*	*Total external resources[c]*
1959	572.9	27.8	58.9	72.2
1960	597.3	28.3	60.1	71.7
1961	565.4	26.1	69.2	73.9
1962	527.3	25.1	80.3	74.9
1963	547.9	27.0	85.9	73.0
1964	758.9	19.2	73.2	80.8
1965	931.8	22.5	65.2	77.5
1966	1088.0	20.7	65.8	79.3
1967	1342.3	21.7	63.2	78.3
1968	1804.7	20.3	54.3	79.7
1969	2072.2	20.3	53.0	79.7
1970	2365.1	17.6	53.9	82.4
1971	3013.8	19.4	71.3	80.6
1972	3502.4	21.1	74.2	78.9

Source: Karshenas (1990), p. 212.

[a]-Imports of goods (c.i.f.) and services.

[b]-Exports of goods (f.o.b.) and services.

[c]-Equals oil sector exchange earnings plus the current account deficit.

Table 3-5: Foreign Exchange providers for imports.

	Imports (B. Rls.)	**As percentages of imports**	
Year		*Non-oil exports*	*Oil exports*
1976	902	4.2	168
1981	1082	2.5	92
1986	721	9.7	64
1987	659	12.3	97
1988	568	12.5	92
1989	2026	8.1	93
1990		6.9	88
1991		8.8	

Source: Calculated based on Iran Statistical Yearbook 1371, Plan & Budget Organisation, Centre of Statistics of Iran, Tehran.

3.5 Spending Effect and Public Expenditure

One of the indirect paths through which the spending effect of an oil boom takes place is the structural changes in government revenues. The share of oil revenues in total government revenue increased from about 50 percent during the third plan (1963-67) period to more than 75 percent over the fifth plan, while domestic taxes remained generally below 10 percent of GNP. Table 3-6 shows the public sector deficit, excluding oil income, during three periods: 1963-67, 1968-72, and 1973-77.

Although share of oil revenue in total public revenues decreased in post-revolution period from 76% in 1976 to only 15% in 1991, this does not necessarily indicate a deviation of public revenues from oil revenues. Figures in Table 3-2 show that while shares of oil revenue in public revenues have decreased after revolution, sales of foreign exchanges (earned from oil exports) at free market exchange rate by government increased from 0% in 1976 to 40% in 1990 and 36% in 1991. So we are faced, in fact, with a change in accounting structure of the public revenues instead of a real deviation from oil revenues.

Table 3-6 Structure of public expenditure (%GNP)

	1963-67	1968-72	1973-77
I-Total income (oil income) (Non-oil income)	16.7 (8.5) (8.2)	21.5 (11.8) (9.7)	41.0 (31.0) (10.0)
II-Current expenditure	12.4	15.9	27.5
Saving (*I-II*)	4.3	5.5	13.5
Capital expenditure	6.8	10.5	14.2
Public sector deficit (excluding oil income)	2.5 (10.6)	5.0 (16.8)	0.7 (32.3)

Source: Karshenas, 1990, table 7.12

The gap between government expenditure and tax-revenues increased from 10.6 percent in 1963-67 period to 32.3 percent in 1973-77. This is an indication of the increase in the disposable income available to the private agents and hence an increase in private expenditure.

The momentum of accelerated public investment (some of which implied large future continual obligations) and growing subsidies proved hard to curb when oil revenues fell, as they did in 1978 and after 1981. The summation of growth of foreign and domestic deficits shown in Table 3-7 imply the increasing gap between supply and demand of the economy.

Table 3-7 Foreign and Domestic Deficits

	Net current account of balance of payments ($ M)	**Government's budget deficit (B. rials)**
1976	3857	-169
1981	-2737	-1004
1986	-4197	-1375
1987	-1451	-
1988	-1349	-2111
1989	1700	-1136
1990	797	-451

Source: Calculated based on Iran Statistical Yearbook 1371, Plan & Budget Organisation, Centre of Statistics of Iran, Tehran, p. 467 and 573

3.6 Agriculture section as the Lagged sector

Pinto (1991) argues that in two oil exporting developing countries, Indonesia and Nigeria, it is the agriculture sector which has been affected mostly after the oil boom. The other main sectors were not so important even before the oil boom. Katouzian (1978) also shows a rapid destruction of Iranian agriculture sector in the period after boom. So, in such conditions the expected result of an oil boom is the depletion of agricultural sector[17] (see Katouzian, 1978 for details). The existing evidence supports

[17] According to Corden's (1984) terminology de-agriculturisation.

that the agricultural sector appeared to worsen in response to oil boom during 1960s and 1970s, despite benefiting from the net resource inflow of a sizeable magnitude.

3.7 Unsustainable Growth

As was discussed in chapter 2 the easy access to external resources in oil exporting economies could allow a reasonable rate of growth to be achieved without the immediate need to bring about the appropriate structural adjustments in the domestic economy in the short run.

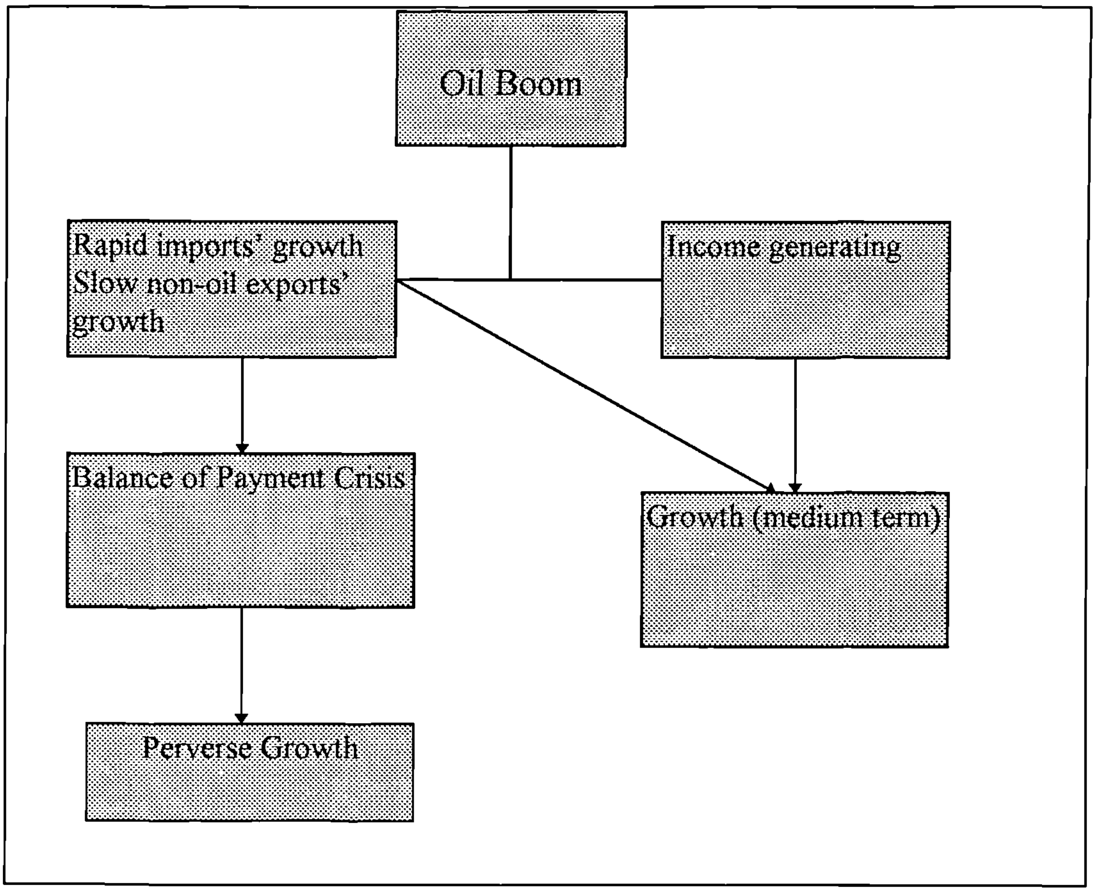
The excessive reliance on external resources pushes the economy towards severe balance of payments crises in the medium term and in the long-run the economy could not sustain itself after the exhaustion of the oil reserves. The existing evidence shows that the main cause of the deficit in the current account of the balance of payments is the widening deficit in the trade balance, and that the manufacturing balance is the main component of the trade deficit over time.

This could lead to a process of unstable growth, process of growth which is not viable in the long-run and is subject to sharp cyclical fluctuations in the medium run. The process of Perverse growth manifests itself in the form of periodic balance of payment crises and is basically related to the supply maladjustment in the economy.

Gelb (1986) in a comparative analysis of oil exporting countries mentions that as the pressure of demand decreased, the temporary boom of the mid-1970s was followed by deceleration in non-oil growth. He claims that 'on average, non-oil economies were 4.1 percent smaller during 1979-81 than would have been the case had they maintained their 1967-72 growth projectories' (p. 78). Results of the regressions of non-oil GDP on growth of oil revenue (which are reported in chapter 6) also show that generally there is a negative relation between non-oil GDP and oil revenue growth rates.

Growth of income per head in 1970-79 is associated with a shift from non-oil tradables (agriculture and manufactures) towards non-tradables (services and construction). This tendency is weaker in constant prices, however, since growth of income per head is also associated with a rise in the price of non-traded relative to traded goods (Gelb, 1986).

The expected growth effect of an oil boom in medium and long run discussed above could be summarised in the diagram below.



3.8 Conclusion

A unique generalisation about a boom sector's impact on the overall economy seems difficult enough to draw up.

According to the core model of Dutch Disease two main effects are expected: resource movement effect and spending effect. The former effect indicates the movement of mobile factor from non-boom economy into the boom sector which gives rise to a de-industrialisation, and later one implies the excess demand resulted from boom which creates a real exchange rate appreciation.

However, some argue that different outcomes can emerge in various circumstances. For instance, when the boom sector does not show a strong participation in the domestic factor market, resource movement effect would not be effective.

Monetary aspects of the boom are parallel forces by which the boom revenue is accommodated into the domestic economy (Edwards, 1986), and which reinforce the real effects. However, the extent of change in the domestic money supply depends on the extent of foreign exchange receipts from boom sector exports and the extent to which the monetary authorities sterilise these proceeds to neutralise their effect on the domestic money supply.

In oil exporting countries, once the oil boom has settled down in the domestic economy, we expect an expansion in the non-traded goods and a stagnation in the lagged sectors (agriculture and traditional manufacturing in oil exporting developing countries and non-oil industry in oil exporting developed countries). The overall effect on non-oil gdp, however, is ambiguous and can not be identified beforehand.

Available evidence show that Iran ranked an overall second in oil exporting developing countries during 1970-1979. However, after the revolution the Iranian share in providing the world's crude oil declined, and changed from 17.1% and 14.2% in 1974 and 1977 to 2.7% and 7.2% in 1980 and 1982 respectively(Gelb, 1986, table 2-2).

The economic movements outlined in this chapter reveal that the 'spending effect' directed by real appreciation of the exchange rate has worked strongly in the period 1953-55; though the 'resource movements effect' has not been observed in that situation.

While some Dutch Disease effects are perceptible during 1974-79, we could not judge on these effects in post-revolution period. Perhaps it is difficult to isolate a number of effects during 1980-1990 including oil crash, war and revolution effects.

3.9 *Appendix 1*

A brief survey of Edwards model (1986)

This appendix outlined a model of investigation of the developments originated from a boom in a commodity exporter country (Colombia) in a DD framework.

In the Edwards model, which is briefly presented here, one can analyse the mechanism through which commodity export prices, money creation, inflation and the real exchange rate interact. The model was used to analyse the case of coffee in Colombia, it emphasises the importance of money creation and inflation during an export boom. This model has two components: a real block and a monetary block. Edward's model points to the fact that *under fixed or managed* nominal exchange rates, an export boom usually results in the accumulation of international reserves, money creation , and inflation.

Assumptions: Capital controls and no domestic financial market.

There are three interrelated main building blocks: a money market block, an inflation block and an exchange rate block.

Definition of variables:

$M_t=$ supply of money.

$M^d{}_t=$ demand of money.

$R_t=$ international reserves.

$DCR_t=$ domestic credit.

$DEF_t=$ government deficit.

$P^c{}_t=$ domestic price of the "commodity exports".

$P_t=$ price level.

$P_{Nt}=$ non-tradable prices.

$P_{Tt}=$ tradable 's prices.

y_t= real income.

E_t= nominal exchange rate (domestic price of a foreign currency).

e_t= real exchange rate.

Hats (^) and star (*) above variables indicate the percentage change and foreign case of those variables respectively.

Money market block

(3.1) $\widehat{M}_t = \alpha\widehat{R}_t + (1-\alpha)D\widehat{C}R_r$

(3.2) $D\widehat{C}R_t = \beta DEF_t$

(3.3) $\widehat{R}_t = \gamma_0[\widehat{M}_t^d - \widehat{M}_{t-1}] + \gamma_1\widehat{P}^c$

(3.4) $P_t^c = E_t P_t^{*c}$

$\widehat{M}_t^d = \widehat{P}_t + \sigma\widehat{y}_t$

Combining (1) to (4) equations we obtain a first order semi-reduced form for the motion of money through time.

(3.5) $\widehat{M}_t = -\alpha_0\widehat{M}_{t-1} + \alpha_1\widehat{P}_t + \alpha_2\widehat{y}_t + \alpha_3\widehat{P}_t^c + \alpha_4 DEF$

Inflation block

(3.6) $\widehat{P}_t = (1-\psi)\widehat{P}_{Nt} + \psi\widehat{P}_{Tt}$

(3.7) $\widehat{P}_{Tt} = \widehat{E}_t + \widehat{P}^*_{Tt}$

(3.8) $\widehat{P}_{Nt} = \phi\widehat{y}_t + \pi(\widehat{M}_t - \widehat{M}^d_t) + \widehat{P}_{Tt}$

Combining equations (6), (7), (8) and (4) we obtain:

(3.9) $\widehat{P}_t = b_0\widehat{M}_t + b_1(\widehat{E}_t + \widehat{P}^*_{Tt}) - b_2\widehat{y}_t$

where $b_0+b_1=1$.

Exchange rate block

(3.10) $\widehat{E}_t = \varepsilon_0\widehat{P}_t - \varepsilon_1\widehat{P}^*_{Tt} - \varepsilon_2\widehat{P}^c_t$

This equation allows for a number of possible exchange rate policies. For example, if , $\varepsilon_0 = \varepsilon_1 = \varepsilon_2 = 0$, the country in question will have a fixed nominal exchange rate. If $\varepsilon_0 = \varepsilon_1 = 1$ and $\varepsilon_2 = 0$, the country will have a strict PPP nominal exchange rate rule. If, however, $\varepsilon_2 > 0$, it means that the authorities in the country in question recognise that increases (decreases) in the commodity export price will have an impact on the real exchange rate and will try to accommodate this effect through a slowing down of the rate of appreciation (depreciation). Here we assume that $\varepsilon_0 \geq 0$.

(3.11) $\hat{Y}_t = g + \rho(\hat{P}_t^{*c} - \hat{P}_{Tt}^{*})$

In this equation it is assumed that changes in the real price of the commodity export (i.e., changes in the term of trade) generate deviations of real income from its long-run trend (g).

(3.12) $\hat{e}_t = \hat{E}_t + \hat{P}_{Tt}^{*} - \hat{P}_{Nt}$

Solution to the Model

Permanent monetary equilibrium

The model can be further divided into a real and a monetary block. The real side, which is composed of eqs. (8) and (11) , can be solved under the assumption of full and permanent monetary equilibrium. In this case the model becomes similar to most models of the Dutch Disease which have traditionally concentrated on real aspects only. Assuming permanent monetary equilibrium, E^=0, substituting (11) into (8) and using the definition given by eq. (12), the change in the real exchange rate resulting from changes in the commodity export world price is:

(3.13) $\hat{e}_t = -\phi\rho\hat{P}_t^{*c}$

In fact, eq. (13) is the ***spending effect*** of a commodity export boom emphasised in the Dutch disease literature (Corden, 1984). Note from eq. (13) that the extent of the real appreciation depends on the value of ϕ, the income elasticity of demand for non-tradable. If ϕ=0 for example, that is, if none of the increased real income is spent on non-tradable, the commodity export boom will have no effect on the real exchange rate. In other words if the extra oil revenue purchases imported goods or is held abroad (ignoring the interest on this reserves) there would be no effect on exchange rate because the balance of payment has not changed (see also Brooks, *et. al.*, 1987 for more discussion on the other extreme position).

Short-run monetary disequiblirium

Allowing for short-run monetary disequilibrium, the complete model works in the following way.

On the money side, the higher price of the commodity exports which raises real income and the price of non-tradables, affects both the demand and the supply for money. From eq. (4), a higher demand for nominal (and real) money will result.

However, an excess demand for money is only one of the possible monetary consequences of the export boom. In fact, according to eqs. (3) and (1), after the boom international reserves will accumulate, and the rate of growth of money will also be higher. Whether the final result is an excess demand or an excess supply of money will depend on the relative values of some of the parameters in the model.

Assuming excess supply position, this will impact on the nominal price of non-tradable, further appreciating the real exchange rate. What is the role of the nominal exchange rate policy in this story? Two things will happen according to equation (10). First, as a result of the higher commodity export price, the rate of the crawl will be slowed down in period t, helping to accommodate the real appreciation generated by the spending effect. Second, there will be a tendency partially to compensate the nominal exchange rate for the higher rate of inflation, through $\varepsilon_0 \hat{P}_t$. The final effect will be a real appreciation resulting, partially, from the slowing down of the rate of the crawl and partially from higher inflation. If the liquidity or money creation effect generated by the higher price of the commodity is large enough, the real appreciation can be larger in the short-run than in the long-run (overshooting) (see Edwards, 1984).

The model can be solved for the rate of changes of the real exchange rate as a function of exogenous variables only. Eqs. (6), (9) and (10) are first solved for $\widehat{E}_t$, $\widehat{M}_t$ and $\widehat{P}_t$. Then the definition of the real exchange rate is used to find $\widehat{e}$:

$$(3.14)\ \widehat{e}_t = k - \lambda_1 \widehat{M}_{t-1} + \lambda_2 DEF_t - \lambda_3 \widehat{P}_t^c$$

(see the expressions of λs in original paper)

From the comparison of equations (14) and (13) , it is possible to find out the extent to which, after the boom, the short-run real exchange rate diverges from the new long-run equilibrium real exchange rate.

There are three different channels, in addition to the spending effect, through which changes in the commodity export price will affect exchange rate. Two of these channels indicate that a higher commodity price will generate a real appreciation. The third channel, however, suggests the opposite result.

The forces that tend to generate a real depreciation as a consequence of the export boom are of a second order of magnitude, and work through the following channel. The higher world commodity export price reduces the rate of the crawl and consequently, through eq. (10), the domestic price of tradables and so reduces inflation. These lower rates of inflation and revaluation, in turn, will tend to result in a lower rate of domestic money creation, through eq. (5), and even lower inflation. This lower inflation, of course, will generate among other things given, *a real depreciation* . However, given the second order nature of this effect, the strong presumption is that under normal circumstances, the appreciation effects will dominate.

An application: coffee and the real exchange rate in Colombia

Three main eqs. ((5), (9), (10)) were estimated simultaneously. The estimation was performed using annual data for 1952-80.

$$\widehat{M}_t = -0.03 + 0.607\widehat{M}_{t-1} + 0.318\widehat{y}_t + 0.137\widehat{P}_{t-1} + 0.095\widehat{P}_t^{*c} + 0.125DEH \tag{3.15}$$
$$\text{t-stat.}\ (0.883)\ (4.067)\quad (0.768)\quad (1.373)\quad (2.776)\quad (2.345)$$

Dw=2.03; SEE=0.035

$$\widehat{P}_t = -0.006 + 0.705\widehat{M}_t - 0.04\widehat{y}_t + 0.311(\widehat{E}_t + \widehat{P}_{Tt}^*) + 0.01DUM \tag{3.16}$$
$$\text{t-stat.}\ (-0.729)\ (2.669)\ (-0.363)\ (2.182)\qquad (0.314)$$

DW=2.23 SEE=0.060

$$\widehat{E}_t = -0.006 + 1.333\widehat{P}_t - 0.85(\widehat{P}_t DUM) - 0.06\widehat{P}_{Tt}^* - 0.198\widehat{P}_t^{*c} + 0.043DUM \tag{3.17}$$
$$\text{t-stat.}\ (-0.119)\ (2.569)\ (-1.678)\qquad (-0.063)\quad (-1.604)\quad (0.469)$$

DW=1.728 SEE=0.108

The results related to money equation confirm that higher (domestic) prices of commodity export gives rise in short run increases in the rate of money creation. The mechanism through which this takes place is the accumulation of international reserves that are monetized by the Central Bank. The significant coefficient of lagged money changes (M^) suggests that the effects of changes in commodity export prices on money growth have some persistence through time. The money creation is also influenced by the fiscal side of the economy captured by fiscal deficit.

Inflation equation shows a significant positive relationship between rate of money creation and inflation on one hand, and domestically inverted world price changes (i.e. rate of devaluation and/or world inflation). The coefficient of real income growth rate is insignificant.

The main interest postulated in this paper is to investigate how changes in a commodity export price affect the real exchange rate. The results reported above indicate higher commodity export prices results in lower rate of devaluation and vice versa.

Comments on Edwards Model:

Edwards' paper analyses the effects of the tripling of real coffee prices between 1975 and 1977 followed by a return within the following four years to the 1975 price. This kind of price boom obviously is different from a typical oil boom in oil exporting countries where, although with some fluctuation, is treated as a permanent phenomenon (compare current oil price with that of pre-1973 oil shock). Another point could be put forward here is that the price of the commodity export can not necessarily perform all the boom effects, instead it could be more appropriate to account for the product of commodity price and actual commodity exports, that is the revenue induced by the commodity boom. On the specification point of view, a little concern has been maintained over a process which take the variables to their steady state positions. This leaves long-run equilibrium values of the variables (prices, exchange rates, money) undefined. Inclusion of an error feedback factor would help to make the analyses more clear and improve the qualifications of the other estimates.

3.10 Appendix 2

Table A.3-1 Index prices: (1974=100)

	Domestic goods and services in rural regions	Oil price index	Imports' price index	Exports' price index	Oil and Gas exports (B. rls., 1974 prices)
1974	100	100	100	100	1412.4
1775	109.9	103	112	103.5	1320.1
1976	128.1	115	113.7	125.2	1483.8
1977	160.2	129	119.2	140.5	1280.9
1978	176.2	128	130	145.8	938.6
1979	196.3	225	151.3	181.6	730.4
1980	242.5	364	183.3	233.9	228.6
1981	297.9	396	193.2	278.1	231
1982	355.2	349	197.8	324.3	486.1
1983	418.1	345	194.4	354.1	533.8
1984	462.1	353	193.8	401.5	433.6
1985	480.9	308	191.8	420.4	390.7
1986	580.9	142	195.4	517.9	336.7
1987	747.2	171	189.9	1076.5	438.5
1988	979	170	203	3477	476
1989	1150	297	225	3633	499
1990	1253	583	219	4113	600

Source: National Accounts of Iran 1974-1987 and 1988-1990, Bank Markazie Iran (Central Bank of Iran) [in Persian language]

Table A.3-2 Government's Capital Formation and non-oil gdp

	Government's Capaital formation in machinery and construction (B. rls at 1982 p.)	**Government's Capital formation in construction (B. rls at 1982 p.)**	**non-oil GDP (B. rls at 1982 p.)**	**Value added of oil sector (B. rls at 1982 p.)**	**oil v.added/non -oil GDP (%)**
1974	938 (21%)	664 (15%)	4517	4826	107
1775	1294 (30)	922 (19)	4978	4250	85
1976	1904 (29)	1516 (23)	6473	4781	74
1977	1781 (26)	1313 (19)	6776	4408	65
1978	1750 (25)	1250 (18)	6927	3144	45
1979	917 (12)	611 (8)	8008	2535	32
1980	861 (10)	624 (7)	8457	866	10
1981	873 (11)	591 (7)	8293	882	11
1982	1057 (13)	688 (8)	8388	1948	23
1983	1144 (12)	717 (8)	9530	2006	21
1984	1078 (11)	635 (6)	9962	1626	16
1985	891 (9)	500 (5)	9963	1644	17
1986	761 (9)	483 (6)	8459	1043	12
1987	570 (7)	394 (5)	8421	1599	20
1988	464 (6)	335 (5)	7480	1754	23
1989	469 (6)	314 (4)	7625	1890	25
1990	613 (7)	383 (5)	8400	2265	27

Source: National Accounts of Iran 1974-1987 and 1988-1990, Bank Markazie Iran (Central Bank of Iran) [in Persian language]
Values in parentheses show percentage share of the related item in the whole value.

4

4. Econometric Modelling

4.1 Introduction

This chapter will review some of the most relevant concepts and ideas in econometric modelling and time series estimation to provide a reference point for the following chapters.

An econometric search maybe regarded as a 'mining' or 'fishing' activity, where the field of search is not the ground or a river, but is a 'data' set. A model in fact is a kind of logical structure to describe the reality which hypothetically exists in the available data. Because of the complexity of the reality, the human mind is unable to comprehend it in its entirety. So to describe a real phenomenon, it is necessary to construct a '*simplification of the reality*' (model). Statistical models (in econometrics) are intended to bear such a work , that is, to describe economic relationships using statistical techniques.

The purpose of constructing a statistical model is not to replace serious economic models with arbitrary statistical descriptions, but rather to provide a framework in which one can compare the economic theories with reality, as measured by the data series. Johansen (1995) suggests that a proper statistical treatment of systems of economic variables should include the formulation of a statistical model in which one can :

- describe the stochastic variation of the data, such that inferences concerning the various economic questions are valid;

- define the economic concepts in terms of the statistical concepts, like long-run relations which become cointegrating relations between non-stationary variables;
- formulate the interesting economic theories and questions in terms of the parameters of the model;
- derive estimators and test statistics as well as their (asymptotic) distribution such that inferences can be drawn.

If we have such a statistical model describing a relevant set of economic variables, the first task is to check for model specification, to make sure that the first point is satisfied, or at least not completely false. If it turns out that the model is a valid description from a statistical point of view, one can proceed to test that the economic theory is consistent with the data.

Time series models are particularly useful when little is known about the underlying data generating process (d.g.p.) that one is trying to model (economic theory). While it is valid to model an economic variable, say y_t, as a statistical process, this is of little use if we are looking to establish (causal) linkages between variables. A pure time series model such as Autoregressive (AR), Moving Average (MA) or Autoregressive Moving Average (ARMA) model can be generated to include other variables (stochastic or deterministic such as intercept).

4.2 Model selection

4.2.1 The Criteria for Evaluating of a Model

Some of the criteria that a satisfactory model should satisfy can be listed below:

Consistency with theory

A model should be consistent with theory or at least with one of any competing theories (otherwise the researcher should put forward a plausible excuse). One would reject, for example, statistically significant long-run average propensity to consume of 1.6 because of its inherent implausibility.

Data admissibility

A model is data admissible if its predictions automatically satisfy all known data constraints. In other words it should not be possible for models to predict values for variables which are inadmissible. For example a model that is able to predict *negative* values for prices when explanatory variables are given plausible values is an inadmissible model.

Data Coherency

One highly important criterion that a model should satisfy is what is termed data coherency. Data coherency is the goodness of fit criterion. However, there is more to goodness of fit in this context than simply obtaining high values of measures such as R^2 . If a model is an adequate representation of the underlying data generating process, then the residuals from fitted versions of the model should be entirely random in the sense that they are totally unpredictable. For example, the residuals should not be autocorrelated since this would imply that there was some systematic part of reality that was not adequately represented by the model. Because of the complexity of the reality we can not expect our model to provide an exact description of it. The aim of the model building is to reproduce the main systematic parts of the process we wish to represent. In Hendry's view a model can not have achieved this if the residuals it generates are non-random. So, the criteria which test for autocorrelation of residuals, such as Durbin-Watson or Lagrange Multiplier (LM) statistics would also be the criteria for data coherency in a model.

Parsimony

The fourth requirement for a satisfactory model is parsimony. This principle implies that we lose little if unimportant aspects are delivered to the disturbance term in our models. Our models, then, should contain as few explicit variables as possible. To quote Milton Friedman (1953), " A hypothesis is important if it explains much by little."

The number of observations available in time series is rarely large, so that a lack of parsimony frequently results in imprecise estimates.

Encompassing

Ideally a preferred model should also encompass all or at least most of the models presented by previous researchers in the field. One model is said to encompass another if it can explain all the results of the other models. A satisfactory model must therefore not only explain existing data but also be able to explain why alternative models can also do so. Moreover, if a model encompasses other models, it should be able to explain any different conclusions that previous researchers using different models may have come to.

Another requirement for satisfactory models listed by Hendry and Richard (1983) is that of parameter constancy. A model is of little use if it can not forecast adequately outside the sample period used to estimate it. For a model to do this its parameters must obviously remain constant over time.

Exogenous explanatory variables

The explanatory variables should not be contemporaneously correlated with the disturbance in the equation estimated. The major cause of contemporaneous correlation is the simultaneity of many economic relationships. A simultaneous system is a situation in which regressors and some dependent variables are jointly determined.

The model we select or build cannot be a perfect representation of a complex reality and are inevitably a simplification in some sense. Moreover, reality can change over time. Hence, it may always become necessary to improve or adapt our models. In Hendry's view a preferred model is merely a tentatively adequate conditional data characterisation. Such a model is only congruent with that data which is at present available. New data may well mean that we will have to revise and improve the model.

4.2.2 Several Approaches in Model Selection

The range of model selection criteria in econometrics is quite vast and includes diagnostic checking and specification testing (Maddala 1992: 491)

There are two main approaches one can use to select an appropriate model; **Specific to General** method and **General to Specific** one. The former approach has been used by econometricians for many years and is called the Traditional approach (Thomas, 1993: 144). By this method the statistical model underlying the data is assumed to be known at the outset. The problem is, then, to obtain good estimates of the parameters. In this approach the economic theory or the results of previous experiences are used to specify a suitable and reasonable set of variables for the model. This model is then estimated, using Ordinary Least Square or its alternatives, and examined using several usual test statistics such as t-ratio, R^2, tests ... for autocorrelation, heteroscedasticity, multicollinearity, and so on. In the event of any unsatisfactory test results, the model is to be modified. " A large residual, for example, might suggest that special factors affected a small subset of the observations, and lead to the introduction of a dummy variable" (Krasker 1981:131)[1]. Several such iterations might be made before the investigator settles on a particular model. Although 'purists would consider this "data mining" process as an illegitimate activity, it is equally unreasonable to assume that we know the model exactly at the very outset' (Maddala, 1992:490). Such a procedure normally results in the investigator eventually selecting a model that is more complicated or general than the one he or she started with. In a time-series framework, this approach of model selection is known as the Box-Jenkins approach. This procedure has been summarised in the following chart.

The problem with this approach is that it may **bias the judgements**. An investigator following this methodology is almost certain to encounter omitted variable bias early in the research and it is possible that this will lead to him making invalid generalisations of his original equation. For example, if the omission of a relevant variable leads to a low Durbin-Watson statistics, then this can lead to a quite inappropriate use of the Cochrane-Orcutt iterative procedure. (Thomas, 1993)

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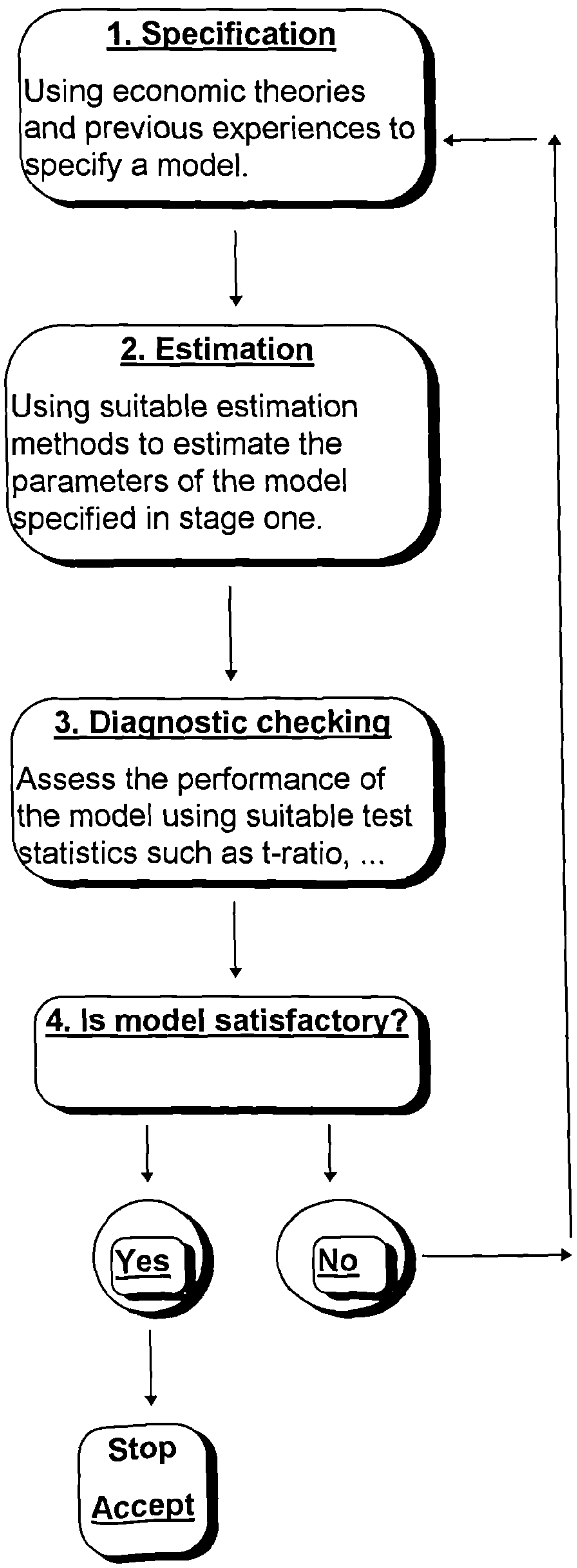
[1] Krasker, William. S. (1981), "The Role of Bounded-Influence Estimation in model selection", Journal of Econometrics 16; 131-138.

Box-Jenkins Approch



4.2.2.1 General to Specific Methodology

Although there is some convergence in the different views about research methodology, Pagan (1990)[2] identified three major contenders for the best methodology title in literature: "Hendry", "Leamer", and "Sims" methodologies[3].

The Hendry's Methodology is essentially constituted of **four steps**[4]:

- Commence from the most general model that is reasonable to maintain. That is, which is consistent with what economic theory usually offers as an equilibrium relationship.
- Re-parametrize the model so that the explanatory variables become closer to orthogonal and are interpretable in terms of the final equilibrium.
- Simplify the model to the smallest version that is compatible with the data.
- Evaluate the resulting model by extensive analysis of residuals and predictive performance.

In this methodology, theory suggests which variables should enter a relationship, and the data are left to determine whether this relationship is static or dynamic. In step 1 the investigator would make clear which variables should enter in the equilibrium relation. In step 2 he should reparameterize the equation so that the explanatory variables appear orthogonal and sensible, however, this step seems to be more of an "art" than a "science" and, therefore, is difficult to codify (Pagan, 1990). Often in typical time-series data the variables in the general model are likely to be highly correlated regardless of whether dependent and independent variables are stationary or not. In estimating a general model in levels of variables, we will face the usual problem of multi-collinearity-large standard errors. However, the variables in the equivalent ECM (see next section) representation will normally be far less highly correlated. In

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[2]Pagan, Adrian R. (1990) "Three Econometric Methodologies: A critical Appraisal", in : Modelling Economic Series ed. by C.W.J. Granger, 1990 Oxford Univ. Press.
[3]To see the most accessible summaries of the materials concerned to each one of these procedures one can refer to Hendry and Richard (1982), Leamer (1978), and Sims (1980).
[4]Much of the material in this subsection is based on Pagan (1990).

fact they tend to be almost orthogonal - that is correlations between them are often close to zero. This facilitates the testing down procedure because, with low standard errors, the normal t-statistics in an estimated ECM will provide a good guide to which difference variables should be eliminated. Thus it becomes easier to arrive at a sufficiently parsimonious final preferred equation. Notice that since the differenced variables simply reflect short-run dynamics, about which theory typically has nothing say, their elimination from the general model does not violate the respective theory.

Problems arise in step 3, because the investigator faces alternative criteria functions and decision rules for deciding which variables should be removed from general model. How to use and report inferences from at this step is difficult (Pagan, 1990). What is the criteria for deletion of a variable? There are some suggestions of alternative decision rules that may be useful, such as Akaike (1973) and Rissanen (1983)[5]. A criterion which is used in this stage is something equivalent to the likelihood ratio test statistic, $-2\log (L_S / L_g)$ where L_S and L_g are the likelihood of simplified and general models respectively. None of these is incompatible with the 'Hendry' methodology; but to date they not been used much, mainly as a matter of choice rather than necessity.

What should be reported, after reaching a final simple model? Pagan (1990) believes that there is no an exact description of what to do at this stage. Hendry tends to compare the finally chosen simplified model with the original one.

4.2.2.2 Leamer Methodology

Leamer's (1978 and 1983) methodology is somewhat different from Hendry's. Leamer regards as inevitable the fact that an investigator's prior beliefs will tend to influence his research strategy and maintains that this should be explicitly recognised. In the Leamer methodology a researcher should identify the parameters of interest early in his

[5]Akaike (1973) and Mallows (1973) derive decision rules that opt for the deletion of a variable in a linear model if the change in the residual variance is less than $\sqrt{2}$ times the inverse of the sample size. Rissanen (1983), looking at the likelihood as an efficient way to summarise all the information in the data, formulates a decision rule that the change in residual variance must be less than a function of the sample size and difference in model dimensions. (Pagan, 1990: 102)

study. The sensitivity of conclusions regarding these parameters to alternative specification of an estimating equation should then be made clear. For example, is the statistical significance of the coefficient on a variable affected by including other variables in the equation or is the relatively robust to their inclusion? Leamer regards what he terms the 'fragility' of inferences about parameters as a matter that should be rigorously investigated in any research study.

4.2.2.3 Sims Methodology

To estimate a simultaneous equation model using traditional method one needs to take two steps: classifying the variables into two categories, endogenous and exogenous and second imposing some constraints on the parameters to achieve identification. Both these steps, as Sims (1980) argues, involve many *arbitrary* decisions and suggests Vector Autoregression (**VAR**) approach as an alternative. This approach which is a multi time-series generalisation of the AR model can be undertaken using OLS estimation method (Maddala, 1992).

In the Sims (1980) methodology the data is almost all-important and can be allowed to determine even causality, sometimes in the face of recognised theory.

Since VAR presumes that no variables are exogenous, and that all variables, each with multiple lags, appear in each equation, it usually faces severe degrees of freedom problems. This forces modellers to choose a small set of variables.

As an example, a *first-order* vector autoregression (VAR) model (in a *structural form*) is shown below:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt}$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt}$$

The structure of the system incorporates feedback since y_t and z_t are allowed to affect each other. For example $-b_{12}$ shows the contemporaneous effect of a unit change of z_t

on y_t and γ_{21} the effect of a unit change in y_{t-1} on z_t . Due to the feedback inherent in the system, these equations cannot be estimated directly. The reason is that z_t is correlated with the error term ε_{yt} and y_t with the error term ε_{zt}. ε_{yt} and ε_{zt} are pure innovations (shocks) in y_t and z_t, respectively. It is possible to transform the system of equations from the *structural form* into a system of VAR in a *standard form* :

$$y_t = \alpha_{10} + \alpha_{11} y_{t-1} + \alpha_{12} z_{t-1} + e_{1t}$$

$$z_t = \alpha_{20} + \alpha_{21} y_{t-1} + \alpha_{22} z_{t-1} + e_{2t}$$

The error terms in these equations (e_{1t} and e_{2t}) are composites of the two shocks ε_{yt} and ε_{zt} . Once the condition for stability is satisfied, we can express each variable (y_t and z_t) as a function of the current and lagged values of e_{1t} ant e_{2t}, the vector moving average (VMA) representation of the VAR. These are known as the *impulse response functions*. They show the current and lagged effects over time of changes in ε_{yt} and ε_{zt} on y_t and z_t. The VMA representation is an essential feature of Sims' (1980) methodology in that it allows one to trace out the time path of the various shocks on the variables contained in the VAR system.

There is an issue concerning whether the variables in a VAR need to be stationary. Sims (1980) and others, such as Doan (1992), recommend against differencing even if the variables contain a unit root. They argue that the goal of VAR analysis is to determine the interrelationships among the variables, not the parameter estimates.

If some of the VAR equations have regressors not included in the others (i.e. different lag length etc.), seemingly unrelated regressions (SUR) provide efficient estimates of the VAR coefficients. Hence, when there is a good reason to let lag length differ across equations, estimate the so-called **near VAR** using SUR.

4.2.3 The Advantages of Hendry's Methodology

Regardless of the attractions of the Leamer and Sims approaches, the fact remains that studies adopting the Hendry approach are more common, particularly in the UK, than research work using either of the other methodologies (Granger, 1990).

One reason for misspecification in a model maybe because of including too many or too few explanatory variables or regressors. In other words, excluding relevant variables or/and including irrelevant variables might leads to misspecification problem. Omitted variable error is the more serious problem because it leads to *bias and inconsistency*. An important part of the Hendry's general to specific methodology is that the misspecification problem is (hopefully) limited to those occurring because of the inclusion of irrelevant variables rather than the omission of relevant ones. Moreover, the problem of the *lack of efficiency* in estimators, arising from the inclusion of irrelevant explanatory variables, becomes less and less serious as the testing down process proceeds and such variables are gradually dropped from the equation.

4.3 Stationarity

4.3.1 Definition

A stochastic process may be defined as a collection of random variables which are ordered in time (Harvey 1993).

Consider the following equations all giving different explanations of the determination of a stochastic process:

(4.1) $y_t = \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \ldots + \varphi_p y_{t-p} + \varepsilon_t$

(4.2) $y_t = \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \ldots + \theta_q\varepsilon_{t-q}$

(4.3) $$y_t = \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \ldots + \varphi_p y_{t-p} + \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \ldots + \theta_q\varepsilon_{t-q}$$

where ε_t is a sequence of independent[6] random variables drawn from a distribution with mean zero and constant variance. θ's and φ's are constants. Models (4.1), (4.2) and (4.3) define the mechanisms by which the observations (y) are generated (DGP). Model (4.1) is called autoregressive process of order p [AR(p)]. Model (4.2), by which we assume that the y is generated by the random disturbances ε_t and its lags, is called moving average process of order q [MA(q)]. Finally the model (4.3) is a mixed of AR and MA process which is called Autoregressive Moving average process of order p and q [ARMA(p,q)].

For a stochastic process to be stationary, the following conditions must be satisfied for all values of t :

(4.4) $E(y_t) = \mu$ (constant)

(4.5) $E[(y_t - \mu)^2] = \sigma_y^2 = \gamma(0)$

and

(4.6) $E[(y_t - \mu)(y_{t-\tau} - \mu)] = \gamma(\tau) \quad \tau = 1,2,\ldots$

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[6] covar(ε_t, ε_τ)=0 *for* $t \neq \tau$.

Equations (4.4) and (4.5) imply that the mean and variance of y_t remain constant over time, while equation (4.6) gives the autocovariance at lag τ, which in turn implies that the correlation between any two values of y taken from different time periods depends only on the difference apart in time between the two values. That is, for example, although $cov(y_t, y_{t-2})$ may differ from $cov(y_t, y_{t-5})$ both these covariances remain constant over time. For example, $cov(y_6, y_4)$ may differ from $cov(y_6, y_1)$ but is the same as $cov(y_7, y_5)$, $cov(y_8, y_6)$ and so on.

These conditions (4.4-4.6) provide a definition of what is known as weak stationary. If a series is weakly stationary and normally distributed, then it is also stationary in the strict sense (Harvey, 1993).

4.3.2 Non-stationarity and it's Consequences

Much conventional asymptotic theory for least-squares estimation (e.g. the standard proofs of consistency and asymptotic normality of OLS estimators) assumes stationarity of the explanatory variables, possibly around a deterministic trend. The differences between the features of stationary and non-stationary variables could be summarised as follow:

- The variance of stationary x_t is finite, whereas in the case of non-stationarity it goes to infinity when t goes to infinity.
- an innovation will affect the values of x_t only temporarily in the case of stationarity and permanently when it is non-stationary.

the autocorrelations decrease steadily in magnitude for large orders in stationary cases, but tends to 1 as t goes to infinity for non-stationary variables.

Many important economic time series are not stationary. In such cases OLS estimation might produce *spurious* results, implying that there are (apparently) significant correlations between underlying variables when, in fact, there is not[7].

[7] See Banerjee et al, 1993, p. 70 for a detailed discussion.

It has been shown that the standard regression techniques are invalid and problematic when applied to non-stationary variables (see below). There have been a number of methods suggested to solve these problems.

A generalised dynamic model of the short-run adjustment may be introduced by[8]:

$$(4.7)\quad y_t = \alpha_0 + \sum \gamma_i x_{t-i} + \sum \alpha_j y_{t-j} + u_t, \quad i=0,\ldots,q\,;\, j=1,\ldots,p$$

which in a very simple model ($p = q = 1$) is:

$$(4.8)\quad y_t = \alpha_0 + \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + u_t$$

where $u_t \sim (0, \sigma^2)$ is a white noise error. If γ_1 and $\alpha_1 \neq 0$, the parameter coefficient γ_0 denotes the short-run reaction of y_t to a change in x_t, and not the long-run effect that would occur if the model were in equilibrium. The latter is defined as:

$$(4.9)\quad y_t = \beta_0 + \beta_1 x_t + v_t$$

which is obtained from [4.8] when we impose the long-run restriction where $y_t = y_{t-1}$ and $x_t = x_{t-1}$. So in the long-run, the elasticity between y and x is β_1 [$= (\gamma_0 + \gamma_1)/1-\alpha_1$], assuming that $\alpha_1 < 1$ (which is necessary if the short-run model is to converge to a long-run solution).

The dynamic model represented by [4.8] is easily generalised to allow for complicated, and often more realistic, adjustment processes (by increasing the lag length p and q). However, there are several potential problems with this form of the dynamic model. The first is concerned to the likely high level of correlation between current and lagged

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[8] See for example Banerjee et al (1993).

values of a variable, which will therefore result in problems of multicollinearity[9] (high R^2 but imprecise parameter estimates and low t-values, even though the model may be correctly specified). Using the Hendry's general to specific approach, discussed before, which would involve dropping out insignificant variables from the estimated model, might therefore result in **misspecification** (especially if x is in fact a vector of variables). Also, some (if not all) variables in a dynamic model of this kind are likely to be non-stationary, since they enter in levels. As explained earlier, this leads to the potential problem of common trends and thus *spurious* regression, while t- and F-statistics do not have standard distributions and the usual statistical inference is invalid (see Banerjee *et. al.*, 1993).

4.3.3 Solving the problem of spurious results

4.3.3.1 Differencing

A popular past method to overcome the problem of spurious results has been to respecify the model in (first) differences of variables rather than their absolute levels. However, this removes any information about the long-run from the model and consequently is unlikely to be useful for forecasting purpose. For example if we rewrite [4.9] as:

(4.10) $y_t - y_{t-1} = \beta_1(x_t - x_{t-1}) + \varepsilon_t$

where

$\varepsilon_t = v_t - v_{t-1}$.

If we estimate [4.10] instead of [4.9], we can not obtain any information about β_0. The other problem which may exist is that if the disturbance term in [4.9] (v_t) is non-autocorrelated, then the disturbance ε_t in equation [4.10] is a moving average and

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[9] Maddala (1992) insists that ' if there is enough variation in the explanatory variables and the variance of the error term is sufficiently small, high intercorrelations among the explanatory variables need not cause a problem' (p. 294).

hence will be autocorrelated. Therefore, the differencing method to overcome a spurious correlation problem seems unsatisfactory. An alternative to this approach is the Error Correction Method. A major advantage of error-correction models is that they result in equations with first-differences and hence stationary dependent variables but avoid the problem discussed above.

4.3.3.2 Error-correction Model

The ECM goes some way toward providing an answer to a problem that has long plagued economists - the problem of *spurious* correlation. The ECM was first applied in economics by Sargan (1964) but in more recent years has been associated with Hendry's approach to econometrics we discussed earlier.

Correlations can be spurious when the variables involved exhibit consistent trends, over time. So we can not necessarily treat a correlation between dependent and explanatory variables as a *causal* relationship. Since much econometric works is concerned with 'time series' data, it is therefore wise not to be impressed with high values of R^2. R^2's for time series regression equations are typically very high compared with those obtained from 'cross sectional' data for which the trending problem does not arise. In fact ' classical' statistical inference in general was specially designed for variables which are stationary in the sense that their mean, variance and covariances remain constant over time. Whereas, in economics many variables are stochastic and consist of non-stationary time-series. Consequently, we cannot rely on the standard regression procedures.

ECM models are introduced as a proper solution for this problem. Rearranging and reparameterising (4.8) gives:

(4.11) $\Delta y_t = \gamma_0 \Delta x_t - (1-\alpha_1)[y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-1}] + u_t$

where $\hat{\beta}_0 = \hat{\alpha}_0 / 1 - \hat{\alpha}_1$. Estimations of [4.8] and [4.11] are equivalent, but the ECM has several distinct advantages. First, assuming that x and y are *cointegrated*, the ECM incorporates both potential short-run and long-run effects. This can be seen by the fact that the long-run equilibrium, [4.9], is incorporated into the model (squared bracket). Thus, if at any time the equilibrium holds then, the ***disequilibrium term*** in [4.11] will arrive at zero: $y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-1}] = 0$. During periods of the diseqilibrium, this term is non-zero and measures the distance the system is away from equilibrium during time t. Thus, an estimate of $(1-\alpha_1)$ will provide information on the speed of adjustment, that is, how the variable y_t changes in response to the disequilibrium[10]. For instance, suppose that y_t starts to increase less rapidly than is consistent with [4.9], perhaps because of a series of large negative random shocks (captured by u_t). The net result is that $y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-1}] < 0$, since y_{t-1} has moved below the steady-state growth path, but since $-(1-\alpha_1)$ is negative, the overall effect is to boost Δy_t, thereby forcing y_t back toward its long-run growth path as determined by x_t (in equation 4.9).

The second feature of the ECM is that all the terms in the model are stationary so standard regression techniques are valid (assuming cointegration). There is clearly a problem if the β's need to be estimated at the same time in the ECM. Often β_1 is set equal to one (and β_0 is set equal to zero), and justified on the basis that the theory imposes such a long-run elasticity. This can be tested by including x_{t-1} as an additional regressor, since it should have an estimated coefficient value of zero, if in fact $[\beta_0, \beta_1]' = [0, 1]'$. However, including the coefficient of x_{t-1} is itself problematic, since the t-statistic of this coefficient does not have a standard distribution, thereby invalidating the usual testing procedure. Third, as should be obvious from equations (4.9) and (4.11), the ECM is closely bound up with the concept of cointegration. In fact, Engle and Granger (1987) show that if y_t and x_t are *cointegrated I(1,1)*, then there must exist an ECM (and conversely, that ECM generates cointegrated series). The practical implication of Granger's representation theorem for dynamic modelling is that it

[10]Large values of $-(1-\alpha_1)$ (tending to -1) indicate that economic agents remove a large percentage (since the model is in log.) of the resulting diseqilibrium each period. Small values (tending toward zero) suggest that adjustment to the long-run steady- state is slow, perhaps because of the large costs of adjustment.

provides the ECM with immunity from the spurious regression problem, provided that the terms in levels cointegrate.

4.3.4 Testing for Stationarity

The discussion above made it clear that the stationarity of the variables under investigation is a key factor in determining the econometric modelling strategy. Given this, testing for stationarity (non-stationarity) of the variables is a high priority in econometric modelling.

It can be shown that all MA processes such as (4.2) are stationary (see for example Harvey 1993, p. 12). However, it is not necessarily the case with AR processes.

The AR model denoted by [4.1] can be simplified as $A(L)y_t = \varepsilon_t$, where A(L) is the polynomial lag operator $-\varphi_1 L - \varphi_2 L^2 - ... - \varphi_p L^p$. Forming the characteristic ($-\varphi_1 L - \varphi_2 L^2 - ... - \varphi_p L^p = 0$), for given (or estimated) values of the φs, this is an equation in lag operator L. If the roots of this equation are all greater than unity in the absolute value, then y_t is stationary. For the simple AR(1) case, if the root of $1 - \varphi_1 L = 0$ is greater than unity in absolute value then y_t will be stationary. Having $L = 1/\varphi_1$, this means that $|\varphi_1|$ should be less than one. Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and some of their extensions are the various tools by which one can formally test for Unit root in a variable.

4.3.4.1 Dickey-Fuller Test

The simplest form of the Dickey-Fuller (DF) test amounts to estimating an AR(1) model :

$y_t = \varphi_1 y_{t-1} + \varepsilon_t$ or:

(4.12) $(1 - L)y_t = \Delta y_t = (\varphi_1 - 1)y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim IID(0, \sigma^2)$

The non-stationarity null hypothesis $\mathbf{H_0}$: $\varphi_1 = 1$ is to be tested against the alternative stationarity $\mathbf{H_1}$: $\varphi_1 < 1$. The advantage of (4.12) is that this is equivalent to testing : $(\varphi_1\text{-}1) = \varphi^* = 0$ against $\varphi^* < 0$. The standard approach to testing such a hypothesis is to construct a t-test; however, under non-stationarity, the statistic computed does not follow a standard t-distribution but, rather, a Dickey-Fuller distribution (Dickey and Fuller 1979). It is worth noting that adding a constant and trend to the model increases (in absolute values) the critical values, that is $|\tau_t| > |\tau_\mu| > |\tau|$[11]; and therefore making it more difficult to reject the null hypothesis, even when it should, in fact, be rejected. Perron (1988) has put forward the sequential testing procedure which starts with the use of a general model and then eliminates unnecessary nuisance parameters[12]. If we fail to reject the null using the most general specification (perhaps because of the low power of the test), testing continues down on more restricted specifications. The testing stops as soon as we are able to reject the null hypothesis of a unit root.

4.3.4.2 Augmented Dickey-Fuller Test (ADF)

If the d.g.p. in fact follows an AR(p) process, then the error term (ε_t) in (4.12) will be autocorrelated to compensate for the misspecification of the dynamic structure of the process y_t. In this case the DF statistics will be invalidated. ADF test is the DF test when adjusted for some appropriate (significant) differenced dependent variable to capture autocorrelation in the error term[13]:

$$\Delta y_t = \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi_i \Delta y_{t-i} + \varepsilon_t$$

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[11] τ_μ indicates the original unit root model (4.12) with the addition of a constant term, whereas τ_t indicates that model when includes a constant and trend term at the same time.

[12] Several criteria such as significance of the terms and serrial correlation can be used to catch the best specification of the model. See also section 4.2.2 for more discussion in this concern.

[13] See Perron (1988) for an alternative non-parametric approach for correcting this problem (also see Banerjee, et al, 1993, for a brief explanation of that).

or to allow for the possibility of deterministic components such as a constant or/and trend:

$$\Delta y_t = \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi_i \Delta y_{t-i} + \varphi_0 + \lambda t + \varepsilon_t \ , \ \varepsilon_t \sim IID(0,\sigma^2)$$

The number of lags could be chosen based on an approximation of the number of observations, such as $T^{1/3}$ (T indicates the numbers of observation), which is an upper bound on the number of lags (Banerjee, *et. al.* 1993, p. 108). Selecting too few lags may results in over-rejecting the null when it is true, while too many lags may reduce the power of the test (through reducing the number of observation available for the test).

4.3.4.3 Structural Breaks and Unit root Test

Perron (1989) argues that standard tests of the unit root hypothesis against the trend-stationary alternatives can not reject the unit root hypothesis if the time series has a structural break. In other words, a unit root test which does not take account of the structural break in the series can result in (wrongly) not-rejecting the differenced stationary hypothesis when in fact the trend stationary alternative is true (low power). If the breaks in the series are known a - priori, then it is relatively simple to adjust the ADF test by including appropriate dummy variables to the model. Kim (1990) considered a situation in which the breaks are unknown a - priori using a Perron type model. The relevant critical values for unit root tests involving shifts in trend and/or intercept are found in Perron (1989, 1990).

4.4 Co-integration

The concept of cointegration is the connection between relationships between integrated processes (from statistical point of view) and the concept of (steady state) equilibrium (from economic point of view). It was introduced by Granger (1981) and extended by Engle and Granger (1987).

Testing for stationarity of a single variable is similar to testing whether a linear combination of variables cointegrate to form a stationary, equilibrium relationship.

The two issues of being able to test for the existence of an equilibrium relationship among variables and to accurately estimate such a relationship are complementary. Indeed static regressions among integrated series are meaningful if and only if they involve co-integrated variables.

Suppose that all the elements in vector of X_t are $I(1)$ series. In general, then, any linear combination δ' Xt of the elements of X_t will produce an $I(1)$ series U_t. The only exemption, if one exists, is a co-integrating vector α such that $\alpha'X$ is $I(0)$:

$$\alpha' X_T = v_t, \qquad v_t \sim I(0)$$

Since ordinary least squares , in fact, minimises the residual variance of X_t, a simple OLS regression of the form above should provide a good approximation to the true co-integrating vector when one exists.

All that is needed to parameterize a long run equilibrium relationship among a set of variables is a static OLS regression. This regression is performed as the first step of the Engle-Granger two-step estimator and serves as a preliminary check on the equilibrium relationships postulated by economic theory to exist among the variables. However, as I point out below, in practice the static OLS regression has proved to be an inferior estimator of a cointegrating vector.

4.4.1 Concept and Definition

If a series must be differenced d times before it becomes stationary, then it contains d unit roots and is said to be integrated of order d, denoted $I(d)$. Consider two time series y_t and x_t, which are both $I(d)$. In general, any linear combination of the two series will also be *I(d)*; for example, there exists a vector β, such that the disturbance term from the regression ($\mu_t = y_t - \beta x_t$) is of a lower order of integration, *I(d-b)*, where *b>0*, then Engle-Granger (1987) define y_t and x_t as **cointegrated** of order (*d, b*). Thus, if y_t and x_t were both *I(1)*, and $\mu_t \sim I(0)$, then the two series would be cointegrated of order *CI*(1, 1)[14].

4.4.2 Methods of Estimation

4.4.2.1 Single Equation Approach

4.4.2.1.1 Two-stage Engle-Granger Method

This method uses the residual-based ADF test to investigate for cointegration between the variables. If we wish to estimate the long-run relationship between y_t and x_t , given they are cointegrated, it is only necessary to estimate the static model:

(4.13) $y_t = \beta x_t + \varepsilon_t$,

(including an intercept and time trend if necessary for ε_t to be *I(0)*). Estimating (4.13) using OLS achieves a **consistent** estimate of the long-run steady state relationship between the variables in the model, and all dynamics and endogeneity issues can be ignored asymptotically. This is because of the **superconsistency** property. Superconsistency indicates that if y_t and x_t are both non-stationary *I(1)* variables, and $\varepsilon_t \sim I(0)$, then as sample size, T, becomes larger the OLS estimator of β converges to its true value at a much faster rate than the usual OLS estimator with stationary *I(0)*

[14] It is possible to have a mixture of different order series when there are three or more series in the model. As Pagan and Wickens (1989) point out, in this instance a subset of the higher-order series must cointegrate to the order of the lower-order series. So. if $y_t \sim I(1)$, $x_t \sim I(2)$, and $z_t \sim I(2)$, then as long as we can find a cointegration relationship between x_t and z_t such that v_t $(=x_t - \lambda z_t) \sim I(1)$, then v_t can potentially cointegrate with y_t to obtain ω_t $(=y_t - \xi v_t) \sim I(0)$.

variables[15] (Stock, 1987). That is, the I(1) variables asymptotically dominate the *I(0)* variables, Δx_t, Δy_t and ε_t[16]. Of course, the omitted dynamic terms (and any bias due to endogeneity[17]) are captured in the residual, ε_t, which will consequently be serially correlated. But this is not a problem due to 'superconsistency'. The estimated error term ($\hat{\varepsilon}_t$), then, should be tested for stationarity, i.e. the necessary condition for the validity of two-stage Engle-Granger method.

Estimating $y_t = \beta x_t + \varepsilon_t$, is only the first stage of the EG procedure, with stage two comprising estimating the short-run ECM itself using the estimates of disequilibrium ($\hat{\varepsilon}_{t-1}$) to obtain information on the speed of adjustment to equilibrium. That is, having ($\hat{\varepsilon}_{t-1} = y_{t-1} - \hat{\beta} x_{t-1}$) from the **static long-run estimation** in the first stage, it is possible to estimate:

$$\mathrm{A}(L)\Delta y_t = \mathrm{B}(L)\Delta x_t - (1-\mu)\hat{\varepsilon}_{t-1} + \mu_t$$

where $\mathrm{A}(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \ldots - \alpha_p L^p$, and $\mathrm{B}(L) = \gamma_0 + \gamma_1 L + \gamma_2 L^2 + \ldots + \gamma_q L^q$ and $\mu = \alpha_1 + \alpha_2 + \ldots a_p$. This equation allows for a general dynamic structure to be determined by the data. If y_t and x_t are *I(1)* and cointegrated, thus **all** the terms in this equation are I(0) and statistical inferences using standard t-and F-tests are applicable.

There are difficulties if one tries to estimate accurately a 'long-run' relationship with only a small sample over a short time period. Furthermore, while the estimator produced by this method may be superconsistent, it can be biased in finite samples especially of the size typical in economics (Hargreaves, 1994).

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[15] In other words, a superconsistent variable is of order 1/T instead of the usual 1/√T. (Hargreaves, 1994)

[16] A simple dynamic model of short-run adjustment: $y_t = \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha y_{t-1} + \mu$ can be rewritten as: $y_t = \beta x_t + \lambda_1 \Delta x_t + \lambda_2 \Delta y_t + v_t$. Thus estimating the static model (4.9) to obtain an estimate of the long-run parameter β is equivalent to estimating this dynamic model without the short-run terms Δy_t and Δx_t .

[17] See Hargreaves, 1994 for a brief clarification on endogeneity problem.

Furthermore, in finite samples, it has been shown that bias is a problem (and this will be discussed later on). Moreover, Philips and Durlauf (1986) have derived the asymptotic distribution of the OLS estimator of β, and its associated t-statistics, showing these to be highly complicated and non-normal and thus invalidating standard tests of hypothesis. Thus, in the case of finite samples bias and the inability to draw inferences about the significance of the parameters of the static long-run model are problems.

The other potential problem that appears when using Engle-Granger approach of cointegration is the *common factor* problem. To sketch this problem, we remember that ADF begins with estimating a supposed long-run model:

(4.14) $y_t = \beta x_t + \varepsilon_t$,

with an AR(1) (stationary) error term; $\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t$. These two equations imply:

(4.15) $y_t = \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + u_t$,

where $\gamma_0 = \beta$, $\gamma_1 = -\beta\rho$ and $\alpha_1 = \rho$. So: $\gamma_0\alpha_1 = -\gamma_1$ (common factor restriction). (Cuthbertson and Barlow, 1991) If γ_0, γ_1 and α_1 are all significant and the common factor restriction holds, then, we have the static model (4.14) (with an AR(1) error) and hence the estimated β in the first stage of ADF proceeding indicates truly the long-run coefficient. If, however, the common factor rerstriction does not hold we have a dynamic model. In these circumstances the estimated coefficient in the first stage is in fact a short run coefficient (which we have wrongly taken as a long-run coefficient). So treating the coefficients in the first step of ADF as the long run, while they are not, is equivalent to imposing the common factor restriction on the original model while it does not hold (see Kendy, 1992).

4.4.2.1.2 Alternative Methods

There are a number of alternative tests for cointegration. The simplest is the cointegration regression Durbin-Watson (CRDW) test proposed by Sargan and Bhargava (1983). However this criteria value is only relevant when the error term in static model follows a first-order process, that is no higher-order residual autocorrelation.

Kremers, Ericsson and Dolado (1992) suggested an approach according which the parameter α in the error-correction formulation:

$$\textbf{(4.16)}\quad \Delta y_t = \gamma_0 \Delta x_t - (1-\alpha)\hat{\varepsilon}_{t-1} + \mu_t$$

should be directly tested for $\alpha = 1$ as a null which implies no cointegration relationship between variables. But again to apply this approach it is needed to estimate ε_t in a static separate stage which results in the same problems as for the EG test.

4.4.2.1.2.1 Non-Linear simultaneous Estimation Method

As discussed before, when using EG method we need to estimate static (long-run) coefficients in the first stage without accounting for short-run effects. This could potentially lead to a set of inaccurate (biased) results. Although, because of super-consistency, this problem can be overlooked when we consider a large set of data; in the case of small samples, however, the problem can be serious. Bewley (1979) and also Wickens and Breusch (1988) argue that one should estimate both the long-run and short-run parameters simultaneously and one would get more efficient estimates of the long-run parameters by this procedure (Maddala, 1992, p. 263). Therefore, it seems reasonable to consider estimating a full model including all short-run and long-run components simultaneously. Such a model is, in fact, a *disequilibrium representation* of the process under investigation (see Thomas, 1993).

(4.17) $A(L)y_t = B(L)x_t + \mu_t$

where $A(L) = 1 - \alpha_1 L - \alpha_2 L^2 - ... - \alpha_p L^p$, and $B(L) = \gamma_0 + \gamma_1 L + \gamma_2 L^2 + ... + \gamma_q L^q$. This is a general model involving long-run and short-run components. The purpose of the ECM is to focus on the short-run dynamics while making them consistent with the long-run solution. For *p=q=1*, we can rewrite the general model as:

$$y_t = \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + \mu_t$$

and in an ECM form as:

(4.18) $\Delta y_t = \gamma_0 \Delta x_t - \lambda(y_{t-1} - \beta x_{t-1}) + \varepsilon_t$

Where $\beta = (\gamma_0+\gamma_1) / 1-\alpha_1$, and $\lambda = 1-\alpha_1$. The term in bracket shows the *disequilibrium error* which in EG method is to be estimated in a separate and static stage.

One can estimate short-run and long-run coefficients in (4.18) directly using a **non-linear estimating method**. Using this method, by not ignoring the short-run dynamics compared with the EG method, the finite sample biases of the long-run estimates will be likely reduced[18]. Banerjee, *et. al.* (1993) argue that this method is as good as estimating the full system, but only if there is only one cointegrating vector.

[18] Given the existing limitation in the number of observations in the data utilised in this thesis, this method, among other single equation methods, was chosen as the most appropriate method in the empirical models applied through the next chapters.

4.4.2.2 Multivariate VAR Procedure

4.4.2.2.1 Johansen Procedure

If there are more than two variables in the model, the single equation approach can be misleading, particularly if more than one cointegration relationship are present. When the number of cointegration vectors is unknown, and given the need to allow all variables to be potentially endogenous then one would gain little advantage in starting the single equation method. Rather the multivariate VAR approach developed by Johansen (1988) is the more proper frame to begin testing for cointegration. In a system of equations including a vector of n potentially endogenous variables, the number of co-integrating vectors will be unknown. Determining the number of cointegrating vectors is very important since over-estimation or under-estimation of them have potentially serious consequences for estimation and inference (see Banerjee, *et. al.*, 1993)

Johansen (1988) proposed a maximum likelihood approach to test the null hypothesis that there are $r \leq n\text{-}1$ different cointegrating vectors. Suppose that the following unrestricted VAR:

$$\textbf{(4.19)}\ X_t = A_1X_{t-1} + A_2X_{t-2} + \ldots A_kX_{t-k} + \mu_t, \qquad \mu_t \sim \mathrm{IN}(0, \Sigma)$$

shows DGP under consideration. Where, X_t is (n×1) vector. This model can be transformed into a vector error-correction form:

$$\textbf{(4.20)}\ \Delta X_t = \Gamma_1\Delta X_{t-1} + \Gamma_2\Delta X_{t-2} + \ldots + \Gamma_{k-1}\Delta X_{t-k+1} + \Pi X_{t-k} + \mu_t,$$

where

Γ_I = - (I-A_1-...-A_i), (i=1,...k-1) and Π = - (I-A_1-...-A_k). The coefficient attached to Π are comprised of two components α and β which represent the speed of adjustment to equilibrium and the long-run coefficients of the model respectively ($\Pi=\alpha\beta'$). So the terms $\beta'X_{t-k}$ represent up to n-1 cointegration relationship in the set of variables under consideration. Given that X_t is a vector of non-stationary I(1) variables, then equation (4.20) involves two sub-sets of I((0) and I(1) variables (ΔX and X respectively). For the error term μ_t to be a white noise in (4.20), which is a necessary condition for the validity of the estimation process, the terms ΠX should also meet the stationarity condition (i.e. $\Pi X \sim I(0)$). Given that all the variables in X_t are I(1), for ΠX_{t-k} to be I(0), up to $r \leq (n-1)$ cointegration vectors should exist in X_t : $\beta' X_{t-k} \sim I(0)$. So $\Pi = \alpha\beta'$ contains n columns of which *r* non-zero and *n-r* zero ones[19]. Testing for cointegration amounts to an investigation of the rank Π that is, finding the number of *r* linearly independent columns in Π. Rewriting (4.20) as:

$$\textbf{(4.21)}\ \Delta X_t + \alpha\beta' X_{t-k} = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1}\Delta X_{t-k+1} + \mu_t,$$

If one partials out the short-run effect (ΔX_{t-1}, ..., ΔX_{t-k+1}) on both ΔX_t and X_{t-k}, one could then estimate Π by regressing the adjusted ΔX_t on X_{t-k}. These adjusted values are the residuals of two multivariate regression on (ΔX_{t-1}, ..., ΔX_{t-k+1}) i.e.:

$$\Delta X_t = p_1 \Delta X_{t-1} + \ldots + p_{k-1}\Delta X_{t-k+1} + R_{0t}$$

$$X_{t-k} = t_1 \Delta X_{t-1} + \ldots + t_{k-1}\Delta X_{t-k+1} + R_{kt},$$

which can then be used to form residual (product moment) matrices:

$$S_{ij} = T^{-1}\sum R_{it}R'_{jt},\ \text{i,j} = 0,\text{k}$$

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[19]Each of the *r* cointegrating vectors in β is associated with a particular column in α which must contain at least one non-zero element.

The maximum likelihood estimate of β is obtained as the eigenvectors corresponding to the *r* largest eigenvalues from solving the equation:

$$\left|\lambda S_{kk} - S_{k0} S_{00}^{-1} S_{0k}\right| = 0,$$

which gives the eigenvalues $\hat{\lambda}_1 > \hat{\lambda}_2 > ... > \hat{\lambda}_n$ and the corresponding eigenvectors $\hat{V} = (\hat{v}_1, \hat{v}_2, ..., \hat{v}_n)$. Those *r* elements in $\hat{V}$ which determine the linear combinations of stationary relationships can be denoted $\hat{\beta} = (\hat{v}_1, ..., \hat{v}_t)$, that is those are the cointegration vectors. Additionally, in Johansen's methodology we can test restrictions on the cointegrating vectors, using Likelihood Ration tests.

There are different considerations on advantages and disadvantages of Johansen method in related literature. Whilst Enders (1995) assesses this method as 'nothing more than a multivariate generalisation of the Dicky-Fuller test' (p.386), Chremza and Deadman (1992) regard this method as 'superior' to the Engle-Granger single equation method[20]. The statistical properties of the Johansen procedure, they argue, are generally better and the power of the cointegration test is higher.

One of the most interesting aspects of the Johansen procedure is that it allows for testing restricted forms of cointegrating vectors. For instance, in a Purchasing Power Parity relationship one can test restrictions concerning the long-run proportionality between exchange rate and price differentials. In terms of equation:

$$e_t = \alpha_0 + \alpha_1 \Delta p_t + v_t,$$

[20] They emphasised, however, that the Engle-Granger and Johansen procedures are established within different econometric methodologies and therefore cannot directly be compared.

where e_t is logarithm of the nominal exchange rate (domestic price of foreign currency) and Δp_t shows the logarithm of ratio of domestic to foreign prices, the restrictions of interest are: $\alpha_0 = 0$, and $\alpha_1 = 1$.

Johansen's test also provides a technique for testing all possible cointegrating vectors, as well as the corresponding set of error-correction coefficients. (see Cuthbertson *et. al*, 1992)

A major drawback associated to the Johansen procedure is that with this method two different researchers may well lead to different estimates depending on the number of lags they have used. Even it is hard to see how the Johansen method obtains its results and why they varied so much as one changed the lag length or sample size. To get rid of autocorrelation problem in error terms (which is assumed theoretically), the usual practice is to allow for relatively long-lags. Using long-length lags, however, may be inconsistent with economic sense. The lag-length, in fact, corresponds to the length of response to a deviation from a long run path (equilibrium) which is usually assumed occur after a relatively short period of time. So, to interpret the adjustment matrix (α) sensibly, the length of lags cannot be large. On the other hand, a low length of lags increases the possibility of autocorrelation in the error terms and this may affect the validity of the entire estimation process.

Moreover, one practical problem with the Johansen estimator is the difficulty of expressing what is going on inside the procedure which it probably is the case to most users.

4.5 ARCH Models

The presence of *uncertainty* in economic relationship could be captured by the variance of the error term which in standard estimations is presumed to be a constant over the sample period.

Engle (1982) proposed a model in which the variance of the dependent variable is allowed to depend upon the available information set and so called that ARCH (Autoregressive Conditional Heteroskedasticity) model. The presence of ARCH in a model enables conditional variances to alter through time, thus explicitly allowing changing uncertainty to be modelled and hence leading to more realistic forecast intervals. The presence of ARCH can also lead to serious model misspecification if it is ignored (Mills, 1990). In a simple case we can consider the model:

$$(4.22)\quad y_t = \lambda y_{t-1} + \beta x_t + \varepsilon_t, \quad \varepsilon_t \sim IN(0, h_t)$$

$$(4.23)\quad h_t = \operatorname{var} \varepsilon_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2,$$

ε_t are not autocorrelated, but the variance of ε_t depends on ε^2_{t-1}. A simple test for the ARCH effect, that is, a test for the hypothesis $\alpha_1 = 0$ in [4.23] is to regress the OLS residuals $\hat{\varepsilon}_t$ on $\hat{\varepsilon}_{t-1}$ (with constant term) and testing whether the coefficient of $\hat{\varepsilon}_{t-1}^2$ is zero. For example, an LM test would enable us to see whether the significant DW test statistic is due to serial correlation in ε_t or due to the ARCH effect.

4.6 Conclusion

An econometric model can be considered as a 'bridge' between economic theory and a simplified translation of the reality, and statistical inferences are the foundation of this bridge.

While it is valid to model a single economic variable as a pure statistical process (time series model), it is of a little use if one is intending to establish casual linkages between variables.

Regarding the fact that the traditional 'specific to general' model selection approach, which has been used for many years, may bias the judgement, the alternative 'general to specific' approach is considered now as a preferred approach. In this approach theory suggests which variables should enter a relationship, and the data are left to determine any possible static (long-run) or dynamics (short-run) of the d.g.p. In such a formulation, which includes a combination of different variables with possibly different degree of integration (say, I(1) and I(0)), cointegration is a necessary condition for the validity of the results.

Two-stage E.G. method for estimating an underlying cointegrated relationship is a common and superconsistent method when the data observations are sufficiently available. Nevertheless, in finite sample, it has been shown that the bias is a problem. To avoid this problem, non-linear one-step estimation method is treated as a preferred method.

In next chapters Johansen's method will be used to search for cointegrating vectors among variables under consideration. Where we find cointegration relationship(s), we try to test for any theoretically sensible restriction applicable on them. But because of data restrictions, which lower the performance of Johansen's method, a general non-linear model is used to specify the final model.

5

5. Exchange Rate Modelling: Theoretical Concepts and Empirical Evidence

5.1 Theoretical Survey

5.1.1 Purchasing Power Parity Theory of Exchange Rate

5.1.1.1 Introduction

Given the importance attached to the exchange rate in the success or failure of an open economy, it is not surprising that exchange rate economics is one of the most heavily researched areas of the discipline. Despite this extensive research, a large number of unresolved issues remain, and exchange rate economics continues to be an extremely challenging area.

Early contributions to the post-war literature on exchange rate economics include Nurkse (1945) and Friedman (1953). Both of these contributions are to a large extent concerned with the role of *speculation* in foreign exchange markets. Nurkse warns against the dangerous of *'bandwagon effects'*, which may generate market *instability*. Friedman's classic apologia for floating exchange rates (1953) is remarkable in its anticipation of much of the literature of the following two decades and is still cited as the seminal article on *stabilising speculation* (MacDonald, and Taylor, 1992).

The early literature gave prominence to the current account in the determination of exchange rates. Initial developments stressed the role of goods arbitrage; that is currencies are valued for what they can buy. The spot rate would then be determined by the relative prices between the domestic and foreign country. Frenkel (1978b, 1981b) provides a very useful survey of the long intellectual history of the goods arbitrage theory, commonly known as Purchasing Power Parity (PPP).

5.1.1.2 Theoretical description of PPP

Purchasing Power Parity theory is one of the oldest theories[1] of exchange rate determination. It says simply that, starting from a given base period, the exchange rate between any two currencies (or between one currency and a trade-weighted bundle of the other currencies) will move in line with relative price levels in the two economies (or with prices at home relative to the trade- weighted inflation in the other countries). There are two main assumptions required for this: domestic tradable goods be perfect substitute for foreign goods; and the goods market be 'perfect' (low transaction costs, perfect information, perfectly flexible prices, no artificial restrictions on trading) (Cuthbertson and Taylor, 1987). Because the theory singles out price level changes as the predominant determination of exchange rate movements it has also been called the *"inflation theory of exchange rate"* (Dornbusch,1987 pp1075).

This theory argues that exchange rate movements primarily reflect differences in inflation rates between countries. PPP is a plausible description of the trend behaviour of exchange rates, especially when inflation differentials between countries are large. Dornbusch (1987) has argued that "the PPP relationship does hold in the case of an increase in the money stock. If price level movements are caused by monetary changes- as they are likely to be if the inflation rate is high- then we should expect PPP relationships to hold in the long term."

According to the *absolute* version of PPP, the price of foreign currency in terms of domestic currency, or the exchange rate, E, should equal the ratio of an index of the price of a domestic basket of goods (P^d) to an index of the price of a foreign basket of the same goods (P^f) in the absence of transactions costs. This can be expressed as:

$$E = K\,(P^d/P^f)$$

[1] Although, some writers believed that the roots of PPP theory extend back more than two (Humphrey and Keleher, 1982) or even four (Berholnz, 1982) centuries; the modern attention, however, was revived by Cassel (1916). Based on the historical view the first contribution on the subject of PPP was published in 1916 in the Economic Journal, using price level and exchange rate data for US, and Sweden.

where K is the real exchange rate. According to the strict version of absolute PPP, K=1. Taking logs of the variables in the above equation yields:

$$e=k+p^d-p^f$$

where the lower case representation corresponds to the log of the upper case representation. In this case, k is assumed to equal 0. This relationship is often specified in its relative version which is given as:

$$\Delta e=\Delta k+\Delta p^d-\Delta p^f$$

Here, PPP implies that changes in the domestic currency value of the foreign currency will reflect the inflation differential between the domestic and foreign countries and also changes in the real exchange rate which, in the strong version of relative PPP, are assumed to be zero.

As a comprehensive model we introduce the following model[2]:

$$\Delta e_t=\sum_{i=1}^{n}\alpha_i\Delta e_{t-i}+\sum_{j=0}^{n}\beta_j\Delta(p^d-p^f)_{t-j}+\Sigma\Omega Z$$
$$+\lambda(e-\phi_1p^d-\phi_2p^f)_{t-1}+\mu_t$$

where Δ denotes the first difference of underlying variable. Z indicates a vector of the other explanatory variables including oil revenue, and dummy variables[3].

Using this model, we can test for two alternative versions of PPP theory called absolute and relative (long-run and short-run components respectively). Meanwhile,

[2] See chapter 4 for details of a non-linear simultaneous estimation model.
[3] The exigency of adding some extra explanatory variables (including lags) in some situations to the PPP relationship will be discussed in the next sections.

through estimating the ECM term (λ) we can test for the cointegration relationship among variables which, in fact, is a necessary condition in a valid estimating process. This coefficient also indicates the speed of adjustment from a disequiblirium position to equilibrium one.

The possible arrangements are:

- Absolute PPP plus slow adjustment $\Rightarrow -1<\lambda<0$, $\phi_1=1$, $\phi_2=-1$.
- Only-relative PPP $\Rightarrow \Sigma\beta j/1-\Sigma\alpha i=1$; and either $\lambda=0$ or (ϕ_1 and ϕ_2)$\neq |1|$.
- Absolute and relative PPP plus slow adjustment $\Rightarrow \Sigma\beta j/1-\Sigma\alpha i=1$; $-1<\lambda<0$, $\phi_1=1$, $\phi_2=-1$.

The strong version of absolute PPP relies on the 'law of one price' in an integrated, competitive market. Abstracting from any frictions, the price of a given good will be the same in all locations when quoted in the same currency, say dollars: $P^d{}_i = E \cdot P^f{}_i$. , where $P^d{}_i$ and $P^f{}_i$ represent the price of the ith commodity at home and abroad, stated in home and foreign currencies respectively, and E the exchange rate.

Consider now a domestic price index $P^d = f(P^d{}_1, \ldots P^d{}_i, \ldots P^d{}_n)$ and a foreign price index $P^f = g(P^f{}_1, \ldots P^f{}_i, \ldots P^f{}_n)$, if the price of each good, in dollars, are equalised across countries, and if the same goods enter each country's market basket with the same weights, then by definition absolute PPP prevails. The law of one price in this special case extends not only to individual goods but also to aggregate price levels. Spatial arbitrage then takes the form of strong version of PPP:

$$E= P^d/P^f$$

whatever the monetary or real disturbances in the economy, because of instantaneous and costless arbitrage the prices of a common basket of goods in the two countries measured in a common currency will be the same or :

$P^d/E.P^f = 1$,

at all time.

The basic assumptions behind this equation, as implicitly mentioned, include the following:

1- No transport costs;

2- No impediments to trade such as tariffs or exchange controls;

3- Domestic and foreign goods should be perfectly homogeneous;

4- Continual equilibrium in the asset market.

The equilibrium relationship upheld in PPP hypothesis assumes that perfect commodity arbitrage acts as an error correction mechanism to force the domestic price of a bundle of home goods in line with the domestic price of the same bundle of foreign goods.

Whilst there may be little objection to this theory as a theoretical statement, objections arise, however, when it is interpreted as an empirical relationship. In fact the (spot) prices of a given commodity will not necessarily be equal in different locations at a given time. Transport costs and other obstacles to trade, especially tariffs and quotas, do exist and hence the location of delivery does matter. 'We would not expect the price even of an ounce of gold of a specified fineness always to be the same in NewYork and in Calcutta.' (Dornbusch, 1987 pp. 1076)

Information costs and impediments to trade stand in the way of strict spatial equalisation of price. Impediments to trade and imperfection of competition, of course, also make it possible that spatial price differentiation can occur, thus further limiting strong PPP.

The weak version of PPP restates the theory allowing for obstacles to trade (such as tariffs and non-tariff barriers), transport costs, information costs, and market imperfections, under the assumption that they are constant over time:

$$E = K\,(P^d/P^f),$$

where K is a constant factor. This relationship holds exactly in the rates of changes, so that if the factors which cause absolute PPP to fail are constant over time, relative PPP might hold even when absolute PPP does not. According to relative PPP, the real exchange rate is a constant (but not necessarily equal to one).

There are some main questions in this framework:

- What is the relevant price index?
- In what circumstances would one expect divergence from PPP?
- Over what time horizon would PPP be expected to hold?
- How does causation run; is it from relative prices to exchange rate or in an opposite direction?

Choice of the price index to be used in the PPP relationship has been subject to much dispute in the literature. However, there is no strong convention among researchers about which price index is appropriate.

On one hand authors who emphasise the role of commodity arbitrage to explain the PPP relationship (Kravis and Lipsey, 1978; Milone, 1986) argue that an index of traded goods has to be used[4]. The choice here is between export prices and wholesale prices.

On the other hand, authors who explain the PPP relationship by referring to different pricing mechanisms in goods and asset markets indicate that the proper index should cover the broadest range of commodities (Frenkel, 1981a; Daniel, 1986a; Isard, 1977) and that the use of traded goods in a derivation of PPP amounts to nothing more than a tautology. However, if a price index which includes both traded and non traded

[4] They implicitely consider that the relative price of tradables and non tradables remains constant over time.

goods is used, this can impart a bias into the calculation of PPP, stemming from cross-country differences in weight (Officer 1976). The choice, in this case, is between the consumer price index (CPI) and the GDP deflator. Dornbusch (1987b, p. 1079) preferred the GDP deflator because of its 'clear methodological definition'. Rush and Husted (1985) object to the use of GDP deflators, because they cover only prices of currently produced goods and services, while CPI indices contain prices of second hand goods as well. To sum up this part of discussion, those who suggest WPIs (whole price indices which put more weight on traded goods) as more appropriate than CPIs emphasise that the later are more comprised by non-traded goods than WPIs. But when we notice that the definition of traded and non traded goods varies widely across countries (compare, for instance, industrial with mineral or commodity export countries)[5], and especially, when we are discussing developing countries, an index that gives heavy weight to traded goods may not provide a proper framework to test the PPP theory. Hence, we choose CPI as the appropriate indices in our empirical tests in next chapters.

5.1.1.3 Causality

The usual relationship of PPP is, in most cases, presented as if causation runs from relative prices to exchange rates. Any shocks affecting the exchange rate are transmitted through prices. The reality, however, seems much more complicated. There may be common underlying forces, e.g. monetary and fiscal, which drive both exchange rates and relative prices (but at different speeds). If differences in relative prices and in competitiveness persist, and result in persistent current account imbalances, corrective forces are likely to come into play, ultimately producing compensating changes in exchange rates[6]. However, one can think of circumstances where causation might run from exchange rates to relative prices. For instance, a devaluation raises the price of imported goods; this, in turn, may induce further price

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[5] For example, for countries like Japan and Germany, manufatured goods are the major traded goods, but for countries like Astralia it is mining and agricultural products that are the major traded goods.
[6]In an adjustable peg regime a policy change to the exchange rate may come after differences in inflation have persisted for a while.

adjustments. With evidence supporting short-run price stickiness in the goods market relative to rapid adjustment in the foreign exchange market, unidirectional causality, however, becomes highly questionable. The evidence raises the possibility of bi-directional causality or even unidirectional causality, but in the opposite direction from that realised in equation $e = k + p^d - p^f$. Frenkel (1978) looked into the possibility of the latter case and his empirical evidence, based on the experience of the 1920s supports it. Commenting on the results he wrote that "Generally speaking, the results indicate that the data are consistent with the hypothesis that prices do not 'cause' exchange rates (in the Granger sense) while the exchange rates do 'cause' prices".

5.1.1.4 Divergence from PPP

There are strong theoretical reasons for not expecting PPP to hold in the short run; for the longer run the analytical issues are more complicated but even here there are circumstances where it might not hold. We mentioned above some basic and necessary assumptions behind the PPP theory. If none of these assumptions hold, then, we do not expect the PPP to hold. In reality one rarely could find the situation in which these assumptions are perfectly valid. Furthermore, for any real shocks which are irreversible during the short run, the simple version of PPP will be violated even in the long run due to real exchange rate appreciation/depreciation. Argy (1994, p. 331) generalises some main points which may cause divergence from PPP; 'any *protracted* real (or even monetary) changes are likely to change the real exchange rate in the longer run. A real change can come from, say, an oil price shock, a fiscal change, a change in the degree of protection or a change in the demand for a country's exports. A change in the rate of inflow of capital over time would also be expected to produce a change in the real exchange rate.' [The effect of the oil shocks is the determinant which I will consider as significant on oil exporting country such as Iran.] Structural changes are also very effective factors in diverging PPP relationship from its long-run position.

Giovannett (1992, p.83) refers to the real shocks (such as productivity shocks, natural resource discovery and so on) as events leading to divergence from PPP.

5.1.1.5 Real and monetary shocks

Many economists disagree with the assumption that real exchange rate changes are zero and point to findings rejecting PPP as circumstantial evidence. Some economists suggest that real shocks account for deviation from PPP. These economists view changes on the **real side of the economy** as driving the real exchange rate. Economists who fall into this category include Balassa (1964), Samuelson (1964), Hooper and Morton (1982), Jones and Purvis (1983), Davuytan and Pippenger (1985), Edison (1989), Daniel (1986), Schotman (1987).

Another group of economists view divergence from PPP as largely caused by **monetary shocks** in the presence of nominal rigidities. Given this, it is nominal factors that lead to observed changes in the real exchange rate. However, these changes are temporary, this belief is built on an asset theory foundation. This approach is not an explicit model for real exchange rate behaviour since the real exchange rate is described as the residual outcome of changes in the nominal exchange rate relative to changes in the price level differential. Among proponents of this belief are Fleming (1962),Mundell (1964), and Dornbusch (1976).

Explicit models of the real exchange rate have generally concentrated on one real factor or another; for example Feldstein (1986) looks at the effects of the *government budget deficit* on the real exchange rate, while Balassa (1964), Marston (1986) and Huizing (1987) examine the effects of *relative productivity growth*. Hooper and Morton (1982) show that changes in the real exchange rate are relative to *movements in the current account* via an expectations mechanism which picks up changes in underlying real factors, while Lothian (1986,1987) models *structural shifts through changes in monetary policy regime*. None, however, relate these real exchange rate changes back to the PPP relationship.

Lippert and Breuer (1994) have argued that real factors (altogether as one variable) is an omitted variable from the PPP relationship and is the cause of **divergence** from PPP. That is, the real exchange rate is an unobservable that is a factor in the determination of the nominal exchange rate. He concludes that when changes in the real exchange rate are incorporated into the relative version of PPP, PPP is not rejected (see an outline of this work in next section).

Dornbusch compares the PPP theory with the Quantity theory of money. He says that:

"the analogy with the Quantity theory of money holds particularly in the effects of monetary disturbances. The latter theory fails to hold exactly when disturbances are primarily monetary, for instance in the course of hyperinflations, because changes in the expected rate of inflation generate systematic movements in velocity that break the one to one link between money and prices. In the same way, monetary disturbances cause exchange rate movements that at least temporarily deviate from PPP, implying changes in the exchange rate adjusted relative price levels or 'real' exchange rates. It is true that when the economy, following a major monetary disturbance, has settled down again the cumulative changes in money, prices and the exchange rate will tend to be the same or at least close. In that sense PPP holds. The same is decidedly not true, however, in the course of the disturbance." (Dornbusch 1987, 1075-76).

5.1.1.6 Developments in PPP

Although the PPP theory, in its simple version, has failed to explain the volatility of exchange rate phenomenon, it has been the most basic conceptual framework for the later theories of exchange rate. Later developments of PPP theory replaced the relative price by the relative money stock via the quantity theory of money to give the monetary approach to exchange rate determination. In fact the monetary models of the exchange rate supplement the Purchasing Power Parity relation with money demand functions and equilibrium conditions in the money markets. As MacDonald and Taylor (1992) mention: 'since an exchange rate is , by definition , the price of one country's money in terms of that of another, it makes sense to analyse the determinants of that price in terms of the outstanding stocks of and demand for the two moneys.' (pp.3)

As the most important theory of exchange rate determination, one can refer to the monetary (flexible-price, sticky-price, and interest differential) and the portfolio balance approaches. The former has been argued, among others, by Frenkel (1976), Kour (1976), and Mussa (1976,1977), Dornbusch (1976,1983); and the latter has argued by Branson (1977).

Monetary and Portfolio versions of PPP will be discussed in the next section.

5.1.2 Monetary Models

5.1.2.1 Flexible Prices

By definition, an exchange rate is the relative price of one nation's money in terms of that of another. So it is rational to think of an exchange rate as being determined by the outstanding stocks of and the demand for the two Monies, Mussa (1984), Macdonald and Taylor (1992).

There are four basic assumptions on which this model relies. The first assumption is that Purchasing Power Parity holds continuously[7].

$$(5.1.1) \qquad e_t = p^d{}_t - p_t^f$$

where e is the logarithm of the nominal exchange rate (domestic prices of foreign currency); $p^d{}_t$ is the logarithm of domestic prices and $p^f{}_t$ is the logarithm of foreign prices.

The second assumption is the stability of the money demand functions of the domestic and foreign countries:

$$(5.1.2) \quad m_t = p^d{}_t + \alpha y^d{}_t - \beta r^d{}_t$$

and

[7]Mussa (1984) in his works has not regarded this assumption as essential to analysing the role of monetary variables in influencing exchange rates.

(5.1.3) $m_t^f = p_t^f + \alpha^* y_t^f - \beta^* r_t^f$

where $m^d{}_t$, $p^d{}_t$, and $y^d{}_t$ are the logarithm of domestic money supply, domestic price level, domestic real income and the level of interest rate respectively. Their correspondents with a superscript f versions are their foreign counterparts.

If we now subtract (5.1.3) from (5.1.2) to obtain $p^d{}_t$ - $p^f{}_t$:

(5.1.4)
$$\begin{aligned} m^d{}_t - m_t^f &= p^d{}_t - p_t^f + \alpha y^d{}_t - \alpha^* y_t^f - \beta^d r_t + \beta^* r_t^f \\ p^d{}_t - p_t^f &= m^d{}_t - m_t^f - \alpha y^d{}_t + \alpha^* y_t^f + \beta r^d{}_t - \beta^* r_t^f \end{aligned}$$

After substituting for the price differential from (5.1.4) in (5.1.1) we get an expression for the exchange rate:

(5.1.5) $e_t = m^d{}_t - m_t^f - \alpha y^d{}_t + \alpha^* y_t^f + \beta r^d{}_t - \beta^* r_t^f$

An alternative version of equation (5.1.5) maybe made when one assumes homogeneity in the structural coefficients across countries ($\alpha = \alpha^*$, $\beta = \beta^*$) and so

(5.1.6) $e_t = (m^d - m^f)_t - \alpha(y^d - y^f)_t + \beta(r^d - r^f)_t$

The further assumption made in this monetary model is that uncovered interest parity holds continuously. That is, the expected rate of depreciation of the domestic currency is equal to the domestic foreign interest-differential, so that there are no profitable incentives to switch between different currencies.

$$(5.1.7)\quad \Delta e^e_{t+1} = (r^d - r^f)_t$$

where

$$(5.1.8)\quad \Delta e^e_{t+1} = e^e_{t+1} - e_t$$

Having this assumption we can replace for r^d-r^f in equation (5.1.6). Then we get :

$$(5.1.9)\quad e_t = (m^d - m^f)_t - \alpha(y^d - y^f)_t + \beta\,\Delta e^e_{t+1}$$

This implies that we can interchange between the expected change in the exchange rate and the expected change in the interest differential (both of which reflect inflationary expectations). In other words, equation (5.1.7) indicates that the higher interest return on the domestic market (r^d-r^f) is then compensated for by the expected appreciation in the foreign currency (or expected depreciation in the domestic currency). Using equation (5.1.8) in (5.1.9) we obtain:

$$(5.1.10)\quad e_t = (1+\beta)^{-1}(m^d - m^f)_t - \alpha(1+\beta)^{-1}(y^d - y^f)_t + \beta(1+\beta)^{-1} e^e_{t+1}$$

Relaxing the unrealistic restriction of identity of coefficients across countries, we arrive at: (though $\beta = \beta^*$ for this to hold)

$$(5.1.11)\ e_t = (1+\beta)^{-1}(m^d - m^f)_t - \alpha(1+\beta)^{-1}y^d{}_t + \alpha^*(1+\beta)^{-1}y^f{}_t + \beta(1+\beta)^{-1}e^e_{t+1}$$

If expectations are assumed to be rational, then by iterating forward, equation (5.1.11) can be expressed in the "forward solution" form (Macdonald and Taylor (1992)):

$$(5.1.12)\ e_t = (1+\beta)^{-1}\sum_{i=0}^{\infty}[\tfrac{\beta}{1+\beta}]^i\left[(m^d - m^f)^e_{t+i} + \alpha y^{de}_{t+i} + \alpha^* y^{fe}_{t+i}\right]$$

These models of exchange rate determination have been criticized by some researchers for the inadequacy of the assumptions used to derive such models. For example, the collapse of Purchasing Power Parity in 1970s gave rise to the rejection of this model by Dornbusch (1980a).

But, despite the divergence from PPP some researchers who have employed the monetary models have noted that the conditions of monetary markets equilibrium are more immediately relevant for determining asset prices such as exchange rates, than for price levels (Mussa 1984).

Since this monetary model of the exchange rate assumes continuous PPP holds; the collapse of the latter in the years after floating, which has shown itself in ' the wide gyrations in the real rates of exchange between many of the major currencies' (MacDonald and Taylor, 1992, p.6), cast doubts on the validity of monetary models even as an incomplete model (Mussa, 1984).

All in all, to improve the empirical performance of these models one should take account of some shift effects caused by international and exogenous events[8].

5.1.2.2 Sticky Prices

The first and most simple version of the monetary approach of exchange rate determination, according to which prices are assumed perfectly flexible, might be called the *Chicago* theory of the monetary approach to the exchange rate (Frankel, 1979). In this view there is a positive relationship between changes in the exchange rate and changes of the interest rate differential. When there is an increase in the interest differential in favor of the domestic interest rate, then there is to be expected a rise in the inflation rate. Such an expectation leads to an immediate depreciation.

The second approach to the monetary or asset models of exchange rate could be called the Keynesian theory of exchange rate in which the prices are assumed to be sticky, at least in the short-run (Dornbusch, 1976c).

Based on this viewpoint when the domestic interest rate rises relative to the foreign rate it could be interpreted as the effect of a decrease in the domestic money supply. Without any expectation of compensating changes in the price level to keep real balances (M/P) unchanged, this would lead to a capital inflow, which in turn causes an instant appreciation in the domestic currency. Thus there is a negative relationship between the nominal interest rate differential and the nominal exchange rate. In fact the dynamic aspects of exchange rate determination in this model arise from the assumption that exchange rates and asset markets adjust faster than the goods markets (Dornbusch, 1976c).

To explain one kind of sticky-price model we firstly focus on the following equations:

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[8]Changes in oil price, for instance, could cause some changes in money demand and supply and also some expectations about the exchange rates and other economic situations in home and foreign countries.

(5.1.13) $$m^d - p^d = \alpha_1 y^d - \alpha_2 r^d$$

(5.1.14) $$r^d - r^f = {}_t e^e_{t+1} - e$$

(5.1.15) $${}_t e^e_{t+1} - e = \alpha_3(\bar{e} - e)$$

All variables, except for r^d and r^f, are in logarithms. Equation (5.1.13) is a conventional money market equilibrium. Equation (5.1.14) represents the Uncovered Interest Parity (perfect asset substitution) assumption. Arbitrage ensures that the return on domestic investment (r^d) must equal the return on foreign investment after adjustment is made for the expected change in the exchange rate [r^f+ (${}_t e^e_{t+1}$ -e)]. Equation (5.1.15) says that the exchange rate expected in the next period is the current rate plus some proportion of the discrepancy between the rationally expected long-run rate and the current spot rate.

m^d money supply

p^d domestic price

y^d output

r^d domestic interest rate

r^f foreign interest rate

${}_t e^e_{t+1}$ expectation about exchange rate formed in period t for $t+1$

e spot exchange rate

$\bar{e}$ long run equilibrium exchange rate

Combining equations (5.1.13), (5.1.14) and (5.1.15) we get:

(5.1.16) $$m^d - p^d = \alpha_1 y^d - \alpha_2[r^f + \alpha_3(\bar{e} - e)]$$

Total differencing of (5.1.16) and remembering the sticky price situation in which Δp = 0, Δy = 0 and noting that $\Delta m = \Delta\bar{e} \Rightarrow \Delta\bar{e} / \Delta m = 1$; we have[9]:

(5.1.17) $$\frac{\Delta e}{\Delta m} = \frac{1 + \alpha_2\alpha_3}{\alpha_2\alpha_3}$$

Equation (5.1.17) says that with the sticky price assumption the exchange rate will *overshoot*. The extent of the overshooting will depend on the interest elasticity of money demand (α_2) and the expectations (α_3) coefficient. To explain more we can imagine that if the money supply increases the interest rate decreases immediately. To clear the asset market, the exchange rate devalues (see equation (5.1.14)). At the same time, because of the increasing money supply, people expect inflation sometime in the future. This expectation amplifies the amount of the devaluation mentioned above. So in the first period the devaluation is bigger than that require to offset only the interest rate reduction (see equation (5.1.17)).This is just one part of the adjustment procedure. At this situation Purchasing Power Parity does not hold, because without any changes in prices (so far) we observe a devaluation in the exchange rate.

In the next period, the price level starts to increase. This phenomenon causes two movements in our variables:

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[9] Compare equation (4) and (16) in Dornbusch (1976) for the same results.

In money market, the increasing price level raises the interest rate proportionately. This movement in turn motivates the exchange rate to appreciate. So that, finally, when the price level increases as much the percentage rise in the money supply, the interest rate would have climbed back to its original level and the exchange rate would have appreciated up to the point at which Purchasing Power Parity is valid. This is the end of this story in which we have $\Delta m = \Delta\bar{p} = \Delta\bar{e}$ and $\Delta r = 0$

5.1.3 Balance of payments model

Based on economic theory this view of exchange rate determination says that in a pure float framework the exchange rate will equilibrate the flow demand for and the flow supply of foreign currency. Since the balance of payments must be zero in such a situation, any current account *surplus* must be exactly offset by a capital account *deficit*. Thus in this theory, the exchange rate will be determined by the variables which explain the current and capital accounts.

It is evident that many variations are possible depending on how the current and capital accounts are modelled[10]. The model below draws on the stock-flow framework.

5.1.3.1 Balance of payments equation:

$$(5.1.18)\ \frac{B}{X_0} = \frac{CA}{X_0} + \frac{K}{X_0}$$

where B, CA and K are respectively the overall balance of payments, the current account and the net capital inflows all deflated by initial exports. The elements are all defined in domestic currency.

[10]See for example Pesaran (1984) for the adjusted Capital and Current Accounts defined for oil exporting countries.

5.1.3.2 Current account equation:

$$(5.1.19)\ \frac{CA}{X_0} = \alpha_1\left(e + p^f - p^d\right) + \alpha_2\left(y^f - y^d\right) + CA_0$$

This says that the current account is explained by the real exchange rate and by relative output levels. CA_0 represents all other 'exogenous ' influences on the current account.

5.1.3.3 Capital account equation:

Now we need to take account of the foreign country's purchases of domestic bonds (inflow) as well as home purchases of foreign bonds (outflows). ΔBF and ΔEFA respectively stand for these.

$$(5.1.20)\ K = \Delta BF - \Delta EFA$$

The stock demand by foreigners of domestic bonds is a function of foreign wealth (W^*) and relative returns $[(r^d-r^f)-(e^e + e)]$. The stock demand by residents for foreign bonds is a function of home wealth (*W*) and relative returns. So we can derive the equation:

$$(5.1.21)\qquad \frac{K}{X_0} = \alpha_3 \Delta W^f - \alpha_4 \Delta W^d + \alpha_5 \Delta\left[\left(r^d - r^f\right) - \left(e^e - e\right)\right]$$

where W is the logarithm of wealth and e_e is the expected exchange rate in logarithm.

If we combine (5.1.21) with (5.1.19) and then substitute into (5.1.18) we can arrive at an exchange rate equation:

$$e = \beta_1 e_{-1} + \beta_2 \frac{\mathrm{B}}{\mathrm{X}_0} - \beta_3(\mathrm{P}^f - \mathrm{P}^d) + \beta_4(y^d - y^f) - \beta_5 \Delta W^f + \beta_6 \Delta W^d - \beta_7 \Delta(r^d - r^f - e^e)$$
$$-\beta_8 CA_0$$

wherein:

$$\beta_1 = \frac{\alpha_5}{\alpha_1 + \alpha_5} \qquad \beta_5 = \frac{\alpha_3}{\alpha_1 + \alpha_5}$$
$$\beta_2 = \frac{1}{\alpha_1 + \alpha_5} \qquad \beta_6 = \frac{\alpha_4}{\alpha_1 + \alpha_5}$$
$$\beta_3 = \frac{\alpha_1}{\alpha_1 + \alpha_5} \qquad \beta_7 = \frac{\alpha_5}{\alpha_1 + \alpha_5}$$
$$\beta_4 = \frac{\alpha_2}{\alpha_1 + \alpha_5} \qquad \beta_8 = \frac{1}{\alpha_1 + \alpha_5}$$

This equation says that :

- Central bank intervention (B/X0) in the form of purchases of foreign assets will depress the currency.
- An increase in output at home relative to that abroad will depress the currency.
- An increase in home prices relative to those abroad will depress the currency
- An increase in wealth at home (abroad) will depress (appreciate) the currency.
- An increase in returns favouring the home economy will appreciate the currency and
- An exogenous improvement in the current account will appreciate the currency.

5.1.4 Conclusion

Despite many works on the exchange rate, many issues remain unresolved.

The PPP theory has been regarded as a key building-block of exchange rate models. The general consensus which seems to have emerged is that whilst Purchasing Power Parity may have relevance to the long-run determination of exchange rates, in the short-run, however, other factors dominate the movement of exchange rates (Argy, 1994; Giovakketi, 1992). Literature highlights various reasons to explain a persistent deviation from PPP; omitted variables from this relationship and inefficiency in empirical methods employed are two important explanations we will argue next. Several works implemented in this area also revealed that this theory can produce better empirical results by adding some other explanatory variables (Officer, 1976, ...).

In next section a breif investigation on some empirical works in this area will be introduced.

5.2 Empirical Review on PPP hypothesis

5.2.1 Introduction

The objective of this section is to review the empirical literature on PPP with special attention to the studies addressing the issue of *deviations* from PPP. This phenomenon is sometimes treated as temporary which would vanish in the long run. If this is the case, the question which immediately arises is of what time interval would be enough to capture the equilibrium situation, and if it is not, how this deviation can be explained. Omitted variables from this relationship, inefficiency in empirical methods, trade barriers imposed on the relations between countries and so on are different reasons put forward to explain deviation from PPP.

It seems that the results of testing PPP are very sensitive to the nature of the study, to the features such as the countries under consideration, the time period of the study, the price index, econometric method and so on.

Empirical work on PPP during recent decades reveals that several methods have been used to test the validity of this theory. The criteria I have chosen in this regard to categorise this review is the econometric method applied on these works[1].

We can classify empirical work on PPP in three ways. First, before 1987, is the period with the lack of the cointegration concept. Up to this time, most works on PPP used simple regression techniques. See for example, Frenkel (1978); Adler and Lehmann (1983); Roll (1979); Hakkio (1984) ; Mecagni (1986); Rush and Husted (1985). The results obtained from these works seem mixed. Some of these who found evidence against this theory attempted to explain the deviation from PPP. The low power of empirical methods, among others reasons[2], was attributed for that.

The second type of studies were initiated from 1987 when the cointegration concept was introduced by Engle and Granger, and until the appearance of multivariate cointegration method introduced by Johansen. The main criticism made against the previous studies is that they have disregarded the fact that the level of the exchange

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[1] Abuaf and Jourin (1990) believe that ' the negative results obtained in previous empirical research reflect the poor power of the test rather than evidence against PPP.' (p. 157)

[2] See some other reasons in previous section.

rates and price levels are usually **non-stationary,** and so the estimated coefficients are not reliable (see chapter 4 for more details in this point). Following this criticism, researchers tried to analyse the residuals of the models for stationarity or tested for the stationarity of the real exchange rate directly. Throughout these residual-based works, the authors have basically used the two-stage cointegration method presented by Engle and Granger (1987). Example of this groups are: Schotman (1987), Giovannetti (1987), Corbae and Ouliaris (1988), Taylor (1988), Edison and Klovland (1987), Enders (1988), Hakkio and Rush (1989), Mark (1990), Fisher and Park (1991), Hoque (1995), Henricsson and Lundback (1995) and so on.

The third generation started when the Multivariate VAR cointegration approach was proposed by Johansen (1988). In this approach 'endogeneity' is not imposed on the variables previously. If there are more than two variables in the set of the variables in the model, the single equation approach is likely misleading, given that the number of cointegration vectors is unknown. 'Analysing the data in a full system of equations allows for possible interactions in the determination of [variables under consideration]. This would eliminate the single-equation bias likely to have affected many of the previous studies' (Johansen and Juselius (1992, p.212)

5.2.2 Review

5.2.2.1 Pre - cointegration studies

A huge number of works using traditional econometric methods have been conducted by different authors among them: Frenkel (1978); Adler and Lehmann (1983); Roll (1979); Hakkio (1984) ; Mecagni (1986); Rush and Husted (1985).

Early studies of Roll (1979), Frenkel (1978), and Adler and Lehman (1983) suggest that the real exchange rate closely follows a random walk which indicates that there is no tendency for Purchasing Power Parity to hold even as a long run relationship. On the other hand, more recent studies have reported some evidence that PPP may still be a valid long run proposition. Huizinga (1987) examines the Spectral properties of ten different monthly rates and finds some evidence of mean reversion towards PPP.

Frenkel (1978) in a seminal paper tried to show the existence of different interpretations of the origin of PPP relationship in the literature. He then implemented two different formulations of PPP (assuming exchange rate and price differentials as dependent variables separately in order to test for 'causality') and using 1920s and 1970s data for Dollar/Pound, Franc/Pound and Franc/Dollar. Furthermore, he used absolute and relative version of PPP for each case. Preliminary, the efficiency of the foreign exchange markets was analysed by regressing the logarithm of the current spot exchange rate, e_t, on the logarithm of the one-month forward exchange rate prevailing at the previous month, f_{t-1}, :

$$e_t = a + bf_{t-1} + u_t,$$

He concluded that the obtained results for the above test were consistent with the hypothesis that during this period the exchange markets under consideration were efficient[3].

To allow for short-run inertia he estimated a partial adjustment equation:

$$e_t = a\gamma + b\gamma(p^d / p^f)_t + (1-\gamma)e_{t-1}.$$

Except for Dollar/Pound, the results were consistent with the homogeneity assumption (unity of b as the long-run coefficient). The speed of adjustments appeared different across exchange rates and price indices.

Additionally, he tested the hypothesis that the price differential is more responsive to the exchange rate if the later has been anticipated than if it has not been anticipated. To do that, he defined e_t - f_{t-1} as the unanticipated component of the exchange rate (forecast error). Then the following relationship was estimated:

[3] In the sense that the current exchange rate is the best predictor of the future exchange rate adjusted difference in inflation rates between two countries (see Roll 1979).

$$(p^d / p^f)_t = a_0 + a_1 e_t + a_2 (e_t - f_{t-1}) + u_t,$$

The more unanticipated is the lead of the exchange rate, the less response is expected from prices to the exchange rate. In other words, a_2 is expected to be negative. The obtained results are consistent with this hypothesis and in all cases a_2 appears negative.

He concludes that :

> The relationship embodied in the traditional formulations of PPP should not be viewed as a theory of the determination of exchange rates. Rather, it describes an equilibrium relationship between two endogenous variables. As such, the PPP relationship should be viewed as a short-cut rather than a substitute for a complete model of the determination of prices and exchange rates.' (p. 188)

Having in mind the Frenkel (1978) results, Hakkio (1984) re-examined PPP hypothesis. He first adds some explanations for deviations from PPP. Imperfect substitution between goods in domestic and foreign markets, inefficiency of the *bilateral* models of exchange rates (in a multi-exchange rate world), suggested theoretical and empirical reasons for why the real exchange rate should follow a random walk, and finally the dynamic misspecification of the models under consideration are the key reasons he states to address the deviation from PPP.

He claims that the poor performance of PPP is based on *imprecise estimates* of the slope coefficient in the previous tests. He argued that by using a multi currency model[4] one could be able to improve the estimation of that coefficient. The equation he chose as the base of his work is :

$$e_{it} = \alpha_i (1 - \rho_i) + \beta_i (p_t / p_{it}) + \beta_i \rho_i (p_{t-1} / p_{i,t-1}) + \rho_i e_{i,t-1} + \varepsilon_{it}$$

which is a product of combination of: $e_{it} = \alpha_i + \beta_i (p_t / p_{it}) + \mu_{it}$ and $\mu_{it} = \rho_i \mu_{i,t-1} + \varepsilon_{it}$. (serial correlation in the errors) A three stage least squares (3SLS) procedure was used to estimate this model. In his view, much of the failure of

[4] By this he means testing the PPP doctrine with a multicountry model of exchange rates. He estimated PPP for four exchange rates (of UK, France, Canada and Japan).

PPP is due to ignoring the contemporaneous correlation of the deviations from PPP[5], and to account for this problem two sets of instrumental variables were used in the model[6].

Contrary to the Frenkel (1981)'s finding, he showed that PPP fails in the 1920s but performs well in the 1970s. To explain this he concludes that:

> 'The failure of PPP in the 1970s is not really a failure. It results from not using as powerful procedure as is possible and from not exploiting the contemporaneous correlation of deviations from PPP.' (p. 275)

His results indicate that PPP holds in the long run, although deviations from PPP are substantial. This was against the results of some other authors which indicated to rejecting this hypothesis. The persistence of deviation from PPP came from this fact that the error term in PPP relationship followed an AR(1) process with a coefficient of about one. This outcome possibly implies that although there is a closed long run relationship between changes in nominal exchange rate and changes in prices ratio; there are still other omitted explanatory variables which play a significant role in changes of nominal exchange rate.

5.2.2.2 Single Equation Cointegration Method

Schotman (1987), Giovannetti (1987), Corbae and Ouliaris (1988), Taylor (1988), Edison and Klovland (1987), Enders (1988), Hakkio and Rush (1989), Mark (1990), Fisher and Park (1991) and Hoque (1995) among others, are the authors who used this method to test PPP.

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[5] That is contemporaneous correlation between deviation of different countries' exchange rates from PPP. The general idea is that if, for example, there is a shock to the French-US exchange rate (so as to cause a positive deviation from PPP), then, there will likely be a (positive) shock to the UK-US exchange rate. This correlation may arise for any of several reasons. For example, an unexpected increase in French real income will tend to appreciate the French franc. If French and UK real income innovations are positively correlated, then we should also see an apprecition of the UK pound. Hence, an (unexpected) increase in the dollar/French franc exchange rate conveys useful information about the dollar/UK pound exchange rate that is ignored in single exchange rate estimation procedures.

[6] In one set , constant, time, time squared, lagged exchange rates and lagged of price ratios and in the second set (with this assumtion that exchange rate can in fact be determined in the asset market) he added current and lagged values of money and real income to the former set.

Hoque (1995), for instance, used residual-based two stage Engle-Granger (1987) cointegration test to test PPP long-run relationship (see chapter 4).

Four less-developed countries located in sub-continent of India, namely: Bangladesh, India, Pakistan and Sri Lanka were under consideration. The study covers the period from 1961:1-1990:4. All these countries are protected by tariff and quota systems and are subject to domestic market distortions. Although relatively more liberalised in recent times the foreign exchange market is under government regulation and is subject to intervention by central banks from time to time.

The tests were performed for the entire period as well as sub-periods. The cut-off point was the fourth quarter of 1973 in which (1) the Bretton Woods system brokdown and (2) The first oil-shock occurred. He considered the model:

(5.2.1) $$\pi_t / E_t = \alpha + \beta\pi*_t + u_t$$

where π_t is the index of domestic price level; $\pi*_t$ is the index of US price level; E_t is the domestic currency price of US dollar; u_t is a stochastic disturbance, and α and β are constants. The PPP hypothesis is valid as a long-run relationship if $\beta=1$ and u_t is a zero mean stationary stochastic process. The model also allows us to determine how the price level and/or the exchange rate adjust to eliminate any deviation from PPP.

He concluded that the results were opposite to PPP except for the period 1961:1 1973:4.

When the hypothesis of no cointegration is rejected, the residuals of the equilibrium regression equation could be used as instruments to estimate an error correction model. He estimated following ECM models to find which variable adjusts the deviations from the long-run path of the PPP.

(5.2.2) $$(1-L)(\pi / E)_t = const. + \delta_1 \hat{\mu}_{t-1}$$

(5.2.3) $$(1-L)\pi_t^* = const. + \delta_2 \hat{\mu}_{t-1}$$

(5.2.4) $(1-L)\pi_t = const.+\delta_3\hat{\omega}_{t-1}$

(5.2.5) $(1-L)(\pi_t^* E_t) = const.+\delta_4\hat{\omega}_{t-1}$

where $\hat{\mu}_{t-1}$ and $\hat{\omega}_{t-1}$ denote the OLS estimated of error terms obtained respectively from ( ) and its alternative: $\pi_t = \lambda + \lambda_1 E_t \pi_t^* + \omega_t$.

Table 5.2-1: ECM Results				
	1961:1-1990:4		**1961:1-1973:4**	
	const.	EC. term	const.	EC. term
( )	1.73	-0.123	1.29	-0.141
	(1.91)	(-2.53)	(1.34)	(-2.94)
( )	1.81	0.072	1.88	0.070
	(3.92)	(3.15)	(3.11)	(3.18)
( )	5.31	-0.006	2.97	-0.008
	(3.79)	(-0.82)	(3.87)	(-2.85)
( )	7.14	0.162	4.21	0.181
	(4.13)	(3.97)	(3.10)	(3.37)

Source: Hoque (1995); Figures in Parentheses show t-values.

Then he conducted ECM model to estimate the time length within which the complete adjustment might occur. He found that it takes about 8.5 quarters to complete the adjustment. The domestic price level did not adjust much so that most adjustment came through exchange rate devaluation by government decision.

The results indicated that among the four countries (Indian, Bangladesh, Pakistan, Serilanka), Indian market forces play a more prominent role in determining prices and exchange rates along with the PPP theory relative to the three other countries involved in his work.

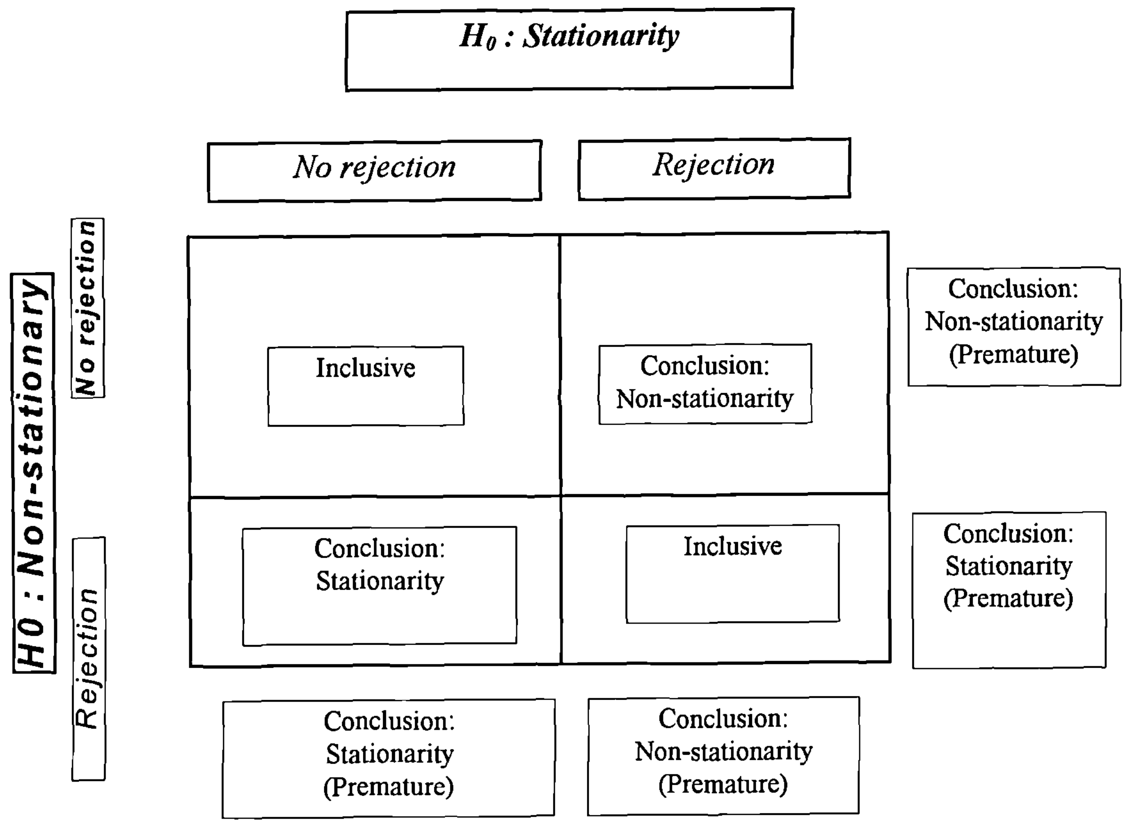
Finally, he postulated that if we accept the PPP doctrine as a final equilibrium relationship rather than a price theory of exchange rate determination (Frenkel, 1976), the finding of this paper suggests that prices and exchange rates may diverge in the long-run.

When there are real shocks; in the absence of trade barriers, arbitrage keeps relative prices between tradable goods across countries, and the PPP is expected to be be hold. But for non-tradable (because of high transaction cost) this relationship does not hold.

He argued that since the price levels and exchange rates should by all means be treated as endogenous variables; this may raise the simultaneity problem which could bias the estimates of cointegrated coefficient to zero.

Usual stationary tests have non-stationarity of the variable under consideration as the null hypothesis. If the null can not be rejected, it is usual to conclude non-stationarity. So, no-rejection of non-stationary hypothesis of real exchange rate leads to the conclusion of the absence of PPP. Hedricsson and Lundback (1995) argue that although such a conclusion could be correct, it is not always the case. 'It might be the case that PPP is really true, but as a result of lack of information in the data and/or low power of the test, the null is not rejected'. (p. 636) On the other hand, when 'stationarity' is embedded as the null, the same reasons may lead to the rejection of the null when it is in fact true. To gain stronger conclusion, they suggest that one can test both, the presence and absence of PPP simultaneously. A robust conclusion is then obtained when these two stationary tests (with opposite nulls) maintain each other. If the null of stationary[7] real exchange rate can not be rejected and the null of non-stationary real exchange rate can be rejected, then it is clear that the real exchange rate is really stationary. But if these two tests do not support each other a certain conclusion will be defective. Other possible outcomes have been shown in following chart:

[7] Some major pitfalls are discovered in procedures that are designed to test a null cointegration (rather than no cointegration). These defects... support the continuity use of residual based unit root tests. (Phillips and Ouliaris (1990, p. 165)



Source: Hedricsson and Lundback (1995)

5.2.2.3 Johansen's Multivariate VAR cointegration method

Engle and Granger (1987) test for cointegration may be valid for assessing cointegration relationship between two variables; but is not valid in a system with more than two variables, in which there may exist more than one cointegrating vector.

Cheung and Lia (1993) using a Monte Carlo experiment, compared the power properties of the ADF and Phillips (1987) Z_α test with Johansen test and concluded that the latter appeared relatively more powerful than the former tests.

Using Johansen method they found evidence favourable to long run PPP in high-frequency (monthly) data for the recent floating exchange rate period. They believe that some hypotheses maintained in previous works, namely symmetry, proportionality[8] and no measurement error in prices, can lead to different results concerning the validity of PPP in this period[9].

Cheung and Lia (1993) mention that previous cointegration analyses of long run PPP have been primarily based on residual-based tests following Engle and Granger's (1987) two-step procedure. The residual-based tests have very low power in rejecting the non-cointegration hypothesis, even when an equilibrium relationship in fact holds in the long run and when deviations from equilibrium are corrected relatively quickly. The residual-based tests consistently find little evidence of cointegration between nominal exchange rates and prices (CPI and WPI) . 'The Johansen test results differed dramatically from those of the residual-based tests'(p. 186, 187).

Giovannetti (1992) argues that one can consider the presence of cointegration as supportive evidence in favour of PPP, but PPP may yet fail to hold because the estimated cointegrated parameters are significantly different from theoretically expected ones. He argues that 'these cases motivate the use of cointegration versus the

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[8]The symmetry and proportionality restrictions which are usually imposed on PPP hypothesis imply that in a relationship such as:

$$e_t = \alpha_0 + \alpha_1 p_t + \alpha_2 p_t^* + \mu_t$$

$${}_1 = -\alpha_2 \qquad \text{(symmetry condition)}$$

$$|\alpha_1| = |\alpha_2| = 1 \quad \text{(proportionality condition).}$$

[9] See an explanation for measure error in this paper and also Taylor (1988).

strategy of simply examining the time series behaviour of the real exchange rate' (p.,95). On the other hand, Cheung and Lia(1993) argued that imposing the symmetry and proportionality on coefficients (as is expected based on the PPP) may lead to a failure to find a cointegrated relationship, when there is one in fact, because of existing of measurement errors in price indices. 'As a result (contrary to the Giovanitti's view expressed above), the findings of no cointegration can be interpreted as rejections of the imposed restriction on the underlying equilibrium relationship rather than the equilibrium condition itself....finding of non-stationary in the real exchange rate can indicate a violation of the symmetry or proportionality restriction and still be consistent with long-run PPP with measurement errors'.

In the case of presence of measurement errors in prices [the theoretical reasons for rejecting PPP: the symmetry and proportionality [$a_1 = a_2 = 1$] restrictions are not treated as necessary conditions. He found that, in nine out of ten cases the restriction of either symmetry or proportionality is rejected statistically. When these restrictions are not supported by the data, its imposition can bias the test towards finding no cointegration.

The stability of parameters of cointegrated system was tested by the Hansen test (1992). In addition to using Johansen's procedure, he tested the stationarity of real exchange rates directly, using the test of Kwiakowsky, Philips, Schmidt and Shin (1992). The null hypothesis of stationarity of the real exchange rate could not be rejected with only a few exceptions.

He did not impose the proportionality restriction. In this regard, Cheung and Lia (1993) explain that imposing such a restriction, while it is not supported by the data, may bias the test towards finding no cointegration relationship. Rather, finding a cointegration relationship among variables involved in PPP without imposing that restriction is consistent with long-run PPP with the presence of measurement errors in prices (Taylor, 1988; Cheung and Lia, 1993).

Dutt and Gosh (1995) running Phillips-Hansen Fully Modified Ordinary Least Squares (FM-OLS)[10] and using CPI and WPI indices for six EMS countries; they found

[10] This method corrects for both endogeneity in the data and asymptotic bias in the coefficient estimates. (see Banerjee *et. al*, 1993 and Hargreaves, 1994 for a description of this method)

evidence to support the Weak form of PPP (except in one case), but did not get any supportive results for the Strong form. They consider weak form of PPP where there is (at least) one cointegrating vector between exchange rate and price differentials; and strong form when in addition to this condition there is evidence supporting the existence of a vector (b_0, b_1, b_2)= (0, 1, -1).

In order to examine the absence or the presence of PPP this paper employed two residual based stationarity tests; the standard DF test having non-stationarity as the null and a test proposed by Kwiatkowski; *et. al.* (1992) using stationarity as the null. We can be sure of the support for PPP only when both the null of stationarity is not rejected and the null of non-stationarity is rejected.

Purchasing Power Parity appears to fail (using some OECD countries) as a proper description of the long-run relationship between exchange rates and price levels.

They argue that some authors have tried to test PPP theory through testing the random walk hypothesis for real exchange rate. If one actually can present that the real exchange rate follows a random walk process, he could infer that the **deviation** from PPP persist. For example Roll (1979) and Adler and Lehmann (1983) used the relationship below to test whether the real exchange rate has a unit root:

$$\Delta re_{t+1} = b_0 + b_1 \Delta re_t + \ldots + b_k \Delta re_{t-k+1} + \mu_{t+1}$$

where k is the number of lags. Roll (1979) used t-ratios and Adler and Lehmann (1983) used joint f-tests to see if all b's are zero (which implies support to the random walk hypothesis). They were unable to reject the random walk hypothesis that is the PPP does not hold.

Abuaf and Jorin (1990) argue that failure to reject the random walk emphasised by previous authors could be due to the *low power of the used tests* in their works. The contribution of their paper is to estimate an autoregression model in a multivariate setting which would allow for more powerful tests. Their results cast doubts on the hypothesis that the real exchange rate follows a random walk.

In and Sugema (1995) applied multivariate cointegrating framework of Johansen and also band-spectral regression methods using quarterly data to test PPP relationship between Australia and 11 major trading countries and supported this theory. They used Classical and Generalised PPP versions[11], using both CPI and WPI indices for comparing purpose, and concluded that there is evidence to support this theory. It is evident that generalised PPP holds for all countries under consideration and for both CPI and WPI; although the magnitudes of the coefficients varied across countries. There was no consistency in the magnitudes obtained from the WPI and CPI-based regressions. The two measures produced different estimates, but they could not conclude which one is better.

Sarantis and Stewart (1993) have concluded that the hypothesis that exchange rate and relative prices contain an autoregressive unit root with no deterministic time trend is accepted for all countries under consideration. This implies that deviation of exchange rates from their PPP levels persist indefinitely.

The departure from PPP can be due to deviations in productivity differences, changes in tastes, and shifts in comparative advantages (Baillie and Silover, 1987), measurement error in the construction of the price indices (Gernberg, 1977) and tariff and non tariff barriers (Frenkel, 1981b).

Sarantis and Stewart (1993), using cointegration concept, rejected overwhelmingly the long run purchasing power parity hypothesis for all sterling exchange rates.

5.2.2.3.1 Efficient markets version of PPP

The theory of efficient markets suggests that the current exchange rate will be the best predictor of the future exchange rate-adjusted for difference in inflation rates between two countries. Roll's (1979) classical view of efficient markets version of PPP implies that any observed departure from PPP reflects a disequilibrium in either the commodity markets or the foreign exchange market.

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[11] They consider $\varepsilon_t = \gamma_0 e_t + \gamma_1 p_t^d + \gamma_2 p_t^f$ as the Classical PPP when all γs are supposed to be unity.They also used a weaker definition of the PPP relation, called Generalised PPP, that does not restrict the magnitude of the coefficients to unity but instead simply restricts the signs.

As an empirical example of this view, Lippert and Breuer (1994) tried to test the relative PPP for Canada and Japan. They took the position that real factors are omitted variables from the PPP relationship and are the cause of divergence from PPP. They viewed the unobservable real exchange rate as *a factor in the determination of nominal exchange rate*. At first they tested the original relationship:

$$\Delta e_t = \alpha + \beta\,(\Delta p^* - \Delta p)_t + u_t$$

	Canada	*t-ratio*	*Japan*	*t-ratio*
α	0.0013	0.509	-0.0098	1.299
β	0.5851	1.468	0.1971	0.5588
F[a]	0.57		2.79	
R^2	0.03	0.005		
DW	1.82	1.6		
Q(24)	22.28	20.33		
ARCH	0.47	0.38		

[a] F-test for α = 0, β = 1. Source Lippert and Breuer (1994).

Since the results showed no evidence of PPP relationship and since the relative version of PPP was rejected, they postulated that PPP's failure is due to changes in the real exchange rate. To do this they introduced the following equation:

$$\Delta R = \alpha + \beta_1 \Delta PROD + \beta_2 \Delta PROD^* + \beta_3 \Delta TECH + \beta_4 \Delta TECH^* + \beta_5 \Delta CTX + \beta_6 \Delta CTX^* + \beta_7 \Delta PTX + \beta_8 \Delta PTX^* + u$$

where:

R= real exchange rate, the price of US goods in terms of foreign goods;

PROD= productivity;

TECH= technology;

CTX= corporate tax rates;

PTX= personal tax rates;

and * and Δ denote a foreign country and first difference respectively.

The fitted value from this specification was used as a proxy for the real exchange rate. Then, they added this variable to original PPP equation. This procedure is consistent with studies that view the real exchange rate as an unobservable but distinct influence on the nominal rate.

The amended version of PPP is given below:

$$(5.2.6)\quad \Delta e_t = \alpha + \beta_1 \Delta\hat{R}_t + \beta_2(\Delta p_t - \Delta p_t^*) + v_t$$

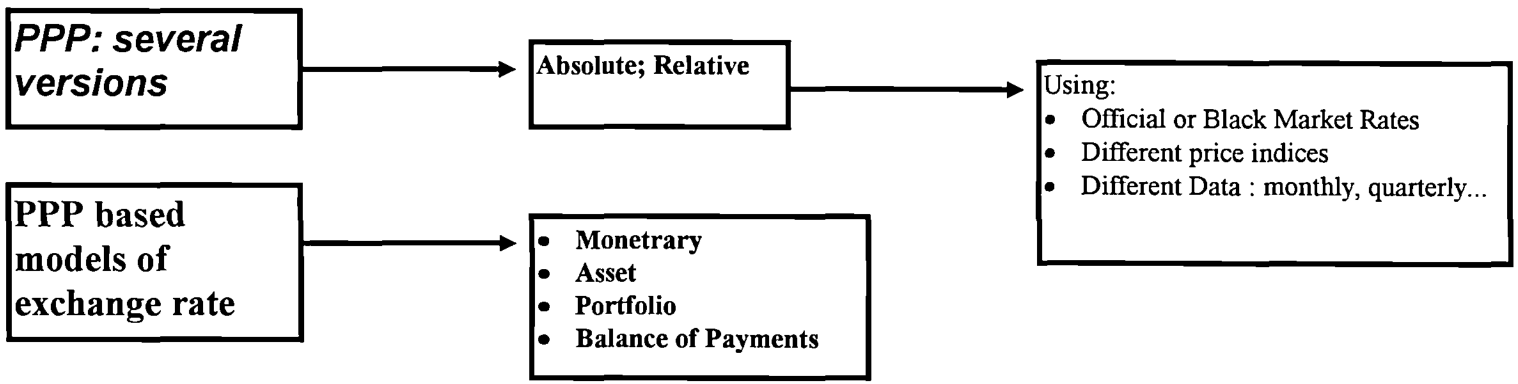
Some of results obtained form this test are shown in table below:

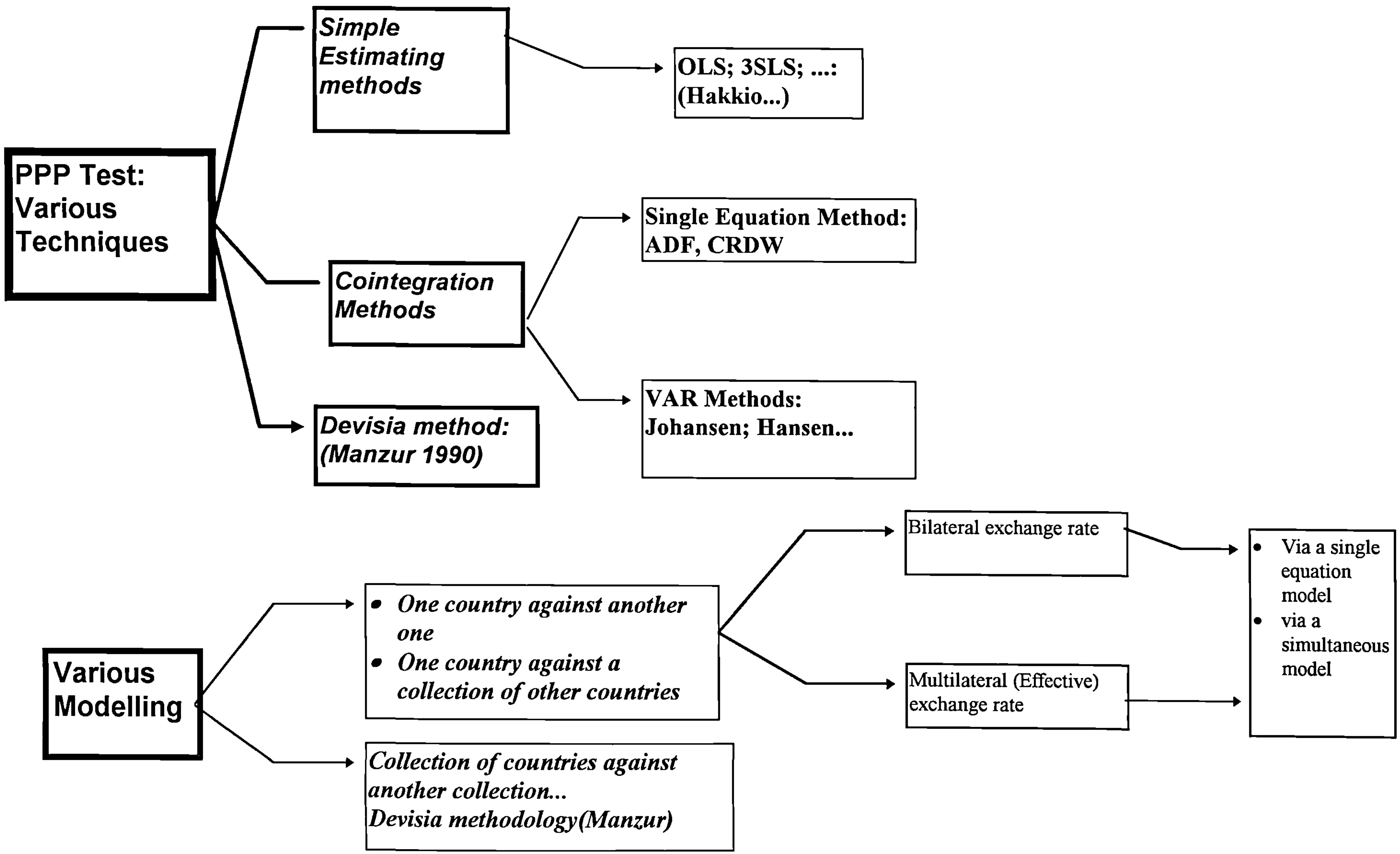
	Canada	*t-ratio*	*Japan*	*t-ratio*
α	0.0006	0.234	-0.0067	0.98
β_1	0.9867	3.822	1.0267	5.011
β_2	0.7015	1.882	0.0652	0.209
R^2	0.21		0.28	
DW	1.92		1.45	
Q(24)	30.04		24.65	

Source Lippert and Breuer (1994)

Finally they reported that:

"The results suggest that when real exchange rate changes arising from the real side of the economy are taken into account, the hypothesised one-to-one relationship between changes in the exchange rate and the relative inflation differential cannot be rejected for Canada. The results support an amended version of relative PPP that allows the nominal exchange rate to be influenced by changes in the real exchange rate as well as changes in the relative inflation differential."


PPP: several versions
Absolute; Relative
Using:
Official or Black Market Rates
Different price indices
Different Data : monthly, quarterly...
PPP based models of exchange rate
Monetrary
Asset
Portfolio
Balance of Payments


PPP Test:
Various
Techniques
Simple
Estimating
methods
OLS; 3SLS; ...:
(Hakkio...)
Cointegration
Methods
Single Equation Method:
ADF, CRDW
VAR Methods:
Johansen; Hansen...
Devisia method:
(Manzur 1990)
Various
Modelling
• One country against another one
• One country against a collection of other countries
Collection of countries against another collection...
Devisia methodology(Manzur)
Bilateral exchange rate
Multilateral (Effective) exchange rate
• Via a single equation model
• via a simultaneous model

5.3 Modelling Official and Black Market Exchange Rates in Iran

5.3.1 Introduction

The Iranian economy has been disturbed by several violent shocks in recent decades, Large swings in the revenue from Iran's main export (oil), political revolution and war are examples of such shocks. Many such factors are likely to have influenced the free market value of the Iranian Rial. During the 1980s the real official exchange rate became greatly overvalued, which is indicated by the massive premium of the black market rate over the official rate. The high black market premium weakened the balance of payments and gave rise to a crisis and ultimately to a collapse of the official exchange rate in 1993[1]. The scarcity of foreign currency at the official rate greatly increased activity on the black market and there could be spill over effects between the markets[2]. In such circumstances the question of whether or not to adjust the official exchange rate and to what extent to adjust it remain major issues for exchange rate policy. Therefore, tracking the dynamic process of the relationship between official and black market exchange rate (i.e. the behaviour of black market premium) is instrumental for choosing and operating a proper strategy to unify official and black market exchange rates as a part of any economic adjustment programme[3].

For many years a free market for foreign exchange has existed alongside the official market for foreign exchange in Iran. The official exchange rate has been fixed[4] and subject to infrequent changes of nominal value. Sometimes the free market has been almost dormant, at such times the premium that could be earned in the free market has been almost zero. But at other times, most notably since the revolution of 1979, the free market has been the dominant source of foreign exchange. The social and political unrest starting shortly before the revolution began a rapid depreciation of the black

[1] 'In March 21, 1993, the multiple exchange rate system was unified, and the exchange rate of the rial became market determined. Prior to that date, the exchange rate referred to the basic official exchange rate of the Iranian rial, which was pegged to the SDR.' (IFS, December 1995, p. 310)

[2] We were unable to obtain the black market exchange rate for the period since 1990, and so our estimation period ends before the exchange rate reform of 1993.

[3] Such an operation is a key policy issue for many developing countries.

[4] In February 1975, the pegging of the rial to the dollar was abrogated in order to reduce the rial's sensitivity to fluctuations in the value of the us. dollar *vis-à-vis* the other major currencies, and an SDR peg was adopted at a par value of 82.2 Rials for SDR. In addition, the commercial rate was allowed to float within a ± 2.25 percent band. The US dollar, nevertheless, remained as the currency of intervention by the central bank. Throughout this period the parallel market exchange rate floated closely above the official exchange rate (see chapter 2).

market exchange rate as the demand for foreign currency exceeded the official supply. In the post-revolution period, the premium on foreign currency sold in the black market over currency sold in official markets has been rapidly increasing, from near to zero shortly before the revolution to over 2000% by 1990. The purpose of this section is to see if Purchasing Power Parity has influenced either the black market or official exchange rates; and also to see if there are any links between the two exchange rates.

Throughout this section we have used modern econometric techniques to investigate static and dynamic components of the processes under consideration. These methods of modelling usually are more sensible from the economic point of view and less problematic from the econometric point of view. Since many economic time series appear to be non-stationary processes, this kind of modelling prevents some of the problems which potentially could appear when traditional method is applied. (see chapter 4 for more details)

Our findings are: (1) Purchasing power parity is a relevant model of both exchange rates in the pre-revolution period, but only applies to the black market rate after the revolution. (2) Only the black market rate responds to the black market premium. (3) The official exchange rate does not appear to be influenced by the black market rate.

Broadly, we find support for PPP as the long-run determinant of the exchange rate, conditional on an asymmetric relationship between the exchange rate and oil revenue. Oil revenue is found to influence the exchange rate only in the post-revolution period.

Since the revolution higher oil revenue appears to have generated extra demand for imports and deflected domestic production away from exports, so that in the long run the exchange rate tended to depreciate. What is perhaps most interesting in this study is that once this asymmetry is taken into account we find evidence of a long run economic relationship despite the tremendous shocks and changes the Iranian economy has been subjected to.

5.3.2 Alternative Theoretical Frameworks

Several alternatives theories could be used to model exchange rate behaviour. Among them one of the most basic and simple one is the Purchasing Power Parity theory. We also examine whether other models of the exchange rate have any relevance in either pre or post-revolutionary periods. One such relationship is that an exchange rate responds to the premium earned in the black market, for example, the official rate becomes devalued if the premium becomes 'excessive'. Another possibility is that movements of one exchange rate have a spillover effect on the other exchange rate, such as a devaluation of the official rate influencing the black market rate.

In section 5.3.3 we try to model official and black market exchange rates separately in the pre and post revolutionary periods. Their possible effects on each other will be also assessed. In section 5.3.4 PPP is used to model the relationship between the black market rate and oil revenue. This equation is then used in later chapters to model the effect of oil revenue upon the Iranian economy. A brief outline of these theories is provided in next section.

5.3.2.1 Theory

There are numerous mechanisms that could determine exchange rates. One is *purchasing power parity* which follows from the assumption that in equilibrium it should not be possible to profit from buying a good in one country and selling it in another. In this case the exchange rate adjusts to maintain a constant real exchange rate in the long run. Either trading in the free market forces an incorrectly valued exchange rate back to the equilibrium value, or flows of foreign reserves force the authorities to correct the official exchange rate. In the first case, when the currency is overvalued falling demand for net exports creates an excess supply of home currency which depreciates the exchange rate. In the second case, the drain on reserves due to intervention to support an overvalued currency eventually forces a devaluation. In either case in the long-run $e = k + p^d - p^f$, where k is a constant, e, p^d, and p^f are, respectively, the exchange rate, the domestic price level and the foreign price level, all measured in natural logarithms. Despite a number of objections to the simplistic theory of PPP, the model has a good empirical record, especially in high inflation countries (Dornbusch, 1987).

An alternative relationship is that the government does not permit the black market premium to rise too high, either because it fears the inflationary consequences or because as the premium rises it is tempted to sell foreign currency on the free market to make profit. One possibility is that the official rate may be devalued to reduce the black market premium. Or, as considered by Culbertson (1975), Dornbusch *et. al.* (1983) and Olgun (1984), the black market exchange rate may respond to the premium earned in the black market.

A third possibility is that a mixture of PPP and the black market premium are relevant. Or even that the real value of one exchange rate spillover onto the value of the other exchange rate. This latter may be particularly relevant to the post-revolutionary period in which the official rate has become excessively overvalued and so increasingly demand become deviated to the black market. Additionally, real or nominal appreciation/depreciation in one exchange rate may spill over onto the other exchange rate, such a model of black market rates is considered by Culbertson 1975. In this model a devaluation of the official rate produces a depreciation of the black market rate.

5.3.3 Black Market and Official Exchange Rates: Different Models

5.3.3.1 Exchange Rate Evolution

Before entering into the main stream of the discussion a brief review of the exchange rate evolution in Iranian economy could be useful. Iranian economy has experienced a number of shocks during the last three decades. Three boom and bust oil shocks, revolution, war with Iraq, and some other minor shocks plunged the economy in a complex situation. Capital flight, destruction, and loss of human capital forced the economy into internal and external crises.

Restrictions on the supply of foreign currency whilst demand was increasing made the black market exchange rate jump. Between 1980 and 1988 Iran fought a hugely destructive war with Iraq. The diversion of oil revenue earnings towards imports of armaments increased black market transactions for a given level of oil revenue and so put downward pressure on the black market rate. A further source of downward pressure came from the loss of physical and human capital that raised the demand for imports. The eruption of the war with Iraq forced the authorities to impose a collection of restrictions, regulations and controls on economy. During this period imports were restricted quantitatively to save foreign exchange and foreign exchange was allocated to prevent capital flights.

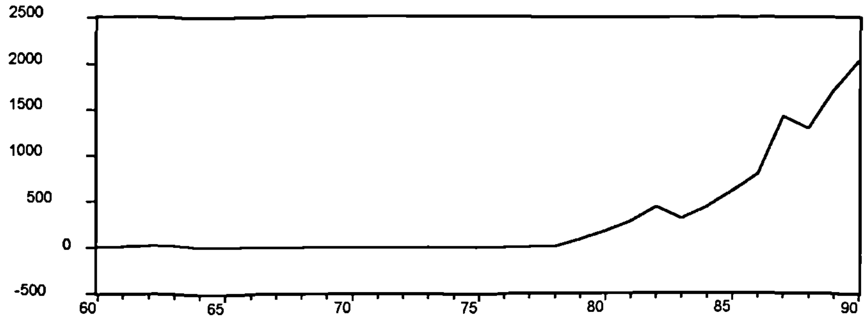
For more comprehension, it is essential to show the movements of official and black market exchange rates and the premium of the black market rate over the official rate during the period under consideration. As Pesaran (1992) describes the premium in the black market rose from 5.8 percent in 1960 to 21 percent in 1963, and fell back to 4.1 percent in 1966 as financial and economic conditions began to improve. With increasing economic and political stability and increasing revenues from oil exports, the black market premium practically disappeared for most of the 1967-1977 period. The black market premium amounted to 5.6 percent in 1977, 9.2 percent in 1978, and then jumped to 81.5 percent after the fall of the Shah in 1979[5]. Since then the black market premium has been fluctuating around a steadily rising trend (see Figure 5.3-1). Between 1979 and 1989 the premium has been rising at a staggering average annual rate of 42.1 percent, and in November 1989, the black market rate for the dollar reached its peak at over 20 times the official rate. The high levels of the black market premium in Iran over the past decade have been sustainable largely because of the fact that over 95 percent of the country's foreign exchange revenues accrue exclusively to the government.

[5] The capital flights around the revolutionary year (1979) and the prior political tensions are the most responsible of this jump.

Table 5.3-1 Exchange Rate Premium (%)[a]	
Year	**Premium**
1960	5.8
1963	21
1966	4.1
1967-1976	≈0
1977	5.6
1978	9.2
1979	81.5
1990	2000

[a] Rounded values of $[(E_b - E_o) / E_o]*100$

Figure 5.3-1 Exchange Rate Premium(%) (1960 - 1990)



From these figure and table it is obvious that for the pre-revolution period (1960-1979) the official and black market rates moved nearly side by side. During this period, active intervention by Bank Markazi (Central Bank) through sales of US dollars in the free market prevented any lasting disparity. Thus for all intents and purposes, Iran had an effective unitary exchange system and a virtually convertible currency (Amuzegar 1993 p. 162). Whereas, in the post-revolutionary period (1980-1990), although the oil revenues during the first five years since the revolution were nearly equal to those during to the last five years of the Shah's regime, the black market exchange rate deviated from official rate very sharply. In fact several new developments mentioned above prevented the exchange system from remaining liberal. In such an environment the maintenance of a free exchange market, inactive since shortly before the revolution, was totally terminated, and a dual exchange rate system immediately followed.

5.3.3.2 Literature

Numerous works have been conducted to analyse the capability of devaluation policies for eliminating the spread between official and black market exchange rates. Dornbusch *et. al.* (1983); Yin and Stoever (1994); Agenor (1991, 1992a); Kamin (1991) and Edwards and Montiel (1989) are some examples of these works.

What is consistent with the conventional international theory is that an official devaluation is effective- that is , causes depreciation in free market exchange rate and brings the official rate closer to the free market rate and thus narrows the black market premium- when the devaluation is accompanied with restrictive domestic economic policies. There is some empirical evidence literature supporting this view. For example Yin and Stoever (1994) using RMB (Chinese currency) obtained some results compatible with this view. Also Dornbusch *et al* (1983) showed how an expectation of future official devaluation leads to an immediate depreciation in the black market and a subsequent decline in the premium when the official depreciation actually occurs. However, some evidence suggests that the reduction in the premium will be only temporary if fiscal and credit policies maintain an expansionary course, thus implying that a devaluation cannot itself permanently lower the premium (see Agenor, 1992b). The econometric results presented in Agenor (1991) also support the view that the parallel rate depreciates less than proportionally immediately after parity change[6]. However, Subsequently, the parallel market rate continues to depreciate while the premium rises, returning in the long-run to its initial level (in six out of 12 countries under consideration).

Studies by Edwards (1989a), Edwards and Montiel (1989), and Kamin (1991) covering a large sample of devaluation episodes in developing countries have also documented these facts.

Also, one of the implications of the Portfolio - balance models, such as Dornbusch *et al* (1983) and Phylaktis (1991), is the existence of an equilibrium spread between the black market and official rates, or so called premium exchange rate (Phylaktis and Kassimath (1994).

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[6]See Agenor (1992), p. 22 for more details.

To catch the relationship between black market and official exchange rates Phylaktis and Kassimatis (1994), considered: $e_{bt} = \beta\, e_{ot} + v_t$, as the long-run relationship between them, where *b* and *o* stand for black and official respectively. Given a constant premium, β should be equal to unity, i.e. that the black market rate depreciates by the same proportion as the official exchange rate.

They, then, used the error-correction models to test for short and long run adjustments between these two variables:

$$\Delta e_{b(t)} = \alpha_1 + \rho_1\left(e_{b(t-1)} - \beta e_{o(t-1)}\right) + \sum_1^n \gamma_i \Delta e_{b(t-i)} + \sum_1^n \delta_i \Delta e_{o(t-1)} + u_t, \text{ and,}$$

$$\Delta e_{o(t)} = \alpha_2 + \rho_2\left(e_{b(t-1)} - \beta e_{o(t-1)}\right) + \sum_1^n \zeta_i \Delta e_{b(t-i)} + \sum_1^n \eta_i \Delta e_{o(t-1)} + v_t$$

The error correction term appeared significant in six out of seven countries under consideration (the exception was Indonesia when the dependent variable is the black market rate), implying that the black market rate adjusts to short-run deviations from long-run equilibrium. In two cases, Korea and Taiwan, the official rate adjusts also to short-run deviations from long-run equilibrium.

In Agenor's (1991) monetary model of exchange rate the parallel market exchange rate is positively related to the official exchange rate (Bhawnani and Kadiyal, 1997). Agenor (1992a) suggests that the impact of a devaluation on the *parallel market premium* is ambiguous, whether one considers an officially fixed exchange rate or a crawling peg.

Another theoretical framework has been chosen in the literature to investigate the relationship between official and black market rates is Purchasing Power Parity theory.

Sundar (1994), used official and black market exchange rates to test PPP relationship. He concluded that PPP can not be rejected for most trading country pairs using official exchange rates. For non-trading country pairs, PPP can not be rejected using black market exchange rates.

Culbertson (1975), in a PPP environment, put two extra variables: official rate and the changes of foreign exchange allocated to the market from official holding (which was assumed equal to change in official reserves holdings), in addition to price deferential, to the right side of the black market exchange rate equation. Although the coefficients related to these variables appeared insignificant, he concluded that "the results are consistent with the theoretical proposition that movements in the black-market rate are closely associated with Purchasing Power Parity induced changes in the equilibrium exchange rate".

Bahmani-Oskooee (1993a) tested PPP theory using the Iranian official and black market exchange rates (1973I-1986II). The purpose postulated in this work was comparing the degrees to which official and black market exchange rates could be explained in a PPP framework. He failed to support PPP when he used official data. However, he could support this theory when he used black market exchange rate, after including the effects of the revolution and war with Iraq.

Bahmani-Oskooee (1993) reports that in cointegration analysis, purchasing Power Parity appears to be a valid model of the black market rate but not of the official exchange rate. Bahmani-Oskooee tests for cointegrating relationships over the pre- and post-revolution period together. Since, the economy of Iran has changed so fundamentally since the revolution an issue we consider is whether or not the findings of Bahmani-Oskooee apply to the periods separately.

This section shows that purchasing power parity holds for the black market rate but not for the official rate. To the Iranian case this should be of no surprise as adjustments to the official rate have been few in the post revolutionary period.

5.3.3.3 Econometrics

We employ simple error correction models to test the alternative exchange rate models, that is:

$$(5.3.1)\quad \Delta e_{jt} = \alpha_j + \beta_j\, \Delta e_{j_{t-1}} + \lambda_j\, (e_j - e_j^{*})_{t-1} + \mu_{jt}$$

Where e^* is the equilibrium value of the exchange rate, and $j = o$ denotes the official rate while $j = b$ denotes the black market rate. Such a model permits slow adjustment through inertia captured by β_j and an adjustment towards equilibrium. If the exchange rate exceeds the long run value, then we expect an appreciation to restore equilibrium, hence $\lambda_j < 0$.

Our data is annual, so that we have at the most 18 observations in the pre-Revolutionary period and 11 in the post-revolutionary period. For this reason we do not employ either Johansen's methodology or the general to specific methodology, but simply test a number of simple models and report the best equation[7].

Modelling the official exchange rate presents a further problem. In the official market, adjustments of the nominal exchange rate were rare in the pre-revolution period, and so data on Δe_t will be dominated by zeros[8]. So that we obtain a clearer picture of the adjustment process we choose to model the official market exchange rate only in the periods when a change in the nominal exchange rate took place. For the post-revolution period this simply means starting our estimation from 1980. For the pre revolution period we estimate:

(5.3.2) $$\Delta e^{+}_{o(t)} = \alpha_o + \lambda_o \, (e_o - e^{*}_{o})_{t-1} + \mu_{ot} \quad ,$$

where + indicates non-zero values.

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[7] In next part of this chapter, however, the Johansen's and general to specific methodologies will be used to model the black market exchange rate in a PPP framework. Also see the results of modelling official exchange rate using these methods, for comparison purpose, in appendix.

[8] A further issue of interest would the determinants of the decision to alter the exchange rate. In the pre-revolution period the Rial was devalued in 1968, 1969, 1975 and 1976 and revalued in 1967, 1973 and 1977. After the revolution devaluations occurred in 1980-1984, 1988 and 1989 and revaluations in 1985, 1986, 1987 and 1990.

5.3.3.4 Results[9]

5.3.3.4.1 Purchasing Power Parity

If the exchange rate adjusts to restore the real rate to the equilibrium value, then e^* is given by the ratio of domestic to foreign prices, p^d - p^f, where p^d is the domestic price level, p^f the foreign price level, and both are measured in natural logarithms (see data defination in section 5.3.6). Thus we estimate equations of the form:

$$(5.3.3)\quad \Delta e_{jt} = \alpha_j + \beta_j \Delta e_{jt-1} + \lambda_j [e_j - (p^d - p^f)]_{t-1}$$

Our preferred equations are reported below[10].

Pre-Revolution:

$$\Delta e^{+}_{o(t)} = 2.0 - 0.35(e_o - p^d + p^f)_{t-1}$$
(1.71) (-1.7)
$\overline{R}^2$ = 0.24; 1960 - 1978;

$$\Delta e_{bt} = 0.992 + 0.44\ \Delta e_{b(t-1)} - 0.17\ (e_b - p^d + p^f)_{t-1}$$
(2.35) (2.4) (2.36)
$\overline{R}^2$ = 0.35; LM(1) = 0.02; 1960 - 1978

Post-Revolution:

$$\Delta e_{ot} = -.26 + 0.05\ (e_o - p^d + p^f)_{t-1}$$
(-0.9) (0.88)
$\overline{R}^2$ = -0.02; ; LM(1) = 0.80; 1980 - 1990

[9] See appendix for further results.
[10] T-statistics in parentheses.

$$\Delta e_{bt} = \underset{(3.4)}{2.33} - \underset{(-3.70)}{0.31} (e_b - p^d + p^f)_{t-1}$$

$\bar{R}^2 = 0.43$; LM(1) = 1.83, 1979 - 1990

Before the revolution, the adjustments to both exchange rates are to restore Purchasing Power Parity, and both λ_o and λ_b are significant at 10% level. When adjustments to the official rate occur the proportion of the disequilibrium removed is about twice the amount removed in the black market in the first year of adjustment. But, of course, the slower initial adjustment in the black market reflects the continuous nature of the adjustment in the black market.

In the post-revolutionary period a very different picture emerges. The value of λ_o is positive, but insignificant from zero, indicating no adjustment to restore a PPP equilibrium in the official market. However, there is still evidence of PPP being restored in the black market. The rate of adjustment in the first year is almost twice the pre-revolution rate, possibly due to the higher post revolution inflation rate which raises the costs of slowly adjusting the price of foreign currency[11].

5.3.3.4.2 Black Market Premium

In this section we report equations of the form:

$$(5.3.4) \quad \Delta e_{jt} = \alpha_j + \partial_j (e_b - e_o)_{t-1} + \beta_j \Delta e_{jt-1} + \upsilon_{jt}$$

These permit the exchange rate to adjust to the level of the black market premium, if the adjustment is to return the premium to a constant equilibrium rate, then we expect $\partial_b < 0$ and $\partial_o > 0$. The economics behind these adjustments concerns the private sector and the state sectors responses to profitable opportunities in the black market. If currency is diverted to the black market to take advantage of higher gains then we expect $\partial_b < 0$. If the authorities use the premium as a guide to setting the official

[11] Dornbusch (1987a) reports that when inflation differentials are high strong support is found for PPP. In terms of cointegration studies this is consistent with a more rapid adjustment to equilibrium. In fact, it is argued that, when inflation is high, monetary growth could dominate real factors and so PPP should be supported.

exchange rate, for example, they may believe that e_b contains information about the appropriate value of e_o, then we expect $\partial_0 > 0$.

Our preferred equations are:

Pre-Revolution:

$$\Delta e^{+}_{ot} = -0.01 \quad - \; 0.05\,(e_b - e_o)_{t-1}$$
$$\qquad (-0.28) \quad (-0.03)$$
$$\overline{R}^2 = -0.2;\ 1960 - 1978$$

$$\Delta e_{bt} = 0.01 \quad + \; 0.54\,\Delta e_{b(t-1)} \; - \; 0.34\,(e_b - e_o)_{t-1}$$
$$\qquad (1.12) \quad (2.73) \qquad\qquad (-2.18)$$
$$\overline{R}^2 = .32;\ LM(1) = 0.02;\ 1960 - 1978$$

Post-Revolution:

$$\Delta e_{ot} = 0.07 \quad - \; 0.04\,(e_b - e_o)_{t-1}$$
$$\qquad (1.06) \quad (-1.24)$$
$$\overline{R}^2 = 0.05;\ ;\ LM(1) = 0.48;\ 1980 - 1990$$

$$\Delta e_{bt} = 0.51 \quad - \; 0.15\,(e_b - e_o)_{t-1}$$
$$\qquad (4.10) \quad (-2.35)$$
$$\overline{R}^2 = .29;\ LM(1) = 1.26;\ 1979 - 1990$$

For the pre-Revolutionary period we find ∂_0 to be incorrectly signed and the insignificance of ∂_0 from zero indicates no adjustment, the latter point also applies to the post revolution period. But the black market is found to adjust to reduce the premium. This is consistent with studies for other countries such as Phylaktis and

Kassimatis (1994). The rate of adjustment in the first year for the black market rate is lower after the revolution, possibly due to the rapid appreciation of the real official rate as inflation increased and because the government used its control over foreign currency revenue to maintain a substantial premium by avoiding devaluations even as the price differential worsened (see Karshenas and Pesaran, 1995).

5.3.3.4.3 Spillovers

The spillovers we consider are that the real exchange rate or change in the nominal value of an exchange rate may spillover onto the other exchange rate. We also consider whether the premium is required in addition to the real rate to explain exchange rate movements. Theoretically, we should expect some sort of spillovers, as disequilibrium in one market implies disequilibrium in at least one other market. For example, if the official exchange rate is overvalued, we may expect the higher demand for foreign currency in the black market will tend to depreciate the black market rate.

Pre-revolution period:

$$\Delta e_{bt} = \underset{(2.12)}{0.83} + \underset{(2.52)}{0.42}\,\Delta e_{b(t-1)} + \underset{(2.00)}{0.53}\,\Delta e_{o(t)} - \underset{(-2.12)}{0.14}\,reb_{t-1}$$

$\overline{R}^2 = 0.47$; LM(1) = .35; 1960 - 1978

$$\Delta e^{+}_{ot} = \underset{(0.99)}{2.26} - \underset{(-0.38)}{0.3}\Delta e_{b(t-1)} - \underset{(-0.05)}{0.15}\,re_{o(t-1)} - \underset{(-0.08)}{0.24}re_{b(t-1)} + \mu_t$$

1960 - 1978

Post-revolution period:

$$\Delta e_{bt} = \underset{(1.56)}{2.55} - \underset{(-0.64)}{0.17}\,\Delta e_{b(t-1)} - \underset{(-0.42)}{0.42}\,\Delta e_{o(t)} - \underset{(-0.05)}{0.009}\,reo_{t-1} - \underset{(-2.20)}{0.33}\,reb_{t-1}$$

$\overline{R}^2 = 0.29$; LM(1) = 1.31; 1979 - 1990

$$\Delta e_{bt} = 2.78 \;\; - \; 0.05\, reo_{t-1} \; - \; 0.34\, reb_{t-1}$$
$$(1.89) \quad (-0.35) \quad (-2.54)$$
$$\overline{R}^2 = 0.38; \;\; LM(1) = 1.4; \;\; 1979 - 1990$$

$$\Delta e_{ot} = .86 + 0.7\Delta e_{b(t-1)} - 0.02\, re_{o(t-1)} - 0.12 re_{b(t-1)} + \mu_t$$
$$(0.84) \quad (0.74) \quad (-0.19) \quad (-1.12)$$
$$\overline{R}^2 = -0.15; \; ; \; LM(1) = 0.09; \;\; 1980 - 1990$$

For the black market rate over the pre-revolution period we find that the devaluation of the official rate causes the black market rate to depreciate, but by less than the percentage change in the official rate[12]. This is consistent with a number of studies (e.g. Dornbusch, 1983; Agenor, 1991; Yin and Stoever (1994); Agenor, 1992b) that report that official devaluations cause the black market rate to depreciate, as the opportunity for profit from switching currency from the official market to the black market declines. The premium is not found to be significant and the black market rate is determined by PPP in the long run. In the post revolution period we find no evidence of spillovers from the official rate to the black market rate. One possible explanation for this is that at the hugely over valued official rate currency from official sources was too scarce to influence the black market rate. We find no evidence of spillovers onto the official market rate in either period.

[12] This implies that the size of black market premium would fall after a devaluation; though this reduction is expected to be only temporary if fiscal and monetary policies maintain an expansionary direction. (see Agenor, 1992a)

5.3.4 Black Market Rial and the PPP: the Effect of Oil Revenue on the black Market Exchange Rate

5.3.4.1 Introduction

This section examines the relevance of purchasing power parity for the black market exchange rate in Iran over the whole period since 1960. The longer estimation period allows us to formally test for cointegration and to test hypotheses on the cointegrating vectors. We find evidence supporting the strong version of PPP; the exchange rate, domestic and foreign prices constitute a unit cointegrating vector, once we permit an asymmetric long run influence for oil revenue. This particular asymmetry is that the exchange rate is insensitive to oil revenue prior to the revolution, but depreciates if oil revenue rises after the revolution. The asymmetry is explained by the income effects of oil revenue raising imports as the economy stagnated after the revolution; but being met by domestic production in the pre-revolution boom. Furthermore, easy access to foreign financial markets before the revolution made it more practical to support official exchange rate.

According to Purchasing Power Parity (PPP) a nation's exchange rate equates the price of imported goods to the price of domestic goods. Numerous tests of this hypothesis have been performed, motivated in recent years by developments in time series modelling, such as cointegration. The consensus that seems to be emerging is that PPP is most relevant to long-run movements in exchange rates. In the short-run other factors are likely to be dominant, such as capital flows, productivity shocks, foreign currency earnings, and where a parallel market exists (such as in Iran) the interaction between the official exchange rate, official reserves and the black market price. Many such factors are likely to have influenced the free market value of the Iranian Rial, for the Iranian economy has been disturbed by several violent shocks in recent decades, for example, large swings in the revenue from Iran's main export (oil), political revolution and war. In addition, during the 1980s the real official exchange rate became greatly overvalued, which is indicated by the massive premium of the black market rate over the official rate (in this decade the Iranian economy has experienced a multiple rate system with a dozen of several exchange rates each one has been officially defined for a specific area of imports or exports (see Amuzegar, 1993 for more details). The scarcity of foreign currency at the official rate and increase in demand for imports caused by stagnation in domestic output greatly increased activity on the black market and there could be spill over effects between the markets[13]. The objective is to test whether or not PPP holds as a long-run relationship in the Iranian free market for the dollar, despite these events.

There is some recent evidence on the behaviour of the black market Rial. Bahmani-Oskooee (1995a) finds that the depreciation can be explained in terms of a monetary model of the exchange rate, in which greater domestic income causes the exchange rate to appreciate. In an earlier paper, Bahmani-Oskooee (1993a) reports support for PPP in a cointegration framework, but his estimation technique did not permit the testing of the parameter restrictions imposed by PPP. Our estimation strategy does permit such tests, and we go further than Bahmani-Oskooee to model the short-run determinants of the exchange rate[14]. Broadly, we find support for PPP as the long-run determinant of the exchange rate, conditional on an asymmetric relationship between the exchange rate and oil revenue. Oil revenue is found to influence the exchange rate only in the post-revolution period. Next subsections are organised as follows: section 1 considers the likely determinants of the black market rate in Iran; section 2 discusses the empirical methodology; section 3 presents the results and section 4 concludes.

5.3.4.2 PPP and the Determinants of the Black Market Value of the Rial

If we denote the price of foreign currency in terms of the Rial by E, domestic prices by P^d and foreign prices by P^f, then PPP predicts a constant real exchange rate:

(5.3.5) $E * P^f \,/\, P^d = K$

[13] We were unable to obtain the black market exchange rate for the period since 1990, and so our estimation period ends before the exchange rate reform of 1993.

[14] Modern econometric techniques allow us to distinguish between short and long-run effects of the process under consideration.

where K is a constant, which we can arbitrarily set to 1. If we use lower cases the denote the natural logarithm of a variable then (5.3.5) becomes:

$$(5.3.6)\quad e = p^d - p^f$$

Thus we expect the exchange rate to have a unit price differential elasticity. An equation such as (5.3.5) will represent long-run equilibrium exchange rate. In the short-run a multitude of shocks could push the exchange rate away from the long-run equilibrium, and in the long-run the real exchange rate could also be influenced by permanent changes in the economy. Some researchers suggest that one reason responsible for failing to support PPP hypothesis, is the omission of relevant variables from the PPP relationships[15]. (See previous sections of this chapter for more discussion in this concern)

[15] In explaining the PPP theory, three alternatives are distinguished in literature:

1. In the most extreme we can expect:

$$E_t = \frac{P_t^d}{P_t^f}$$

where E_t indicates to short run equilibrium exchange rate in period t (number of units of domestic currency per unit of foreign currency). In this expression, the exchange rate cannot deviate even temporarily from the current value of P_t^d/P_t^f. Empirically this interpretation of the PPP theory has been rejected repeatedly.

2. In the second extreme(Cassel's form), the P^d/P^f component is but one variable to explain the exchange rate:

$$E_t = f\left(\frac{P_t^d}{P_t^f}\cdots\right)$$

where f refers to "an arbitrary increasing function with respect to the explicit independent variable, with the ellipse denoting space for additional explanatory variables" (Officer 1976).

Cassel allows room both for random influences and for other explanatory variables in the f function. Several variables, other than P^d/P^f, were put forward by some contributors in literature. Some of them are accounted as systematic influences on the exchange rate, such as trade restrictions, speculation in foreign exchange market, anticipation of greater inflation in a country than in another, changes in relative prices within a country, the intervention of government in the foreign exchange market (these variables are mentioned in Cassel's writings about PPP (for more see Officer, 1976)

3. In the third view of explaining the PPP, working from the first extreme , one can replace P^d/P^f by a weighted average of the current and past values of P^d/P^f.

A number of factors are likely to have raised the long run real exchange rate for the Iranian Rial. There has been a massive loss of productive capacity since the 1979 revolution which has increased Iran's demand for imported goods[16]. Prior to the revolution Iran's economy had been growing rapidly (over 1963-78 the average growth rate of non-oil output[17] = 11.7%) partly through a policy of import substitution, and as a consequence of the opportunities for investment opened up by higher oil earnings in the 1970s the growth rate was rising. Since the revolution production has stagnated (average growth rate of non-oil output = 1.2%) as a consequence of both the revolution, the costly and protracted war with Iraq, and falling oil revenue[18]. Events associated with the revolution reduced productive capacity in a number of ways. Firstly, the emigration of factory owners and skilled workers (Ghasimi 1992). Second, the isolation of the economy from the outside world- due to sanctions and frozen assets - reduced the inflow of foreign technology (Karshenas 1995). Third, the introduction of policies that failed to encourage production (Karshenas and Pesaran, 1995). In the Iran-Iraq war much human and physical capital was lost, and infrastructure destroyed. Finally, falling oil revenue reduced government revenues and hence the ability of the state to invest in industry and infrastructure[19] (Ghasimi 1992; Karshenas 1995; Karshenas and Pesaran 1995, Mazarei 1996). Hence, after the revolution Iran moved from a position of import substitution to one of more import dependence. This greater demand for imports relative to exports would raise the equilibrium real exchange rate, that is the value of K in equation (5.3.5) [20].

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16 Since the revolutionary years (especially after the Iran-Iraq war was launched in 1980) the share of consumption in the national expenditure of Iran has increased, whilst national income and industrial output have stagnated. This has produced a considerable increase in demand for imported goods (see Behdad, 1988 for more discussion).

17 Calculated at constant 1990 prices from: Bank Markazi Iran (Central bank of Iran), Annual Economic Reports and Balance sheet; several issues.

18 Stagnation had, in fact, started since 1977 in the end of Fifth Plan (1973-77). (see chapter 2 and Looney, 1985, p. 100)

19 The loss of oil revenue reflected falling world prices, government decisions to conserve oil and international political developments.

20 Import dependence began to rise immediately prior to the revolution as higher consumption raised the demand for imports (Karshenas, 1995) but due to Iran's large foreign reserves the exchange rate remained stable. However, in the post-revolution years the increasing import demand coincided with a great scarcity of foreign exchange put downward pressure on the black market exchange rate.

Portfolio adjustment following the revolution and war[21] also depreciated the free market rate as Iranian assets were frozen and capital fled Iran either to find safer investments or as the emigrants turned to the black market to obtain foreign currency. Because of the war this capital flight persisted throughout the 1980s. However, we have been unable to distinguish between the effects of capital flight and lost productive capacity[22].

There is some ambiguity about the possible effects of greater oil revenue on the black market rate, and furthermore given the structural changes that have occurred in Iran the effects of oil on the exchange rate could differ between the post-Revolution and the pre-Revolution eras. Since oil earnings are the authorities main source of foreign currency, then higher oil revenue increases the amount of currency that could be provided at the official rate. The consequent reduction in demand for currency on the free market would cause an appreciation of the black market exchange rate. This effect may be more important after the revolution as the authorities have had difficulties borrowing to support the exchange rate and so have become more dependent upon oil revenue as a source of foreign exchange. The ambiguity in the effect of oil arises as a result of the spending of the extra income earned by oil[23]. If higher incomes increase the demand for (net) imports[24], then this must depreciate the exchange rate[25]. This effect could be larger since the revolution as the economy has had difficulties in meeting extra demand for goods, and the greater scarcity of foreign currency has forced people to turn to the black market for hard currency to buy imported consumer goods[26]. In the short run the extra reserves may cause an appreciation of the exchange rate, but in the long run the spending effect may be dominant. Thus the effect of higher

21 Agenor (1991) considers portfolio adjustment to secure private assets to be a key determinant of the black market exchange rate.

22 We could of course try to model the effect of lost productive capacity, however, measuring the loss of productive capacity has proved difficult. The main problem is that prior to the revolution the growth in output was unbalanced (Pesaran, 1982) and the rapid growth that occurred was likely to be in excess of the true long-run rate. (see chap 6 for modelling output)

23 For more discussion see Dutch disease interpretation in chapter 3.

24 Due to increased demand for foreign goods and the diversion of exports to the home market.

25 Edwards (1986d) concludes that to avoid a boom-induced real apprecition, the government should not spend too much on non-traded goods. He warns, however, that this advise may encourage to spend most of the revenue on arms and weapons, that has occured in many countries.

26 As the authorities strictly ration the uses of official reserves.

oil revenue could be to cause a short-run appreciation followed by a long-run depreciation, at least since the revolution.

5.3.4.3 The Model and Econometric Methodology

Our estimating equation is of the error feedback form:

$$\begin{aligned} \Delta e_t &= \alpha_0 + \alpha_1(L)\Delta e_{t-1} + \alpha_2(L)\Delta p_t^d + \alpha_3(L)\Delta p_t^f + \alpha_4 DR_t + \\ &\alpha_5(L)\Delta oil_t + \alpha_6 oil_{t-1} + \alpha_7[e-(\beta_1 p^d + \beta_2 p^f)]_{t-1} + \varepsilon_t \end{aligned} \qquad (5.3.7)$$

where oil_t is the log of real oil revenue (see Data Sources in 5.3.6), DR_t is a dummy variable for the post revolution period, DR_t is equal to 1 from 1979 and 0 otherwise, Δ and L are respectively the difference and lag operators, and ε_t is a random error term. For PPP to hold in the long-run we require $\alpha_7 < 0$ (that is cointegration) and $\beta_1 = -\beta_2 = 1$. The discussion in the previous section suggests that $\alpha_4 > 0$, $\alpha_5 < 0$, $\alpha_6 > 0$. Initially we assume that the parameters are invariant over time, but later we allow for differing values before and after the revolution. If domestic and foreign prices, the black market exchange rate, and oil revenue are I(1) and cointegrated, then estimation of (5.3.7) by least squares is valid. We employ a non-linear estimation technique to obtain estimates of the βs together with their standard errors. (see chapter 4 for an explaining of this technique)

5.3.4.4 Results

5.3.4.4.1 Data: order of integration and cointegration

We first test the orders of integration in the data. The Phillips-Perron[27] test for unit roots was applied and the results are shown in Table (5.3.2).

Table 5.3-2 Phillips-Perron Unit Root for Stationarity

Variables	Level		First difference
	Z_α	Z_t	Z_α
p^d	1.7	3.79	-7.06
p^f	0.36	0.65	-5.91
e_b	1.41	1.11	-22.77
oil	-3.2	-1.59	-26.62

Notes:

RATS software was used to produce these results.

Z_t and Z_α are Perron and Phillips test statistics for Unit roots respectively with and without deterministic trends. The 5% critical values (for 25 observations) are -3.0 without trend and -3.6 with trend. The number of lagged difference terms in each equation is 4. No. of observations for lavels =31

The variables all appear to be I(1). As an initial test for cointegration Johansen's technique was employed. The inferences are sensitive to the maximum lag length, and we report the results for a lag length of 4, since Banerjee, et al. (1993, p. 286) and Gonzalo (1990) have shown that the Johansen method is more sensitive to under-parametrisation than to over-parametrisation.

The full results are reported in Table 5.3-3 to Table 5.3-6. We find evidence of one cointegrating vector for *e*, p^f and p^d , with correctly signed parameters and the restriction of relative prices can not be rejected($\beta_1 = -\beta_2 = \beta$, $\chi^2(1) = 1.74$) (Table 5.3-3). But when relative prices are imposed the restriction of a unit coefficient ($\beta = 1$, χ^2

[27] When the data under consideration includes one or more structural break this test is usually more suitable compared with its altarnatives.

(1) = 11.94) is rejected (Table 5.3-4). With *e*, p^f, p^d and *oil* we find 2 cointegrating vectors, but the second vector makes little sense. Relative prices can be imposed on the first cointegrating vector (χ^2 (1) = 0.11), but a zero coefficient on oil cannot be rejected (χ^2 (1) = 0.16) (Table 5.3-5), and when relative prices are imposed a unit relative price coefficient (β = 1) is strongly rejected (χ^2 (1) = 12.66)[28] (Table 5.3-6). The Johansen results show that even conditional on oil revenue strong Purchasing Power Parity does not hold even though the black market exchange rate, relative prices and oil revenue constitute a cointegrating vector. For comparison purpose Engle-Granger method for cointegration was also implemented and the results are reported in Table 5.3-7 and Table 5.3-8. If all variables in the model are I(1) then in Engle-Granger (1987) terminology the necessary condition for PPP (weak form) is the existence of a stationary error structure. But the necessary and sufficient condition for PPP (strong form) is the existence of a vector (α, β_1, β_2), such that the error term is a stationary process and (α, β_1, β_2) = (0, 1, -1). Tests for non-stationarity of variables were conducted and reported in previous section. We estimate equation: $e_b = \alpha + \beta_1 p^d + \beta_2 p^f + \gamma dr + \mu_t$, using OLS and test the residuals for stationarity (Table 5.3-7). We cannot reject the non-stationarity hypothesis of the residuals (RESID1) (ADF St. = -2.3; Pillips-Perron St. = -2.8)[29]. Then, *oilr* (oil revenue variable) was added to the long-run equation and E.G. procedure was repeated (Table 5.3-8). In this case results of ADF and PP tests for non-stationarity hypothesis of the residuals (RESID2) reject the null and produced PP St. = -4.4 (significant in 1%) and ADF St. = -2.6 (significant in 10%). These results clearly introduce the oil revenue as a necessary variable that should be included in PPP relationship to get a cointegrated vector.

However, PPP can also be tested by estimating equation (5.3.7). The advantage of this test is that it is less sensitive than Johansen's method to misspecification in the full system of equations. We use this equation to show that PPP is not rejected once we allow for an asymmetry in the response of the exchange rate to oil revenue.

[28] All of the Johansen estimates include the post -revolution dummy as an additional I(0) variable.

[29] Result of Pillips-Perron test (-2.8) is insignificant in 1% and 5% but significant in 10%.

5.3.4.4.2 An Error Feedback Equation

Our preferred equation is reported below. It is free from serial correlation and provides a reasonable fit to the data. We find that oil revenue only appears significantly in the equation when it is allowed to interact with the post revolution dummy variable. We believe this is due to a reduction in the ability of the economy to absorb the increased demand which greater oil revenue generates. Before the revolution the economy was growing rapidly, import substitution was being encouraged and foreign currency reserves were plentiful, thus extra demand was met by increased domestic production with little consequence for the exchange rate. But after the revolution, as production stagnated[30] extra aggregate demand caused higher inflation, increased the demand for imports and diverted non-oil exports to the domestic market. With the official exchange rate becoming increasingly overvalued in real terms, increased oil revenue raised the demand for foreign currency in the parallel market, and caused the black market exchange rate to depreciate[31]. We find no evidence of any other pre- and post-revolution asymmetries in the slope parameters:

$$\underset{}{\Delta e_t} = \underset{(2.45)}{1.40} - \underset{(4.79)}{0.47}\Delta e_{t-1} - \underset{(7.22)}{0.66}\Delta e_{t-4} + \underset{(3.70)}{0.05}(DR)oil_{t-1} +$$

$$\underset{(6.98)}{0.50}DR_t - \underset{(4.09)}{0.25}\left[e - (\underset{(2.09)}{0.72}p^d - \underset{(1.42)}{0.80}p^f)\right]_{t-1}$$

Period :1965-1990; $\overline{R}^2$ = 0.93; SER = 0.0601; LM(1) = 0.12; LM(4) = 6.35; A = 0.007.

Notes: Numbers in brackets are absolute t-ratios, SER is the standard error of the equation, LM(x) is a Lagrange multiplier test statistic for serial correlation of up to order x, and A the test statistic for first order ARCH. None of LM(x), or A exceeds the 5% critical value.

---

[30] Arguably the productive capacity of Iranian economy actually fell after the revolution. According to Pesaran (1995) over the period 1978-1988, the real output and investment fell by annual average rates of 1.8 and 6.6 per cents, respectively. See also Pesaran (1992).

[31] Without the oil variable interacting with the dummy the equation performs very poorly, there is no evidence of a long-run relationship, and essentially the rial is determined by an auto-regression with an intercept shift after the revolution. We found no significant pre-revolution effects for the oil variable.

The positive value of α_4 is consistent with a fall in the equilibrium real exchange rate following the revolution and is also consistent with depreciation caused by the flight of capital. Cointegration is present ($\alpha_7 < 0$) since in absolute value the t-statistic on α_7 exceeds Mackinnon's critical value[32](-3.58). The imposition of relative prices on the long-run equilibrium is not rejected ($\beta_1 = -\beta_2 = \beta$, $\chi^2(1) = 0.07$), and neither is a unit price differential elasticity ($\beta = 1$, $\chi^2 = 1.25$). Thus, we find PPP to be a valid model of the long-run exchange rate conditional on a shift in the real exchange rate and the asymmetric long-run effects of higher oil revenue. This gives us the final equation:

$$\underset{}{\Delta e_t} = \underset{(6.57)}{1.74} - \underset{(4.63)}{0.42}\Delta e_{t-1} - \underset{(7.13)}{0.63}\Delta e_{t-4} + \underset{(3.97)}{0.05}(DR)oil_{t-1}$$

$$+\underset{(7.57)}{0.45}DR_t - \underset{(6.66)}{0.30}\left[e - (p^d - p^f)\right]_{t-1}$$

1965-1990; $\overline{R}^2 = 0.90$; SER = 0.060; LM(1) = 0.01; LM(4) = 4.24; A = 0.10

The long-run solution (ignoring the constant and dummy) is :

$$e = (p^d - p^f) + \alpha(oil)$$

where $\alpha = 0$ before the revolution and $\alpha = 0.17$ from 1979.

Finally, the dynamics of the equation are far from smooth, with the depreciation of the Rial being negatively related to past depreciations. We suspect that this finding, which we find to be very robust, is due to a mixture of policy responses and expectations of such responses. In particular, the government has tended to raise revenue by selling dollars in the black market (Pesaran 1992). If government sales of dollars are greater

[32] MacKinnon's critical values have been reproduced by Banerjee et al (1993).

when the Rial has depreciated quickly, then this may partly explain the dynamics, as this intervention would slow down the rate of depreciation.

Table 5.3-3 Johansen Maximum Liklihood Procedure (Non-trended Case)

List of Variables included in the cointegrating vector: e_b, p^d, p^f, Intercept. ***DR is included in VAR as an I(0) variable.*** **Maximum lag in VAR = 4**

A:
Cointegration LR test based on Maximal Eigenvalue of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r=1)	42.29*	22.00	19.77
r<=1 (r=2)	10.55	15.67	13.72
r<=2 (r=3)	1.96	9.24	7.53

B:
Cointegration LR test based on trace of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r>=1)	54.8*	34.91	32.00
r<=1 (r>=2)	12.51	19.96	17.85
r<=2 (r=3)	1.96	9.24	7.53

Johansen Test; Estimated Cointegrated Vectors (Normalised in Brackets)		**Restricted Cointegrated Vectors in Johansen Estimation**
	VECTOR 1	$\beta_1 + \beta_2 = 0$
e_b	-1.36 (-1.00)	-1.07 (-1.00)
p^d	2.30 (1.69)	2.21 (2.07)
p^f	-1.54 (-1.13)	-2.21 (-2.07)
Intercept	7.15 (5.25)	8.04 (7.83)
		LR Test of Restrictions: $\chi^2(1) = 1.74$

Notice: Star (*) indicates significant at 95% probability.

Table 5.3-4: Johansen Maximum Likelihood Procedure (Non-trended Case)
List of Variables included in the cointegrating vector: $e_b, (p^d - p)^f$, Intercept. . *DR is included in VAR as an I(0) variable.* Maximum lag in VAR = 4

A:
Cointegration LR test based on Maximal Eigenvalue of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r=1)	35.71*	15.67	13.75
r<=1 (r=2)	.27	9.24	7.52

B:
Cointegration LR test based on trace of the Stochastic Matrix

r=0 (r>=1)	35.98*	19.96	17.85
r<=1 (r>=2)	.27	9.24	7.53

	Johansen Test; Estimated Cointegrated Vectors (Normalised in Brackets)	**Restricted Cointegrated Vectors in Johansen Estimation**
	VECTOR 1	$\beta = 1$
e_b	-1.08 (-1.00)	-.63 (-1.00)
$(p^d - p^f)$	2.2 (2.03)	.63 (1.00)
Intercept	8.13 (7.52)	3.69 (5.82)
		LR Test of Restrictions: $\chi^2(1) = 11.94$

Notice: * indicates significant at 95% probability.

Table 5.3-5 Johansen Maximum Likelihood Procedure (Non-trended Case)
List of Variables included in the cointegrating vector: e_b, p^d, p^f, *oil*, Intercept. *DR is included in VAR as an I(0) variable.* Maximum lag in VAR = 4

A:
Cointegration LR test based on Maximal Eigenvalue of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r=1)	47.48*	28.14	25.56
r<=1 (r=2)	41.30*	22.00	19.77
r<=2 (r=3)	9.12	15.67	13.75
r<=3 (r=4)	3.68	9.24	7.53

Table 5.3-5, **continued**
B:
Cointegration LR test based on trace of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r>=1)	101.64*	53.12	49.65
r<=1 (r>=2)	54.16*	34.91	32.00
r<=2 (r=3)	12.80	19.94	17.85
r<=3 (r=4)	3.68	9.24	7.53

Table 5.3-5, **continued**

	Johansen Test; Estimated Cointegrated Vectors (Normalised in Brackets)		**Restricted Cointegrated Vectors in Johansen Estimation**	
	VECTOR 1	VECTOR 2	$\beta_1 + \beta_2 = 0$ (Imposed on vector 1)	oil-coefficient =0
e_b	-1.38 (-1.00)	1.92 (-1.00)	-1.09 (-1.00)	-1.04 (-1.00)
p^d	2.15 (1.56)	0.95 (0.49)	2.24 (2.05)	2.27 (2.18)
p^f	-1.27 (-0.92)	-7.09 (-3.70)	-2.24 (-2.05)	-2.42 (-2.32)
oil	-0.29 (-0.21)	1.83 (-0.96)	-0.07 (-0.06)	0.00 (0.00)
Intercept	7.77 (5.63)	4.53 (-2.36)	8.43 (7.74)	8.48 (8.13)
			LR Test of Restrictions: $\chi^2(1) = 0.11$	LR Test of Restrictions: $\chi^2(1) = 0.16$

Notice: * indicates significant at 95% probability.

Table 5.3-6 Johansen Maximum Likelihood Procedure (Non-trended Case)
List of Variables included in the cointegrating vector: e_b, $(p^d - p^f)$, *oil*, Intercept.
***DR is included in VAR as an I(0) variable.* Maximum lag in VAR=**

A:

Cointegration LR test based on Maximal Eigenvalue of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r=1)	39.63*	22.00	19.77
r<=1 (r=2)	18.16*	15.76	13.75
r<=2 (r=3)	3.24	9.24	7.53

B:

Cointegration LR test based on trace of the Stochastic Matrix

r=0 (r>=1)	61.03*	34.91	32.00
r<=1 (r>=2)	21.4	19.96	17.85
r<=2 (r=3)	3.23	9.24	7.53

Johansen Test; Estimated Cointegrated Vectors (Normalised in Brackets)			**Restricted Cointegrated Vectors in Johansen Estimation**	
	VECTOR 1	VECTOR 2	β=1	β=1 (only on first Vec.)
e_b	-1.09 (-1.00)	-.59 (-1.00)	.55 (-1.00)	.55 (-1.00)
$p^d - p^f$	2.65 (2.44)	.64 (1.08)	-.55 (1.00)	-.55 (1.00)
oil	.12 (.11)	-.14 (-.24)	.07 (-.13)	.07 (-.13)
Intercept	8.2 (7.55)	4.54 (7.74)	-3.36 (6.16)	-3.36 (6.16)
			LR Test of Restrictions: $\chi^2(1) = 12.67$	LR Test of Restrictions: $\chi^2(1) = 12.67$

Notice: * indicates significant at 95% probability.

Table 5.3-7 Engle-Granger Method of Cointegration (Model 1)				
LS // Dependent Variable is eb				
Sample: 1960 1990				
Included observations: 31				
Variable	Coefficient	t-Statistic	**Wald Test:**	
			Null Hypothesis:	$\beta_1 = 1$
α	8.254344	10.66054		
p^d	1.626000	11.01179	F-statistic	17.97310
p^f	-2.034115	-6.966038	Chi-square	17.97310
dr	0.893696	5.394483	**Null Hypothesis:**	$\beta_2 = -1$
R-squared	0.970442		F-statistic	12.54175
Adjusted R-squared	0.967158		Chi-square	12.54175
S.E. of regression	0.189729		**Null Hypothesis:**	$\beta_1 + \beta_2 = 0$
Sum squared resid	0.971917			
Log likelihood	9.681219		F-statistic	4.959108
Durbin-Watson stat	0.990372		Chi-square	4.959108

Augmented Dickey-Fuller Test Equation			
LS // Dependent Variable is D(RESID1)			
ADF Test Statistic	-2.269678	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290
*MacKinnon critical values for rejection of hypothesis of a unit root.			

Phillips-Perron Test Equation			
LS // Dependent Variable is D(RESID1)			
PP Test-Statistic	-2.832445	1% Critical Value*	-3.6661
		5% Critical Value	-2.9627
		10% Critical Value	-2.6200
*MacKinnon critical values for rejection of hypothesis of a unit root.			

Table 5.3-8 Engle-Granger Method of Cointegration (Model 2)

LS // Dependent Variable is eb
Sample: 1960 1990
Included observations: 31

Variable	Coefficient	t-Statistic		
			Wald Test:	
			Null Hypothesis:	$\beta_1 = 1$
α	5.339865	5.031810	F-statistic	0.508982
p^d	1.134260	6.027207	Chi-square	0.508982
p^f	-0.570656	-1.171529	**Wald Test:**	
oilr	-0.218755	-3.479894	**Null Hypothesis:**	$\beta_2 = -1$
dr	0.645855	4.124752		
			F-statistic	0.776907
R-squared	0.979835		Chi-square	0.776907
Adjusted R-squared	0.976732		**Wald Test:**	
S.E. of regression	0.159697		**Null Hypothesis:**	$\beta_1 + \beta_2 = 0$
Sum squ. resid	0.663082			
Log likelihood	15.60798		F-statistic	3.121281
Durbin-Watson stat	1.616552		Chi-square	3.121281

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(RESID2)

ADF Test Statistic	-2.569073	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290

*MacKinnon critical values for rejection of hypothesis of a unit root.

Phillips-Perron Test Equation
LS // Dependent Variable is D(RESID2)

PP Test Statistic	-4.384261	1% Critical Value*	-3.6661
		5% Critical Value	-2.9627
		10% Critical Value	-2.6200

*MacKinnon critical values for rejection of hypothesis of a unit root.

5.3.5 Conclusion

In the first part of this chapter we considered the relevance of simple economic models to the determination of the official and black market Rial/Dollar exchange rate. We also considered how the behaviour of these exchange rates differed before and after the revolution. Our findings are: (1) Purchasing power parity is a relevant model of both exchange rates in the pre-revolution period, but only applies to the black market rate after the revolution. (2) Only the black market rate responds to the black market premium. (3) The official exchange rate does not appear to be influenced by the black market rate.

Perhaps the most likely explanation of these findings is that since the revolution the Iranian government has used its monopoly over foreign currency earned from oil revenue to maintain a very profitable high premium on the black market exchange rate. In contrast, in the pre-revolution period the government had ample revenue from oil and credit from abroad to avoid financing expenditure from gains in the black market.

In the second part of this chapter we have shown that the black market exchange rate in Iran can be modelled in a PPP framework once the effects of the revolution, war and oil revenue are taken into account. There is reason to believe that the effect of oil revenue on the black market exchange rate has been asymmetric. During the pre-revolution boom the black market rate seems to have been insensitive to oil revenue, but as the economy stagnated following the revolution so the black market rate became sensitive to oil revenue. Since the revolution higher oil revenue appears to have generated extra demand for imports and deflected domestic production away from exports, so that in the long run the exchange rate tended to depreciate. What is perhaps most interesting in this study is that once this asymmetry is taken into account we find evidence of a long run economic relationship despite the tremendous shocks and changes the Iranian economy has been subjected to.

To have a more comprehensive picture of the oil revenue's impact on the Iranian economy the relationship between other macro key variables and oil revenue must be discussed. In next chapter we try to model inflation, non-oil gdp growth and real money balances in connection with oil revenue fluctuations.

5.3.6 Data Definition

Data Definitions and Sources

Variable	Definition	Source
E_b	Free (black) market Exchange rate of Iran (average annual rate: Rials per US Dollar)	1965-1987: World Currency Yearbook. For 1960-64 and 1988-1990, observations have been provided by Bahmani-Oskooee.
P^d	Consumer Price Index for Iran (Calculated for 1990=100)	Original data from: IFS several issues
P^f	Consumer Price Index for US (Calculated for 1990=100)	Original data from: IFS several issues
Oil	Oil revenue obtained from oil exports (Billions of Rial)	IFS several issues
DR	A dummy variable for post-revolutionary period: 0 for pre-revolution and 1 thereafter.	-

IFS = International Financial Statistics (IMF)

5.3.7 Appendix: Official and black Market Exchange Rates (Further Results)

5.3.7.1.1 Spillovers

LS // Dependent Variable: Δeo
Sample(adjusted): 1962 1990
Included observations: 29 after adjusting endpoints
Spillovers

Variable	Coefficient	t-statistic
C	0.269466	0.673381
Δeb(-1)	0.063939	0.969711
Δeo(-1)	0.290215	1.479691
reo(-1)	-0.010632	-0.283650
reb(-1)	-0.035150	-1.007248
R-squared	0.159094	
Adjusted R-squared	0.018944	
S.E. of regression	0.054844	
Sum squared resid	0.072190	
Log likelihood	45.78921	
Durbin-Watson stat.	2.031840	

Notes: re indicates to real exchange rate and b and o refere to black and official markets respectively.

5.3.7.1.2 PPP

LS // Dependent Variable is Δeo
Sample(adjusted): 1962 1990
Included observations: 29 after adjusting endpoints
PPP

Variable	Coefficient	t-Statistic
C	-0.070530	-0.583157
Δeo(-1)	0.309698	1.610671
reo(-1)	0.011926	0.549780
R-squared	0.109934	
Adjusted R-squared	0.041468	
S.E. of regression	0.054211	
Sum squared resid	0.076410	
Log likelihood	44.96537	
Durbin-Watson stat.	1.845196	

Notes: re indicates to real exchange rate and b and o refere to black and official markets respectively.

5.3.7.1.3 Premium

LS // Dependent Variable: Δeo		
Sample(adjusted): 1962 1990		
Included observations: 29 after adjusting endpoints		
Black Market Premium		
Variable	**Coefficient**	**t-Statistic**
C	0.001430	0.113719
Δeo(-1)	0.306962	1.608249
(eb(-1)-eo(-1))	-0.007857	-0.750667
R-squared	0.118688	
Adjusted R-squared	0.050894	
S.E. of regression	0.053944	
Sum squared resid	0.075659	
Log likelihood	45.10868	
Durbin-Watson stat.	1.856184	

Black Market Exchange Rate					
Dep. Var.: Δe_b					
	cons.	$\Delta e_{b(t-1)}$	$\Delta e_{o(t)}$	$re_{o(t-1)}$	$re_{b(t-1)}$
1960-78	.41	.51	.63	.28	-.35
	(.97)	(3.18)	(2.53)	(1.91)	(-2.80)

Price differential restriction: β_1=- β_2; χ^2=1.13. Real exchange rate restriction: β=1; χ^2=.29. R^2 (adj.)= .56, DW = 2.57

For the whole period there is no response from official exchange rate to the black market premium. PPP is not supported by data when official exchange rate is used as dependent variable. There is no any sign of spillovers from black market depreciation onto official exchange rate. To see a picture of developments in exchange rate market during the whole period refer to the plotted nominal and real exchange rates in chapter 2.

As these pictures show in pre-revolution period two rates have been moving along with each other without a considerable gap between them. This could likely be an indication of existing a long-run equilibrium in the market in that time. Post revolutionary (and war) period shows an opposite story, i.e., there is a serious and growing gap between black and official exchange rates implying that official exchange rate has been kept on an overvalued level.

5.3.7.2 Official Exchange Rate: Further Results

5.3.7.2.1 Johansen Test for Cointegration

As for the black market the Johansen procedure was applied to test whether there is any cointegrating vector among variables under consideration (e_o, p^d, p^f). Four lags were chosen as the short-run dynamics in this procedure. This lag-length was confirmed by applying the general to specified method too. We find two significant cointegrated vectors between variables, however, the signs of obtained coefficients are inconsistent with what the PPP relationship indicates to (Table 5.3-9). The restrictions of relative prices ($\beta_1 + \beta_2 = 0$) and unit coefficient [$(\beta_1\ \beta_2) = (1\ -1)$] were imposed on cointegrated vectors. The related results indicate that these restrictions are irrelevant (χ^2 (2) =15.73 and χ^2 (4) = 34.49, respectively).

5.3.7.2.2 Relative PPP

As it was mentioned before, relative PPP is the alternative framework through which one can possibly explain the behaviour of an exchange rate, especially when he could not find any supportive evidence for a long-run relationship among the interested variables through strong PPP. In fact relative PPP allows us to investigate for any short-run relationship among those variables:

$$(5.3.8)\quad \Delta e_{o_t} = c + \sum_{i=1}^{4}\alpha_i \Delta e_{o(t-i)} + \sum_{j=0}^{4}\beta_j \Delta p^d{}_{t-j} + \sum_{h=0}^{4}\gamma_h \Delta p^f_{t-h} + \delta DR_t + \mu_t$$

Table 5.3-9 Johansen Maximum Likelihood Procedure (Non-trended Case)

List of Variables included in the cointegrating vector: e_o, p^d, p^f and Intercept.
***DR* is included in VAR as an I(0) variable. Maximum lag in VAR = 4**

A:
Cointegration LR test based on Maximal Eigenvalue of the Stochastic Matrix.

Null (Alternative)	Statistic	95% C. Value	90% C. Value
r=0 (r=1)	27.78*	22.00	19.77
r<=1 (r=2)	22.58*	15.67	13.75
r<=2 (r=3)	7.23	9.24	7.53

Table, **continued**
B:
Cointegration LR test based on trace of the Stochastic Matrix.

r=0 (r>=1)	57.59*	34.91	32.00
r<=1 (r>=2)	29.80*	19.96	17.85
r<=2 (r=3)	7.23	9.24	7.53

Table, **continued**

	Johansen Test; Estimated Cointegrated Vectors (Normalised in Brackets)		**Restricted Cointegrated Vectors in Johansen Estimation**			
	VECTOR 1	VECTOR 2	$\beta_1+\beta_2=0$ (Imposed on vectors)		$\beta_1=1$ & $\beta_2=-1$	
e_o	-.69 (-1.00)	11.94 (-1.00)	-3.80 (-1.00)	-2.17 (-1.00)	-2.14 (-1.00)	-.81 (-1.00)
p^d	-.11 (-.16)	3.04 (-.26)	-.98 (-.26)	.91 (.42)	2.14 (1.00)	.81 (1.00)
p^f	-1.43 (-2.07)	-8.35 (.73)	.98 (.26)	-.91 (-.42)	-2.14 (-1.00)	-.81 (-1.00)
Intercept	7.77 (11.28)	-28.98 (2.52)	15.20 (4.00)	10.37 (4.77)	12.22 (5.71)	5.12 (6.33)
			LR Test of Restrictions: $\chi^2(2)=15.73$		LR Test of Restrictions: $\chi^2(4)=34.49$	

Notice: * indicates significant at 95% probability.

By dropping the more insignificant coefficients sequentially we finally obtained the following model as the relative PPP for official exchange rate:

$$\Delta e_o = c \quad + \beta_1 \Delta p^d_{t-1} \quad + \beta_2 \Delta p^f_{t-1} - DRV$$

	c	β_1	β_2	DRV
	-.04	.13	.73	-.03
(t - ratio)	(-2.22)	(.76)	(2.13)	(-1.13)

$\overline{R^2}$ =.13, DW = 1.48, LM(1) = 1.54

These final results still suffer from the wrong signs and show a weak power of explanation (R-SQ.=%13).

5.3.7.2.3 Short and long-run causation

We also applied the simultaneous method, as it was conducted for black market exchange rate, to investigate the short and long-run relationships among the variables. This investigation again shows an unsupportive evidence for PPP for the official exchange rate.

$$\Delta e_{o(t)} = \alpha_0 + \alpha_1 \Delta p^d_{t-1} + a_2 \Delta p^d_{t-2} + \alpha_3 DRV(-1) + \lambda \left(e_o - \beta_1 p^d - \beta_2 p^f\right)_{t-1}$$

	α_0	α_1	a_2	α_3	λ	β_1	β_2
	1.27	.51	.54	.17	-.17	-.56	-.75
(t - ratio)	(2.23)	(2.53)	(2.82)	(3.86)	(-1.38)	(-1.36)	(-.94)

R-SQ.(adj.)=.50, DW=2.43., $\beta_1 + \beta_2 = 0$, $\chi^2(1)$= 1.53

As we can see from the above results, although the error correction term has a correct sign but is insignificant again indicative of the lack of long-run relationship among the variables in this model. Further, the long-run coefficient of domestic prices has a wrong sign and all of long-run coefficients are insignificant[33].

All obtained results using several estimation methods indicate that the official exchange rate explains the reality, as it is expected based on PPP theory, very poorly.

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[33] After imposing symmetry restriction on domestic and foreign prices, i.e. β (p^d - p^f), we got a wrong sign coefficient: β = - .62 (t-ratio = -1.45). The null hypothesis of β =1, χ^2 (1) = 14.43.

6

6. Oil Revenue Effects on Inflation, Growth and Money

6.1 Introduction

A considerable literature on the economic impact of a natural resource now exists. These studies consider how a boom in one sector of the economy influences the remaining sectors of the economy. The most well known strand of this research is the 'Dutch disease' literature, in which the resource boom squeezes the non-boom tradable goods sector as the real exchange rate appreciates. In addition, there is a direct squeeze on the non-boom section as resources shift to the boom sector.

The process by which a resource boom affects the economy is complex and messy, and depends upon such things as the ownership of the resource, how state revenues are used, and the structure of the economy in question. Given these considerations, it is not surprising that there is a broad range of models of 'Dutch disease'. The purpose of this chapter is to examine how oil booms and slumps have affected the Iranian economy, in particular growth of the non-oil sector and inflation.

6.2 Dutch Disease

This term refers to the effects of the boom sector revenues on the other economic sectors including the non -oil tradable (Lagged) sector and the non-tradable sector (see, for instance, Corden, 1984).

In the general model of Dutch disease, a resource boom has two effects on the economy. First, there is the *resource movement* effect. This is the drawing of mobile factors of production away from other sectors of the economy to the booming sector. This process tends to reduce the output in the non-boom tradable and non-tradable sectors. Second, there is the *spending* effect. The boom raises incomes and so raises demand for tradable and non-tradable goods. The prices of the former are fixed by world markets, but the latter prices tend to rise with domestic demand. The result is a real appreciation of the exchange rate which stimulates the production of non-tradables[1] and deters the production of tradables.

A number of reasons may make an oil economy deviate from these stylised patterns. Price controls and import liberalisation can limit the appreciation of the real exchange rate by deflecting demand onto imports. Next, if traded sectors are able to respond strongly to investments financed by oil revenues, product market pulls towards the non-traded sectors may be counterbalanced, particularly if labour markets are slack so that expanding non-traded sectors do not draw labour from the traded sectors. Finally, the overall impact of higher public spending on growth may be low if the quality of investment projects declines with accelerating spending, or if subsidies and other expenditures drain resources from the public investment programme[2].

From this general simple model of the Dutch disease, there are some alternative channels through which a boom can be accommodated. First, if the boom sector does not show a strong participation in the domestic factor market, the *resource movement effect* would not be effective (see for example, Buiter and Purvis, 1983; Fardmanesh, 1991a and 1991c; van Wijnbergen, 1981 and Neary, 1985). The oil sector in the oil exporting developing countries, for instance, is considered as an 'enclave' (Pinto, 1987) a capital-intensive and hyper-technologic sector (with minimum competition with the non-oil economy) and so there does not emerge a considerable resource movement effect in such economies[3].

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[1] The magnitude of this recovery, however, depends on the related elasticities operating in this process: income-elasticity of demand for non-traded goods, output-elasticity of supply with respect to the real wage and so on.

[2] The results of Gelb (1986)'s studies suggest that the impact of expanded investment on growth of non oil GDP has been unsatisfactory during the (oil boom of) 1972-81 compare with 1967-72. (see Gelb, 1986, p. 79)

[3] See also McKinnon (1976) for supporting the 'enclave nature' of the oil sector in oil-exporting developing countries.

Neary (1985) discusses a model of Dutch disease where there may be both *de-industrialisation* and *real depreciation* (instead of real appreciation implied in the core model). But he claims that nobody has yet presented a plausible model which simultaneously had an increase in manufacturing output and a depreciation in the real exchange rate following a boom.

Fardmansh (1991c) argues that in some oil exporting developing countries the oil boom appeared to give rise to growth in non-oil traded (manufacturing) goods, the opposite to what the simple Dutch disease model predicts. Instead it was the agriculture sector which faced a considerable reduction in its share in GDP. He explains that although the *expenditure effect* could undermine the traded goods sector, a rise in the world price of manufactured goods relative to agricultural products (*the world price effect*) following the oil boom may dominate the negative effect mentioned above and leads to an expansion in manufactured output. The observed expansion of the non-oil traded sector in most oil-exporting developing countries has been explained by other authors by other reasons: For example Neary and van Wijnberg (1986) consider this sector in these countries as a protected sector and so put that sector under the non-traded category. Benjamin, *et. al.* (1989) attributed the unexpected phenomenon to the ' imperfect substitutability between domestic and foreign goods as well as to their linkages with the rest of the economy.' (p.90). They argue that, in a typical agricultural country, the importable sector is the industrial one, which is somewhat insulated from foreign competition by reason of the fact that its products are imperfect substitutes for imported goods. They show that in some cases this sector may actually expand its output in the wake of an oil boom[4]. Gelb (1986) in a comparative study of this issue, pointed out that Indonesia has been successful in using oil revenues to expand the non-oil tradable sector manufacturing sector. Usui (1996) confirms that the 1978 devaluation undertaken in Indonesia has been instrumental in this achievement.

Empirical evidence shows that oil booms have not always been followed by a decline in the non-oil tradable goods sector. Explanations for this finding include: government protection of some parts of the economy (van Wijnbergen, 1986); active government

[4] Their findings explain why the agricultural sector contracted in all oil exporting countries during the period 1974-82, while the industrial sector actually expanded in all but two of the countries.

policies to prevent a decline (e.g. Gelb, 1986 and Usui 1996 in the case of Indonesia); and the impact of oil price shocks on the inflation rates of non-oil exporters (Fardmanesh, 1991c).

Resource booms can also have monetary effects. Monetary aspects of the boom are parallel forces by which the boom revenue is accommodated into the domestic economy (Edward, 1986b, 1986d) and which reinforce the real effects. The foreign reserves earned from the boom could give rise to an expansion of the money supply. Noorbakhsh (1990) argues that conversion of oil revenues from foreign exchange proceeds into domestic currency becomes the most significant source of increases in the money supply in the oil exporting developing countries. But he also continued that the magnitude of change in the domestic money supply depends on the magnitude of foreign exchange proceeds from oil exports and the extent to which the money authorities sterilise these proceeds to neutralise their effect on the domestic money supply. Aghevli and Sassanpour (1982) argue that " Unlike domestic taxes, foreign revenues in the form of royalties on natural resources do not induce a reduction in disposable income, and their domestic spending leads to the creation of additional money." (p.792) However, the consequences of such a boom depends upon the responses of money demand to the boom. If the change in money demand is equal to the supply response then the monetary effects may be of little consequence for the rest of the economy[5]. Furthermore, in the case of oil it is not certain that a money supply expansion will follow the boom. In developing countries oil revenue typically accrues to the state; only if the state injects this money into the economy, for example through raising the budget deficit, will the money supply expand (see Morgan, 1979). This raises the possibility of some deflationary pressure following the boom if the money supply fails to expand as fast as money demand.

In the context of Dutch Disease models it is important to consider the characteristics of the Iranian Economy. Firstly, the revenue from oil sales accrues to the state, which

[5] If this revenue accrued to the government and is deposited in the Central bank there will be no increase in the domestic money supply unless the government spends at home out of the increased revenues or domestic credit to the private sector is increased. In the case that this revenue accrued to the private sector and is deposited in the commercial banks, the domestic money supply will increase. In the absence of any increase in public spending the increase in net foreign assets of the central bank is exactly offset by the reduction in net domestic credit to the government (reduction in budget deficit or dept of government to the central bank). So the money supply will increase as government domestic spending *monetises* the boom revenue.

sells the dollars earned to the Central Bank for Rial. This revenue is then used to finance government expenditure. To some extent the effect of oil revenues on the economy will depend upon how the government uses the revenue. Clearly, investment in industry and infrastructure could offset the adverse effects of resources moving from the non-oil sector to the oil sector. Second, the oil sector of the Iranian economy can be considered an enclave of the economy (see Pinto, 1987), which is highly capital intensive and has low linkages to the rest of the economy. This would act to reduce the resource movement effect. Third, following booms the commitments of government have been extended, and current and investment expenditures have been raised, usually in excess of the absorption capacity of the economy. Such a procedure could lead to more pressure on domestic prices. Prices of traded goods are mainly determined externally and so most of the inflationary pressure is reflected in higher prices for non-traded goods. The rise in relative prices of non-traded goods (real appreciation) increases the relative demand for imports. The long run effect of high oil revenue could be, then, to depreciate the nominal exchange rate as imports rise.

A further complication is the exchange rate system. Iran has operated a system of multiple fixed exchange rates. Alongside the fixed official market has existed a free market for foreign exchange. Sometimes there has been little free market activity but at other times the free market has been the dominant source of foreign currency (see chapters 2 and 5). Generally, the free market has been the dominant source of currency for marginal transactions. This is particularly true of recent years, as foreign exchange has been strictly rationed at the hugely overvalued official exchange rate. Thus, we expect to find the influence of the free market rate upon economic activities to dominate the effects of the official exchange rate.

A final complication is the massive disruption caused to the economy by the revolution and the war with Iraq. Both events resulted in large losses of human and physical capital. The consequence of these events is a huge loss of productive capacity, which is indicated by an average annual rate of investment of - 6.29% (according to Mazarei, 1996), and an increasing dependency on imports. This switch from a booming economy to an almost collapsing one presents a number of problems for our study, in particular it is possible that some effects of oil may have become stronger or weaker since the revolution. For example, as the ability of the economy to absorb demand fell following the revolution, the inflationary impact of oil revenue may have risen. We consider this possibility by using a post-revolution dummy to incorporate parameter shifts.

6.3 The Model for Estimation

The equations of primary interest determine the rate of growth of non-oil output and the rate of inflation. We represent the general equations in error-correction form.

$$\begin{aligned}\Delta rnoy_t &= \delta_1 + \delta_2(rnoy - rnoy^*)_{t-1} + \delta_3(\lambda)\Delta re_t + \delta_4 re_{t-1} + \delta_5(\lambda)\Delta oil_t \\ &\quad + \delta_6(\lambda)\Delta rnoy_{t-1} + \delta_7 DR + \mu_t\end{aligned} \tag{6.1}$$

$$\begin{aligned}\Delta p_t^d &= \beta_1' + \beta_2'(\lambda)(\Delta p^f + \Delta e)_t + \beta_3'(\lambda)\Delta(m^s - m^d)_t + \beta_4'(p^d - p^{d*})_{t-1} \\ &\quad + \beta_5'\Delta oil_{t-1} + \beta_6'(\lambda)\Delta p_{t-1}^d + v_t\end{aligned} \tag{6.2}$$

where Δ is the difference operator and λ is the lag operator.

Non-oil output growth is given by equation (6.1). Output in excess of the long run trend (*rnoy**) is expected to slow growth down, $\delta_2 < 0$. The spending effect of the boom operates through the real exchange rate (*re*). Both δ_3 and δ_4 are expected to be positive. The resource effect is picked up by δ_5, which should be negative according to the standard Dutch Disease Model.

Inflation is determined by equation (6.2). Inflation tends to be higher if foreign prices are rising faster than the rate of appreciation of the Rial; if growth in the supply of money exceeds growth in money demand; and if the price level is below the equilibrium value. We experiment with 2 long run equilibrium for prices. These are an inverted money demand function and an inverted PPP relationship. Finally, growth in oil revenue is permitted to influence inflation directly, as well as indirectly through monetary effects.

To complete the model we need to consider the influence of oil revenue on the other variables in equation (6.1) and (6.2). The exchange rate is given by equation (6.3) (for a detailed discussion on modelling exchange rate see chapter 5). In the long run the real exchange rate is assumed to be a function of oil revenue, and the domestic-foreign price differential (through Purchasing Power Parity). This makes the real exchange rate dependent upon oil revenue. To restore the equilibrium real exchange rate $\alpha_7 < 0$.

$$\begin{aligned} \Delta e_{bt} &= \alpha_0 + \alpha_1(L)\Delta e_{t-1} + \alpha_2(L)\Delta p_t^d + \alpha_3(L)\Delta p_t^f + \alpha_4 DR_t + \\ &\alpha_5(L)\Delta oil_t + \alpha_7[e - (\beta_1 p^d + \beta_2 p^f + \beta_3 oil)]_{t-1} + \varepsilon_t \end{aligned} \tag{6.3}$$

where oil_t is the log of real oil revenue, DR_t is a dummy variable for the post revolution period, DR_t is equal to 1 from 1979 and 0 otherwise, Δ and L are respectively the difference and lag operators, and ε_t is a random error term. For PPP to hold in the long-run we require $\boldsymbol{\alpha_7 < 0}$ (that is cointegration) and $\boldsymbol{\beta_1 = -\beta_2 = 1}$. The discussion in the previous section suggests that $\boldsymbol{\alpha_4 > 0, \alpha_5 < 0, \beta_3 > 0}$. Initially I assume that the parameters are invariant over time, but later we allow for differing values before and after the revolution. If domestic and foreign prices, the black market exchange rate, and oil revenue are I(1) and cointegrated, then estimation of (6.3) by least squares is valid. I employ a non-linear estimation technique to obtain estimates of the **βs** together with their standard errors.

$$\begin{aligned} \Delta(m - p^d)_t &= \gamma_0 + \gamma_1(\lambda)\Delta(m - p^d)_{t-1} + \gamma_2(\lambda)\Delta p_{t-1}^d + \gamma_3(\lambda)\Delta y_t + \\ &\gamma_4(m - p^d - y)_{t-1} + \gamma_5(\lambda)\Delta oil_t + \gamma_6 oil_{t-1} + \gamma_7 DR + \upsilon_t \end{aligned} \tag{6.4}$$

$$\Delta p_t^f = \eta_0 + \eta_1(\lambda)\Delta p_{t-1}^f + \eta_2(\lambda)\Delta oilp_t + \omega_t \tag{6.5}$$

where again Δ is the difference operator and λ is the lag operator.

The growth of money is given in equation (6.4). This is a conventional money demand function with the addition of oil revenue terms to pick up this influence on money creation. The long run effect can be interpreted as coming from the demand for money which is expected to rise in a boom (see for example Buiter and Miller, 1981). The effects of Δoil could come from the demand for money but may also be responses to money supply shocks when prices are sticky (see more discussion in next section of this chapter). Finally, foreign inflation is determined by oil price inflation, and we expect $\eta_2 > 0$.

With the exception of equation (6.5) all of the equations include an intercept dummy for the post-revolution period. This may capture: a fall in the underlying growth rate in equation (6.1); changes to the underlying inflation rate in (6.2); either a shift in the real exchange rate in (6.3) or simply an accelerated rate of depreciation; and either a shift in the tendency for government deficits to be converted into money growth in (6.4) or a shift in the demand for money.

6.4 Estimation

Estimation of the full system is infeasible given the shortage of data[6]. Rather, we proceed by estimating single equations. Even with the single equations it is not possible to apply Hendry's general-to-specific approach to modelling[7]. Rather we must try alternative specifications and settle on those which appear to best correspond to general economic theory whilst having acceptable statistical properties. We then test the best equations for shifts in the slope parameters since the revolution, and then test any cross equation restrictions before settling on our preferred specifications.

[6] A system of all equations except money equation is estimated and the obtained results are reported in next chapter. These results are then used to simulate key indigenous variables.
[7] However, where it is applicable we choose this methodology as the strategy of the estimation.

We first test the orders of integration in the data. The Phillips-Perron test for unit roots was applied and the results are shown in table below. The variables all appear to be I(1).

Table 6-1 Phillips-Perron Unit Root for Stationarity

Variables	**Level**		**First difference**
	Z_α	Z_t	Z_α
y	-2.83	-2.31	-14.30
m	0.17	0.35	-27.00
p^d	1.7	3.79	-7.06
p^f	0.36	0.65	-5.91
e_b	1.41	1.11	-22.77
oil	-3.2	-1.59	-26.62

Notes:

RATS software was used to produce these results.

Z_t and Z_α are Perron and Phillips test statistics for Unit roots respectively with and without deterministic trends. The 5% critical values (for 25 observations) are -3.0 without trend and -3.6 with trend. The number of lagged difference terms in each equation is 4.

6.4.1 Exchange Rate

A detailed discussion of exchange rate estimation has been reported in chapter 5. To see a broad picture of our models, we repeat an outline of our principal findings on exchange rate. Our preferred equation is taken from the previous chapter and allows the black market exchange rate to have an asymetric response to oil revenue, the equation is reported below:

$$\Delta e_t = 1.74 - 0.42\Delta e_{t-1} - 0.63\Delta e_{t-4} + 0.05(DR)oil_{t-1}$$
$$(6.57)\ (4.63)\quad (7.13)\quad (3.97)$$

$$+0.45DR_t - 0.30\left[e-(p^d - p^f)\right]_{t-1}$$
$$(7.57)\quad (6.66)$$

1965-1990; $\overline{R}^2 = 0.90$; SER = 0.060; LM(1) = 0.01; LM(4) = 4.24; A = 0.10

6.4.2 Money

Theoretical and empirical works conducted on money are very huge and various. The dominant feature of the literature suggests that given a target or forecast for the rate of price increase, and an assumption concerning the potential of an economy for real economic growth, a certain rate of monetary expansion will then be consistent with the growth in demand for money implied by these assumptions. If a forecast or objective for the likely balance of payments outcome is then added, the appropriate rate of domestic credit expansion can be determined. Credit expansion above or below this rate will cause a divergence of monetary growth from the planned rate, resulting in inflationary or deflationary pressures and tending to bring about a deterioration or improvement in the balance of payments. (Crockett and Evans (1990)

In the absence of a well-developed capital market, monetary assets play a doubly important role in developing countries since they are not only used for transaction purposes, but are also the major form in which savings are held.

In many developing countries the financial system is characterised by the absence of organised markets for securities and equities, by capital controls, and by legal ceilings on bank borrowing and lending rates- a situation that gives rise to parallel markets for foreign exchange and informal loan markets.

Many researchers have tried to appropriately model money market in developing countries. For example, Aghevli, Khan, Narvekar, and Short (1979); Mackenzie (1979); Morgan's (1979); Galibs (1979). Other relevant studies: Hynes (1967), Adekunle (1986); Perlman (1970); Fan and Lin (1971), Khetan and Waghmare (1971)' Wong (1977) and Paljarvi and Russo (1978).

Khan and Knight (1982) introduce a 'standard' model for developing countries as:

$$rm^* = \alpha y + \beta \pi^e$$

where rm^*, y and π indicate real money balance, real output and inflation respectively, and e refers to expectation. Hanson and Neal (1987) used actual rate of inflation while others like Darrat (1986), Khan and Knight (1982) used adaptive expectations framework or as a more general distributed lag on past prices to estimate expectations.

Honahan (1994) discusses that when the expectations proxy is equal to or closely correlated with the actual inflation it is difficult to use time series to test for an effect of inflation expectatins on the demand for money. The main problem in recognising the sensitivity of money holdings to yield is that because changes in prices may appear in dynamic demand for money equations even if the demand for money is not yield sensitive, it is not normally possible to make valid inferences about the inflation sensitivity of equilibrium demand for money. Some evidence support a negative relationship between demand for money and expected rate of inflation, especially in hyper inflation countries. (Cuthbertson and Barlow 1991)

Aghevli (1977a) specified and tested a money equation for Indonesia in 1968-73 period using a partial adjustment framework. His results appeared consistent with theoretical expectations, although they are suspected to spurious regression problems. Phylaktis and Taylor (1991) found evidence supportive of the hypothesis of cointegration between real money balances and current inflation.

Fair (1987) and Gupta and Moazzami (1990) using data of some developed and developing countries found a robust result supporting the hypothesis that adjustment of actual to desired demand for money is in nominal term rather than real term[8].

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[8] Spencer (1985) tested the generally implicit assumptions regarding the role of the price level in money demand equations for the US. These are that money demand adjusts to changes in price level without lag and that the price level elasticity of the demand for real money balances is zero. His results indicates a rejection of the first assumption. This results also support the zero price level elasticity assumption before 1973 and for whole period (1952-82) once the 1973 shift in money demand was accounted for.

Milbourne (1983) tested the hypothesis that the rate of inflation plays an independent (of its effect through its influence on the nominal interest rate) role in the demand for money. His result show that this hypothesis is rejected once an appropriate specification of demand for money is used.

Bahmani-Oskooee (1996) using Iranian data, estimates demand for money equation applying Johansen's methodology. He concludes that the more stable long-run demand for money in Iran would include real M2, real GDP, the inflation rate, and the black market exchange rate as its arguments. His results produces a positive coefficient for BMER variable implying that as the Iranian rial depreciates, demand for M2 increases, supporting the wealth effect argument in the literature.

Theory:

We consider the money market behaviour in the most common formulation of money demand as:

$$(6.6) \quad rm_t = a_0 + a_1 y_t + a_2 r_t + u_t$$

rm , y, and r indicate logarithms of: real money, real GDP and interest rate respectively and u refers to an error term. Due to some problems with measuring interest rate data for developing countries like Iran we follow other authors such as Crockett and Evans (1990), Morgan (1979), Looney (1985) and Bahmani Oskooee (1995a) and use the inflation rate as a proxy for the interest rate.

Buiter/Miller (1981) in a Dutch disease model framework amended the money demand equation above for Dutch Disease analysis. In this formulation " the long-run equilibrium real money stock must be higher (post-oil) because of the increased transaction component of the money demand since, in the short-run, nominal money balances and prices (and hence the real money stock) are fixed, all adjustment is borne by the nominal and hence the real exchange rate." (Cuthbertson and Taylor, 1990, p. 233). The LM equation is written as:

$$(6.7)\quad rm_t = \alpha_0 + \alpha_1 noy + \alpha_2 oil_t + \alpha_3 r_t.$$

where *rm, noy, oil* and *r* indicate respectively to real money balance, non-oil GDP, oil revenue, and interest rate.

To account for the dynamics of money demand, a simple error correction model for money balances is written as:

$$(6.8)\quad \begin{aligned}\Delta(m-p)_t = {} & \beta_0 + \beta_1(L)\Delta y_t + \beta_2(L)\Delta p_t + \beta_3(L)\Delta m_t + \\ & \beta_4(m-p-\alpha_1 noy - \alpha_2 oil)_{t-1} + \varpi_t\end{aligned}$$

where L indicates the lag operator.

If the money balances in the last period exceeded the equilibrium value, $(rm - \alpha_1 noy - \alpha_2 oil)_{t-1}$, then, to achieve equilibrium, the growth in money balances should fall hence $\beta_4 < 0$. β_1, β_2 and β_3 can be interpreted as short run elasticities.

In devising a financial programme for an economy, however, modifications must be made to take into account, as far as possible, the special circumstances of individual cases. In particular, it is important to refine the underlying estimate of the demand for money beyond simple (but often useful) assumption such as that the demand for money grows in step with nominal income, that is the assumption of constant velocity.

6.4.2.1 Previous Evidence

Previous evidence on money demand modelling show that there are two key determinants of the demand for real money balances: a scale variable providing some measure of the volume of transactions in the economy and an opportunity cost variable measuring the return (expected or actual) on holding money relative to alternative assets, real or financial.

The coefficients of the various determinants of the demand for money vary between economies with different structural characteristics. So, estimates of the determinants of the demand for money obtained from data for industrial countries cannot be utilised with confidence for the purpose of making policy prescriptions in developing countries.

The available statistical estimates for a number of important variables in the demand for money equation concerned the most developing countries are generally less reliable than those for more developed countries.

The principle issues in constructing a demand for money function relate to the definition of the money stock and appropriate specification of the income and opportunity cost variables. In addition, it remains for consideration whether in particular cases other variables might systematically affect the demand for money, and whether provision should be made for the lagged adjustment of actual money holdings to the desired money stock.

Theoretical and empirical evidence is not so conclusive as to lead to an exclusively appropriate money stock definition in a money demand equation. It is sometimes held, however, that to be operationally useful, a money stock definition should comprise an aggregate that the monetary authorities can adequately control.

Crockett and Evans (1990) argue that in many developing countries available policy instruments apply principally to the volume of credit extended by the banking system, which would tend to make the total liabilities of the banking system (M2) easier to control than a particular component.

Oil exporting countries usually have important oil sectors, which in a number of cases account for as much as half of total GDP. Crockett and Evans (1990) suggest that decisions on the volume of oil that is produced and on its price neither affect nor are affected by monetary creation, and there is no direct effect on the liquidity of the private sector. The oil sector of these countries is perhaps best regarded as an "enclave" of the whole economy, and is best disregarded when constructing a time series of income that is considered to influence the demand for money. Any possible oil-revenue effect on money creation can occur through direct and indirect means. When such revenue accrues to the government, the rise in foreign assets has no immediate monetary impact, since it is directly offset by a rise in government *deposits*. However, if the government injects the oil revenue into the economy by converting its foreign reserves into domestic currency (usually through Central Bank) and undertakes a higher level of expenditures or subsidies for goods and services, then oil revenue automatically translates into domestic liquidity.

An opportunity cost variable in a demand for money function is intended to measure the yield on money against other assets that might be held. An interest rate is usually used for this propose, especially where the financial market is adequately developed. It is also often argued that inventories of real assets are an alternative form in which wealth can be held, and hence, that the expected inflation rate should enter as a determinant of money demand. Among developing countries, it is quite widely accepted that an interest rate is in practice an unsatisfactory measure of the opportunity cost of holding money[9]. So, it seems appropriate to estimate money demand functions using a measure of expected inflation as the opportunity cost of holding money. Instead of experimenting extensively with different distributed lag proxies for expected inflation, it is often assumed that the expected inflation rate equals the actual rate.

In considering an oil-exporting country, a further question is which measure of price inflation should be used. The GDP deflator is the most general measure of prices within an economy but may be inappropriate for a number of reasons. First, the aggregate GDP deflator reflects changes in the price of oil exports, and, as argued already, the oil sector should be regarded as essentially an enclave within the non-oil economy. Second, the GDP deflator captures changes in the price level of domestic output only. Since we are using the inflation rate as a measure of the opportunity cost of holding money compared with buying goods, the inflation measure should also include changes in the prices of imported goods. For this reason, the consumer price index (CPI) may be a theoretically preferable construct to the GDP deflator as a measure of the opportunity cost of holding money balances. But even the CPI should be used with caution because of the poor quality of the data, and the subsidisation processes which are implemented in these countries.

[9] Firstly, because financial markets outside the banking system are not well developed, so that the possibilities of substitution between money and other financial assets are limited. Secondly, because a more practical objection is that observed interest rates are often centrally determined and remain unchanged for long periods. Furthermore, in certain of countries, the payment of interest is legally prohibited (like Iran, at least in post-revolution period).

Expectations on coefficients

On the basis of theoretical considerations and empirical work performed for other countries some values might be proposed for the coefficients. For the income elasticity, there are three possibilities. When it is supposed that the velocity of circulation increases along with the income increasing (economies of scale), then, the income elasticity would be less than unity. Other theories consider money as a luxury good and that the capacity and desire to hold liquid balances increases more than proportionately with income and wealth. Finally some discuss that the estimated income elasticity of the demand for money may be greater than unity because of the upward bias induced by marketisation (because of the gradual absorption of nonmarket sector into the market sector of a developing economy) (Crockett and Evans, 1990). Thus, we can say little more than that the income elasticities should not be much below one, but could be significantly greater than one. Empirical works in this area show that income elasticity tend to be lower for a narrow definition of money than for a broad one.

For the opportunity cost coefficient in money demand equations, economic theory suggests that an increase in the expected rate of inflation would reduce the attractiveness of money balances. For broad money, whose yield can be adjusted to offset inflationary expectations this effect may appear weaker than for narrow money with zero nominal yield. Empirical works especially in developing countries, have established that the demand for money responds with a lag to changes in its underlying determinants, however, it is more difficult to capture lagged patterns of response when only annual data are available.

Evidence

The basic model has been used by Crockett and Evans is as follow:

$$rm = \alpha_0 + \alpha_1 \Delta p^d + \alpha_2 y$$

where *rm* indicates real money balances, Δp^d changes in price level (inflation) and *y* real income. By using real money, in fact, they assumed that the elasticity of demand for nominal money balances with respect to inflation is unity. With the annual data they used, such a restriction is unlikely to be too strong. They also used non-oil income as the scale variable when an oil exporting country was the case. By this they assumed that the monetary effect of oil-induced part of income is neutral.

On the whole, the estimates for equations using broad money are better determined than those using narrow money

They estimated demand for money equations for nineteen Middle East countries and reported that although the statistical properties of the estimated equations vary widely, a reasonably well-determined equation was estimated (except for Pakistan). A significant income elasticity appeared in all of them. The common theme of all of the results, they suggested, is a range of income elasticity between 1.0 and 1.5 (in an individual estimation method)[10].

They found it difficult to detect an influence of inflation on the demand for money. Only in three cases out of nineteen (including Iran) was the inflation variable significant with the correct (negative) sign.

The reported result for Iran:

$$rm1 = -2.71 - 0.71dp^d + 1.14noy$$
$$\quad (-4.8) \quad (-1.5) \quad (13.8)$$

$\bar{R}^2 = 0.95$; SEE = 0.06; DW = 1.76; sample: 1960 - 78

[10] With pooling data they found income elasticity in the range of 0.8 and 0.9 for narrow money and of 0.9 and 1.00 for broad money.

$$rm2 = -4.17 - 0.7dp^{d} + 1.44noy$$
$$(-6.8) \quad (-1.8) \quad (14.8)$$
$\overline{R}^2$ = 0.94; SEE = 0.051; DW = 1.26; sample: 1960 - 78

where,

rm1 = natural logarithm of real narrow money

rm2 = natural logarithm of real broad money

dp^d = inflation (first difference of natural logarithm of price level)

noy = natural logarithm of real non-oil GDP

As can be seen these results suffer from possible serial correlation problem and the coefficient related to inflation is not adequately significant. There are also spurious regression problems as real money and income are likely to be non-stationary. The long-run income elasticities of real money in two equations appeared highly significant and for broad money the elasticity is more than that of narrow money (1.44 against 1.14).

Morgan (1979) implemented some econometric experiments to test the money demand equation for five oil exporting countries. The results indicate that a stable relationship exists between the demand for real liquid balances and real non oil GDP. He used a partial adjustment version of money demand equation. The produced results for Iran is reported as follow:

$$\log(M/P)_t = \lambda\alpha_0 + \lambda\alpha_1 \log NOY_t + (1-\lambda)\log(M_{t-1}/P_t)$$
$$-4.60 \quad 0.79 \qquad 0.51$$
$$(-3.98)\ (3.24) \qquad (2.81)$$
$\overline{R}^2 = 0.997$; SEE = 0.041; DW = 2.34; Long-run IED = 1.61, sample: 1960-76

In above equation:

M = nominal stock of liquidity

P = price level

NOY = real non-oil GDP

IED = Long-run income elasticity of demand for money

One possible reason for the income elasticity of demand for money being more than one is that a country in the stage of developing "is experiencing a spread of monetary institutions, a spread of the money-way of doing things" (Friedman, 1971).

Pesaran (1995) estimated money demand for Iran in the pre and post-revolutionary periods. Over the period 1979/80-1988/89, the money supply (M2) and the index of the retail prices grew by annual average rates of 20.1 and 19.0 per cents respectively. The smaller rate of increase in the real money balances over the post-revolutionary period is largely explained by the negative output growth experienced during the period. It is, however, important to note that the revolution seems to have significantly affected the relationship between money supply growth, output and inflation which could have important consequences for the efficacy of monetary policy in relation to the control of inflation.

Estimated models (M2):

Pre-Revolution: 1960 1978:

$$\log(M_2 / P)_t = -2.29 + 0.715\log(M_2 / P)_{t-1} + 0.521\log Y_t - 0.71\Delta\log P_t$$

$$(-3.98) \quad (7.85) \qquad (3.75) \qquad (-6.10)$$

$$\bar{R}^2 = 0.997, \text{ SER } = 0.044, \chi_{sc}^2(1) = 0.16$$

This regression implies a long-run income elasticity of demand for money of around 1.83 [S.E. = 0.134]. Pesaran (1995) maintains that this estimate is robust to the possibility of unit root in real money balances, output and inflation.

Post-revolution (*1979-1993*):

$$\log(M_2 / P)_t = 1.481 + 0.715\log(M_2 / P)_{t-1} + 0.116\log Y_t - 0.208\Delta\log P_t$$
$$(1.35) \quad (4.49) \qquad\qquad (1.08) \quad (-1.18)$$
$$\overline{R}^2 = 0.755;\ SER = 0.042;\ \chi^2_{sc} = 0.32$$

The long-run income elasticity of demand for money implied by this regression is only 0.408 (0.296), and is much less precisely determined than the one obtained for the period before the revolution. In both regressions the inflation variable has the correct sign; indicating that a rise in inflation has the expected dampening effect on the demand for real money balances.

The long-run income elasticity of demand for money appears to have declined from around 1.83 before the revolution to around 0.41 after the revolution. This suggests that the same rate of expansion in private sector liquidity is likely to have more inflationary consequences after than before the revolution. The low income elasticity of demand for money after the revolution is also indicative of the serious inefficiencies that exist with in the banking sector.

6.4.2.2 Our results

Equation (6.4) has been used as an essential model to estimate the money demand during the period under consideration (1960 1990). We divide the real GDP into two parts, non-oil GDP and oil revenue, so that we can estimate the elasticity of real money balances to these two parts separately. By this way we can also implicitly test for the neutrality of oil revenue effect on money creation which is debated in the literature.

$$\Delta(m-p^d)_t = \gamma_0 + \gamma_1(\lambda)\Delta(m-p^d)_{t-1} + \gamma_2(\lambda)\Delta p^d_{t-1} + \gamma_3(\lambda)\Delta y_t + \gamma_4(m-p^d-\varphi_1 noy - \varphi_2 oil)_{t-1} + \gamma_5(\lambda)\Delta oil_t + \gamma_6 DR$$

We first follow Morgan (1979), Crockett and Evans (1990) and Looney (1985), using non-oil GDP instead of total GDP in money demand equation assuming the neutrality of oil revenues on money creation. Further, by adding oil revenue to the variables in money equation, we test the neutrality hypothesis of oil-revenue effect on money. The results show that the oil-revenue elasticity of money demand, although significantly greater than 0, is dramatically less than that of non-oil GDP (0.21 compare with 0.83) (below)[11]. The null hypothesis of serial correlation of the residuals is strongly rejected (LM(1) = 0.80; LM(4) = 4.56). Moragan (1979) and Crockett and Evens (1990) obtained an income elasticity of the demand for money over than unity. Our results, however, confirm that this value equal to one.

***noy*= non-oil gdp (log. of real gdp - oil revenue)**

LS // Dependent Variable is DRM

Sample: 1962 1990

Included observations: 29

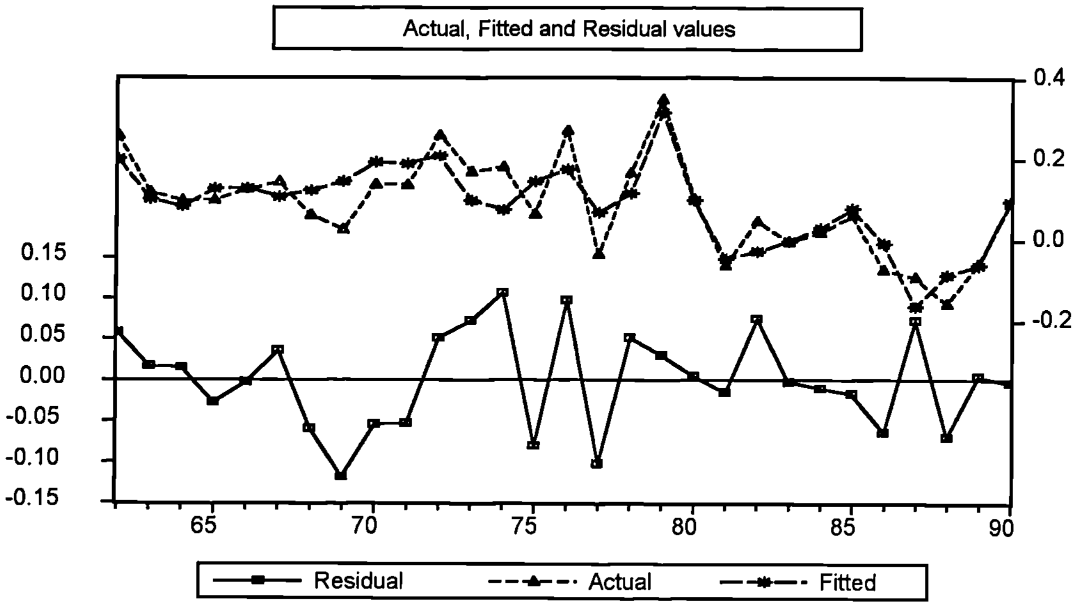
Convergence achieved after 29 iterations

$$\Delta rm_t = -2.9 + 0.32DR - 0.48(rm - 0.83noy - 0.21oil)_{t-1} \qquad (6.9)$$

(-3.57) (3.58) (5.73) (7.23) (3.63)

$\overline{R}^2 = 0.70$; DW = 2.29; LM(1) = 0.80; LM(4) = 4.56

[11] I also tested this model with total GDP. The obtained results are reported in appendix 1.



Breusch-Godfrey Serial Correlation LM(1) Test:

F-statistic	0.653126	Probability	0.427278
Obs*R-squared	0.800767	Probability	0.370864

Breusch-Godfrey Serial Correlation LM(4) Test:

F-statistic	0.934049	Probability	0.464308
Obs*R-squared	4.564745	Probability	0.334939

Wald Test:

Null Hypothesis: $\varphi_1 = 1$

F-statistic	2.113730	Probability	0.158936
Chi-square	2.113730	Probability	0.145983

Wald Test:

Null Hypothesis: $\varphi_1 = 1, \quad \varphi_2 = 0$

F-statistic	11.39538	Probability	0.000332
Chi-square	22.79076	Probability	0.000011

Wald Test:

Null Hypothesis: $\varphi_1 = \varphi_2$

F-statistic	14.12399	Probability	0.000968
Chi-square	14.12399	Probability	0.000171

Wald Test:

Null Hypothesis: $\varphi_2 = 0$

F-statistic	13.19463	Probability	0.001326
Chi-square	13.19463	Probability	0.000281

We found strong supportive evidence for conventional model of real money balances. We found no short-run oil revenue effect on changes of real money[12]. An adjusted version of Buiter-Miller model chosen as the long-run equilibrium money demand. Non-oil income elasticity of demand for money appears more robust and higher (0.83, SE=0.115) than the oil revenue elasticity (0.21, SE=0.057). This finding indicates that the monetary effect of oil revenue is much weaker than that of other parts of real GDP, that is non-oil GDP. This results also partly confirms the assumption of other researches such as Crockett & Evans (1990), Morgan (1979) and Looney (1985) of the sense that oil revenue is neutral in the money market. The obtained significant and positive γ_7 is likely indicative of an upward shift in the growth rate of real money balances since the revolution. But, γ_0 and γ_7 may also be part of a long-run relationship such as $rm = \gamma_0 + \gamma_7\, dr + \varphi_1\, noy + \varphi_2\, oil$. In this case γ_7 shows an increase in the level of money balances rather than its growth.

6.4.3 Inflation

Sources of inflation:

Research on price inflation behaviour is one of the major area of macroeconomic studies. Many scholars have devoted great effort to explaining the origins and

[12] We added Δoil to our final money equation to find any contemporaneous effect of oil on real money balances, no siginificant coefficient was produced [0.03 (t-stat.=1.07)].

dynamics of inflation in developed and less developed countries. Like other economic fundamentals, several theories have appeared to explain the mechanism of price adjustments.

Many researchers have investigated sources of inflation in developing nations. Two general frameworks dominate the inflation literature associated with the developing countries. Some have relied upon the structuralism approach in which many macroeconomic variables, including the inflation rate, are linked through a system of relationships. Otani (1975), Lipschitz (1984), Baer (1987), Lim (1987), Togan (1987), and Anderson et al. (1988) are examples of studies that have used the structuralism model of inflation.

For high inflation countries, many have relied upon the monetarist model of inflation, in which the inflation rate is related to the rate of change of the money supply in excess of the rate of increase of domestic output. The monetary model introduced originally by Harberger (1963) has been applied to Asian countries by Bomberger and Makinen (1979), Sheehey (1979) and Saini (1982). It has been applied to Latin American countries by Nugent and Glezakos (1979), Ize and Javier (1985) and McNeils (1987). Three other studies, i.e. Rana and Dowling (1985), Darrat and Arize (1990) and Bahmani-Oskooee and Malixi (1992), have applied the monetarist model augmented with imported inflation and exchange rate depreciation to some LDCs.

Bahmani-Oskooee (1995b) employed a model called 'augmented monetarist model' outlined by equation:

$$\Delta p_t^d = \alpha + \beta\Delta(m-y)_t + \gamma\Delta p_t^f + \lambda\Delta e_{bt} + \varepsilon_t$$

He examined if there is cointegration relationship among variables. Variables included in cointegration test are logarithms of CPI, M2, real GDP, black market exchange rate (BMER), and world export prices, plus a dummy variable for revolution (0 for pre and 1 for post-1978) and trend. He obtained only two cointegrating vectors when log CPI and log BMER were chosen as the dependent variables.

He conclude that inflation in Iran is not only a monetary phenemenon; it is also a result of the depreciation of the Iranian rial in the free market and of imported inflation[13].

[13] As a matter of comparison, our results in this section reveal that this is the PPP relationship which explains Iranain price movements in the long run, althogh a resonable correlation emerges between

The influence of exchange rates on inflation is explained by the fact that movements in the exchange rate affect the price of imported intermediate goods.

Cagan (1979) summarised three propositions as the conditions for rising inflation. First, the expansion of aggregate expenditures faster than the flow of goods and services pulls up prices and supports a rising price level. Second, excess aggregate demand may originate from a variety of developments, such as an increasing government budget or a vigorous cyclical expansion in private expenditures. And, third, a rise in the money balances is necessary to support, and given time will produce, excess aggregate demand. However, he emphasises that the 'monetary expansion as necessary and sufficient for inflation makes money a proximate cause but not in any simple sense *the* fundamental cause of inflation.' (p. 10)

Aghevli and Khan (1978) deal with a hypothesis indicating that while government expenditures rise concomitantly with inflation, government revenues would tend to fall behind in real terms owing to collection lags. The financing of this inflation-induced deficit would then increase the money supply and generate further inflation. Thus the increase in supply of money would both cause inflation and would be the result thereof.

Sargent and Wallace (1973), Frenkel (1977) and Jacobs (1977) Dutton (1971) and Aghevli and Khan (1978) examine the two-way causality between money and prices in high inflation countries.

Sargent and Wallace (1973), Frenkel (1977) and Jacobs (1977) argue that it is more appropriate to view the causation as running both ways, that is money increase produces price inflation and vice versa.

According to the monetarist view, in a money demand equation (discussed in previous section) it is in fact the price level that is being determined if money is exogenous.

Monetarists argue that inflation is a consequence of a continually expanding money supply in a condition in which the government is unable to meet its increasing fiscal commitments through an efficient system of taxation and the rate of change in real

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inflation and monetary disequilibrium (displayed by Δmy) in short run. Therfore, we may introduce our inflation model as an 'augmented PPP model' rather than 'augmented monetary model' as Bahmani-Oskooee (1995b) claimes. We believe even his results partly comfirms our claim when he finds only two cointegrating vectors with CPI and BMER (and not money) as dependent variables.

money supply. Government intervention with the free market, distortions in the price system, and an overvalued exchange rate are the active elements of this environment.

Equation (6.4) in Money section (previous one) can be expressed as:

$$\text{(6.10)}\quad \begin{aligned}\Delta(m-p)_t &= \beta_0 + \beta_1(L)\Delta y_t + \beta_2(L)\Delta p_t + \beta_3(L)\Delta(m-p)_{t-1} + \\ &\beta_4(m-p-y)_{t-1}\end{aligned}$$

Assuming price level as the dependent variable, this expression can be rearranged as:

$$\text{(6.11)}\quad \Delta p_t = \gamma_0 + \gamma_1(L)\Delta y_t + \gamma_2(L)\Delta p_{t-1} + \gamma_3(L)\Delta m_t + \gamma_4(m-p-y)_{t-1}$$

The basic monetarist contention is: 1) that the causal relation runs from money to prices and output; 2) any persistent increase in money relative to output is a sufficient for inflation; 3) the magnitude and length of inflation is dependent on the magnitude and persistence of monetary growth; 4) the occurrence of inflation is independent of the level of employment in the economy, and 5) it is the increasing growth rate of money which holds inflationary pressures.

Although theoretical models have been developed to study the macroeconomic problems, including the inflation, associated with a booming sector mostly in the context of Dutch Disease literature, empirical examinations of such models are not frequently conducted.

A selective mix of monetarist and structuralism models of inflation in oil exporting developing countries were discussed in El-Mallakh and Atta (1979), Kernan and Al-Malik (1979), Johony et. al. (1986), Moosa (1986), Looney (1988), Salih et al. (1989) and Noorbakhsh (1990).

Noorbakhsh (1990) suggests that since non-oil GDP does not grow at a sufficient rate to balance the increasing aggregate demand[14], consequently, sluggish aggregate supply

[14] Because of inefficiency of existing real capital and its insignificant contribution to the growth of non-oil GDP.

and rapidly increasing aggregate demand stimulated by rapid growth of the money supply may become a very significant source of inflationary pressure in the oil-exporting countries.

The question that repeatedly comes up is whether price behaviour should be characterised by a cost push or demand pull mechanism or alternatively, a blend of what appear to be competing hypotheses. The later option is supported in Laidler and Parkin (1975).

The issue of whether Iran's inflation was the consequence of the cost push or the demand pull mechanism on prices is important largely from the difference between the recommendations for anti-inflationary policy.

6.4.3.1 Previous Evidence

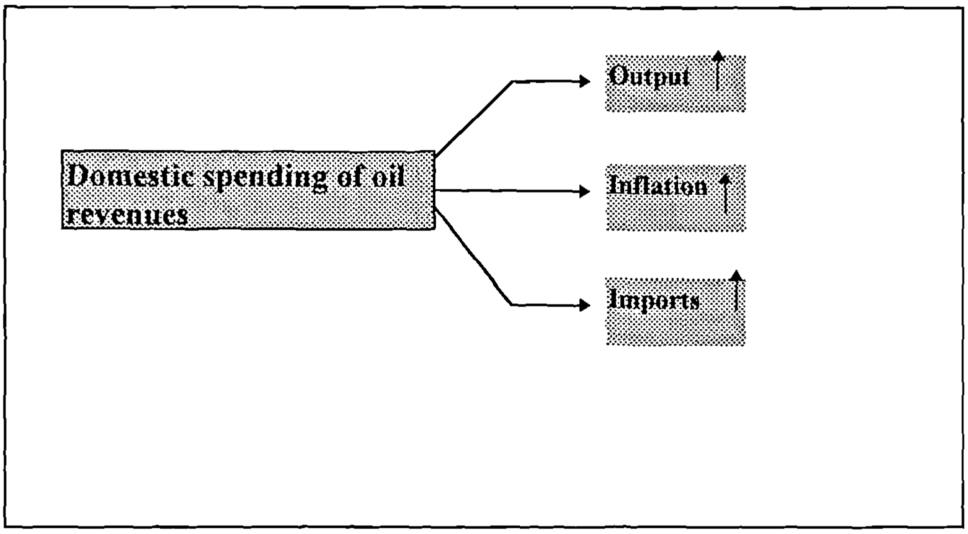
Higher inflation after 1973 in Iran is considered as a reflection of the rapid increase in oil revenues in 1973/74. Aghevli and Sassanpour (1982) argue that despite a high growth rate in real GDP during this period, overspending of oil revenues by government led to a high level of inflation:

	1960-1972	**1973-1977**
Real Output Growth	9%	13%
Inflation	2%	13%

Source: Aghevli and Sassanpour (1982)

As can be seen from this table the inflation rate increased in average about 11% while output growth rate shows only around 4% during these two periods[15].

[15] Our data on real gdp shows even negative growth rate between these two periods (see chapter 2)



The following inflation equation for non-tradable goods was estimated:

$$\Delta p_t^n = 1.16 + 0.37\, rm_{t-1} - 0.45\, y_t + 0.6\, (p^t - p^n)_{t-1}$$

(1.7) (2.4) (2.1) (3.6)

R^2 = 0.64; DW = 1.87 (corrected for autocorrelation)

where p^n and p^t show price of non-tradables and tradables respectably.

Higher oil revenues since 1973 were instrumental in improving the growth of the economy, because of limitations on excess capacity in the economy, the higher growth rates were accompanied by higher rates of inflation in the prices of non-traded goods.

He concluded that there is a constant real wage in the long-run indicating that inflation and wage move side by side and in the same direction.

Edwards (1986b) suggests that if a resource-based increase in reserves is not fully sterilised, the monetary base will increase, and inflation will likely be a result. Real appreciation then could be one of the side effect of this increase (independent of nominal exchange rate behaviour). He tested a model to deal with the effects of an increase in commodity export prices (Coffee in Colombia) in which the inflation equation is defined as:

$$\Delta p_t = \alpha_0 + \quad \alpha_1 \Delta m_t + \quad \alpha_2 \Delta y_t + \quad \alpha_3 \Delta (e + p^f)_t + \mu_t$$

−0.006	0.71	-0.04	0.31
(-0.73)	(2.67)	(-0.36)	(2.18)

p^f here referees to the price of tradable goods and Δx to the rate of change in variables. With the exception of income growth the coefficients are significant and have the expected signs. The obtained results show that an increase in the rate of money creation of 100% resulted in an increase in inflation of around 70%. On the other hand, according to the coefficient of $(\Delta e + \Delta p^f)$, a higher rate of devaluation or higher world inflation, or both, (imported inflation) was passed on in almost one third to price increases.

Salih (1993) used a simple reduced form equation similar to the Edwards' model to model the inflation of Kuwait. He obtained the results as following:

$$\Delta p_t = \alpha_0 + \quad \alpha_1 \Delta p_{im(t)} + \quad \alpha_2 \Delta M2_t + \mu_t$$

1.45	0.23	0.1
(13.29)	(7.35)	(7.57)

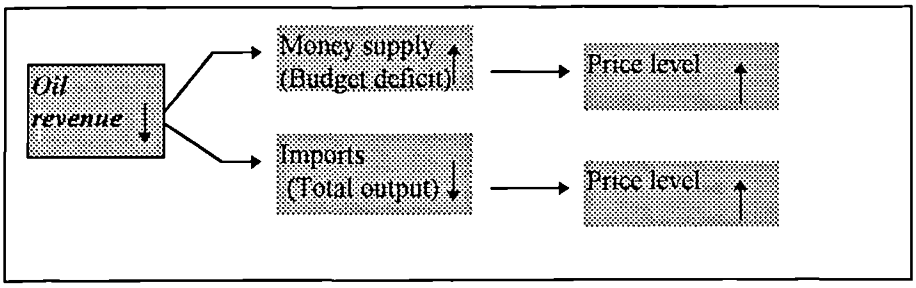
$R^2 = 0.87$, sampl: 1970:2 - 1987:4

These results confirm the results of Edwards (1986b) mentioned above.

According to Mashayekhi (1991) oil revenues affect price level through two major ways. First, through government revenues, and second through foreign exchange availability and imports[16]. Foreign exchange revenue from oil exports together with the formal exchange rate determine government revenue. When oil revenue decreases so do government revenues. This causes the budget deficit to increase and to raise the monetary base. As the monetary base becomes larger, money supply rises and raises the money supply-demand ratio and the price level.

[16] Since oil revenue form a substantial part of total government revenue, any fall in foreign exchange earnings from oil is restricted to an increase in liquidity resulting from the budget deficit. The main source for financing budget deficit is borrowing from banking system. Only when oil revenue is injected over than absorptive capacity of the economy, then, it could increase inflationary pressure (Looney, 1985).

Second effect an oil revenue drop comes from the subsequent decline in net foreign exchange revenues which gives rise to a fall in imports. Fewer imports decreases total supply which again (finally) leads to an increase in price level.



On the other hand when oil revenues increase, oil-induced increases in government's expenditure accompanied by rising of the imports of primary and intermediate goods provided a fair situation for producers to increase their supply. However, due to general shortage of skilled workers and infrastructure capacity in certain key areas, the supply of domestically produced goods could not increase at the same rate as the demand. Inflationary pressures, therefore, mounted while at the same time the feedback effect of the oil price increases- an acceleration in world inflation- resulted in increased import prices. (Looney, 1985)

Iran, for instance, experienced a high inflation rate during the pre-Revolutionary period after 1973/74 oil boom. Initially, the greatest inflationary pressures were concentrated in the construction and housing sector (non-tradables consistent with the Dutch disease prediction), which led to inflation in this sector and then spilled over to other sectors.

Looney (1985) tested some versions of monetary models of inflation. The growth of money relative to output and cost of holding real balances will generate an increase in the rate of inflation. The growth of real income will cause decreases in the rate of inflation. In his model Looney (1985) used real non-oil GDP instead of real GDP.

In oil exporting countries direct policies are the typical policies to control inflation rate. These policies basically depend on the government revenues which as I mentioned before mainly depends on the oil revenues. Morgan (1979) distinguished some direct policies to control inflation in oil-exporting countries. Policies like expansion of direct subsidy payments on a wide range of goods and services; introduction or expansion of indirect subsidies through the pricing policies of public enterprises; reduction or elimination of several categories of domestic taxation (like import duties) and abolition of user charges for government-supplied services in health, education etc. He argued, however, that although such policies may have been used as the means of breaking rising price expectation, the actual experience inflation of these countries revealed only little success. ' This may support the view that any decline in price expectations would probably be short-lived if it were produced by policies involving a direct increase in the domestic budget deficit and domestic liquidity.' (p. 76) Because there is a close relationship between the domestic budget balance, liquidity expansion and inflation.

6.4.3.2 Our results

Equation (6.2) has been used as an essential model to estimate the domestic inflation during the period under consideration (1960-1990). Obtained results are reported below:

$$\Delta p_t^d = \beta_1' + \beta_2'(\lambda)(\Delta p^f + \Delta e)_t + \beta_3'(\lambda)\Delta(m^s - m^d)_t + \beta_4'(p^d - p^{d*})_{t-1} + \beta_5'\Delta oil_{t-1} + \beta_6'(\lambda)\Delta p_{t-1}^d$$

LS // Dependent Variable is DPD

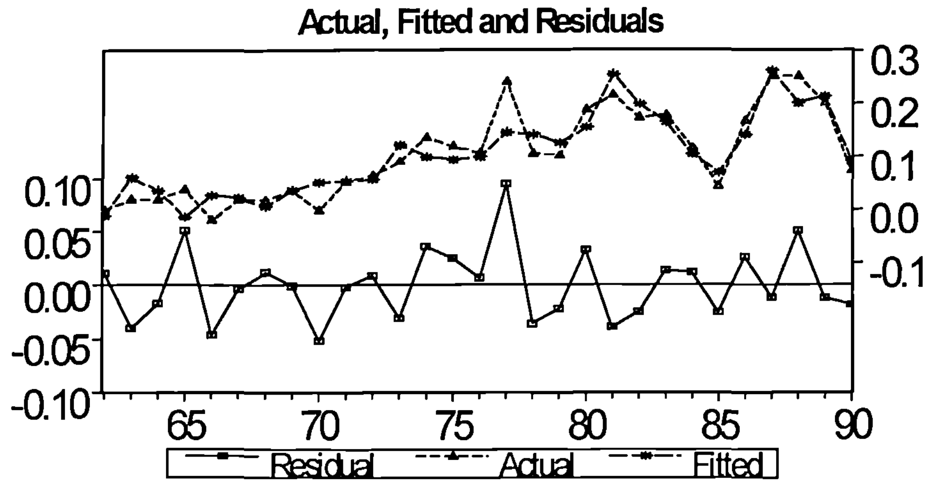
Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

Convergence achieved after 4 iterations

$$\underset{(-2.72)}{\Delta p_t^d = -0.67} + \underset{(2.50)}{0.997\Delta p_{t-1}^f} + \underset{(2.73)}{0.18\Delta my_{t-1}} + \underset{(3.16)}{0.4\Delta p_{t-1}^d} - \underset{(-4.36)}{0.07\Delta oil_{t-1}} + \underset{(2.80)}{0.11}(reb - \underset{(5.37)}{0.15}DRoil)_{t-1}$$

$\overline{R}^2 = 0.79$; DW = 2.52; LM(1) = 3.7; LM(4) = 8.8



Breusch-Godfrey Serial Correlation LM(1) Test:

F-statistic	3.071318	Probability	0.094274
Obs*R-squared	3.700180	Probability	0.054407

Breusch-Godfrey Serial Correlation LM(4) Test:

F-statistic	1.973390	Probability	0.141912
Obs*R-squared	8.840548	Probability	0.065211

Wald Test:

Null Hypothesis: $\beta'_S = 0$

F-statistic	18.98534	Probability	0.000252
Chi-square	18.98534	Probability	0.000013

To establish the reliability of the model by conventional criteria, it was tested for serial correlation and for coefficient restriction. Breusch-Godfrey's Long-run multiplier test, for serial correlation up to fourth order, yields a chi-squared statistics 8.8, which is insignificant.

In the short run a rise in foreign prices inflation is matched by an equal rise in domestic inflation. Only in the long run does inflation respond to the domestic price of foreign goods. Our estimated exchange rate equation offers some explanation for this as the exchange rate is found to respond only to the level of foreign prices, and not to foreign inflation.

We found that a long-run relationship for prices based upon Purchasing Power Parity is considerably more robust than the inverted long-run money demand equation. Hence, when the real exchange rate is overvalued, then inflation tends to fall. There is some degree of inertia in the inflation process, indicated by the significant lagged value of inflation. Excess money growth adds to inflation. We prefer the ratio of money growth to real income growth as a proxy for excess money, though we also experimented with the lagged residuals of a money demand equation. There is no significant contemporaneous effect of oil on inflation [-0.009 (t-stat=-0.51)]. Growth in oil revenue is found to reduce inflation, after one year lag[17].

A remaining issue for our analysis of the impact of oil revenue on the economy is whether higher oil revenue leads to excessive expansions of the money. The problem is that we cannot identify the money supply and demand equations. If prices adjusted fully within one year to the excess creation of money then we would find no contemporaneous correlation between real money holdings and oil revenue, which is our finding. The fact that there is also no contemporaneous correlation between inflation and oil revenue or excess money holdings suggests that there is not a quick adjustment of prices to excess money. Another possibility is that with sticky prices agents may willingly hold excess money until prices rises have risen to absorb the excess money (see Laidler 1976). But there is no sign of oil revenue influencing money holdings except in the long run, thus we find no evidence of such short run buffering behaviour.

[17] We believe that oil effects on inflation come about in two ways, namely, supply side (direct effect) and demand side (indirect effect). Any increase in oil revenue is in fact an increase in real output which normally alleviates inflation rate. (Due to the weighty dependence of the country's industries on imported goods, the availability of foreign exchange is linked to import increases and economic growth) On the other hand oil revenue constitutes the main part of government revenues and finances the main body of its expenditures. More oil revenues usually means more expenditure and (when it is injected in the economy over the productive capacity) higher inflation. We take the ratio of money growth to real income growth as a proxy for indirect effect and growth in oil revenue as a proxy for direct effect.

6.4.4 Non-oil Growth Rate:

As we mentioned in previous sections a rapid increase in aggregate demand induced by oil revenues can improve the productive capacity of the economy in the form of a higher rate of change in non-oil GDP. This is achieved by efforts to increase the rate of domestic capital formation and by importing capital goods and services from abroad. Absorptive capacity is a crucial constraint on the success of this strategy, rigidities in capacity can limit the growth rate of non-oil GDP, and ultimately intensify the inflationary pressure in these countries.

An increase in oil revenues, in an oil exporting country, primarily prevails higher growth rates without a considerable inflation. The relative stability in inflation in this stage is due to the fact that the increase in income levels leads to an increase in the demand for money, matching the increase in money supply associated with higher government expenditure (expenditure motivation of oil revenue). After a period , however, restrictions on the absorptive capacity and inflexibility in the supply side of the economy set in, slowing down the growth of output and leading to an excess supply of money and to higher domestic inflation[18] (see Aghevli and Sassanpour 1982 and also Looney, 1985 for the case of Iran).

Another way through which oil revenues can affect non-oil GDP is the possible response of exchange rate to any change in oil revenues. We discussed this topic in previous chapters. Changes in the exchange rate can, by affecting the balance of payments and inflation rate, in turn, change the growth rate of output. For example, as Dornbusch (1986a) argues, a devaluation can potentially improve exports and then total output. But, on the other hand, devaluation makes imported goods more expensive which in an import-dependent economy has a contractionary effect on output (see Gylfason and Risager (1984). Krugman and Taylor (1978) and Hanson (1983) consider the circumstances in which a devaluation can lead to a contractionary effect on output. Lizondo and Montiel (1989) conclude that a devaluation has an equivocal effect on output.

[18] Pinto (1987) stresses that 'with oil revenues accruing to the government, the composition and timing of public spending were crucial in the adjustment to the boom. (p. 443)

In an innovative study of 12 developing countries Edwards (1986a, p.507) concluded that output-reduction effect of devaluations seems to be short-run phenomenon which is completely reversed in the long-run. In an analysis of time series data over 1960-90 Rhodd (1993, p. 300) assessed the evidence for a single country, and concluded: ' Real devaluation in Jamaica tends to be contractionary in the short-run but expansionary in the long-run'. In contrast to Edward's conclusions, therefore, Rhodd's conclusion emphasised the expansionary effect of real devaluation in Jamaica. However, specification and technical problems with the way the long-run effects were estimated provide grounds to question the validity of Rhodd's conclusions.

As was found by Edwards (1986, p. 506) and according to previous findings of Barro (1979) and Edwarrds (1983) the terms of trade have no detectable effects on real output in developing countries.

Improving the model specification produced evidence which supports the Edwards (1986) conclusion of a neutral impact on output rather than the argument of significantly expansionary long-run effects. (Boyed, 1996, p. 411)

van Wijnbergen (1986) constructs a simple macroeconomics model to elucidate three alternative channels by which a devaluation can exert a contractionary effect on aggregate supply. The first channel arises when, as is typical in many developing countries, imported goods play a significant role in the production process. This contractionary effect may be partly offset by possibilities of substitution between imported inputs and domestic factors in production and by the expansionary effects of expenditure switching. A second contractionary channel is created when real wages are indexed to some index such as the consumer price index, that accounts for both domestic and foreign goods. An increase in competitiveness implies that foreign goods become more expensive than domestic goods. If real wages are indexed to a consumption basket that includes foreign goods, this implies that real product wages rise and that the improvement in competitiveness occurs at the expense of domestic production. The third contractionary channel is a result of the effect of the increase in the price level on the real volume of bank credit. In many developing countries, firms finance fixed and working capital requirements through bank loans. The rise in the price level associated with a devaluation leads to a rise in nominal demand for bank credit, which , given a fixed nominal money supply, leads in turn to a rise in real interest rates and thus a rise in the interest component costs (see Edwards and Liaquat, 1986).

The dimension, nature and outcome of all economic plans in Iran have been very much influenced by the development in the world energy scene and the fluctuations in Iran's foreign exchange earnings from oil sector.

Oil revenues go directly to the government, so that they permeated into the economy via the second-round effects.

Composition of the non-oil GDP by major economic sectors (percent)

	1961/62	1969/70	1975/76
Agriculture	34.6	25.9	14.8
Industries and mines	19.9	26.3	30.6
Services	45.5	47.8	54.6
Non-oil GDP	100	100	100

Source: Bank Markazi: Annual Reports

Our results indicate that, although the overall growth remained high, the rapid increase in 1973-74 was mainly reflected in higher inflation and higher imports.

Agevli and Sassanpour (1982) argue that although the higher oil revenues since 1973 have been instrumental in improving the growth of the economy, they led, however, to a much higher inflation and interrupting of the non-oil exporting sector.

Output and prices during the 1960-72 period with that during the 1973-77 period highlights the impact of higher oil prices on the economy: the average growth of output rose from 9 to 13%. The higher growth of output, however, was partly at the expense of the traded sector. Consequently. the non-oil exports all but vanished.

6.4.4.1 Our Results

Equation (6.1) has been used as an essential model to estimate the rate of growth of non-oil output during the period under consideration (1960 1990). A variety of experiments including various definitions of the trend of potential real non oil GDP have been conducted. We were unable to find any evidence for an influence of the deviation of output from trend, not surprising given the unbalanced nature of the recent decades[19].

Our results are presented below. We find that increasing oil revenue decreases the rate of growth of non-oil output by about a 1/4 of the growth rate of oil revenue. There is a long lag on this effect, which probably reflects the slowness of the resource transfer to the oil enclave and also government spending to stimulate the non-oil sector. The only evidence of a spending effect is through growth in the real exchange rate, a real depreciation produces extra growth, but this effect is not significant from zero at the 10% level. This finding is consisted with the finding of Edwards (1986a) which is indicative of neutrality of devaluation on real output, and may be explained by the stimulus given to products by falling costs of imported inputs. Finally, the underlying growth rate has changed from a high positive rate before the revolution to a slightly negative rate since the revolution. This is consistent with the rapid pre-revolution expansion, the post-revolution stagnation, and the strongly negative rates of investment since the revolution.

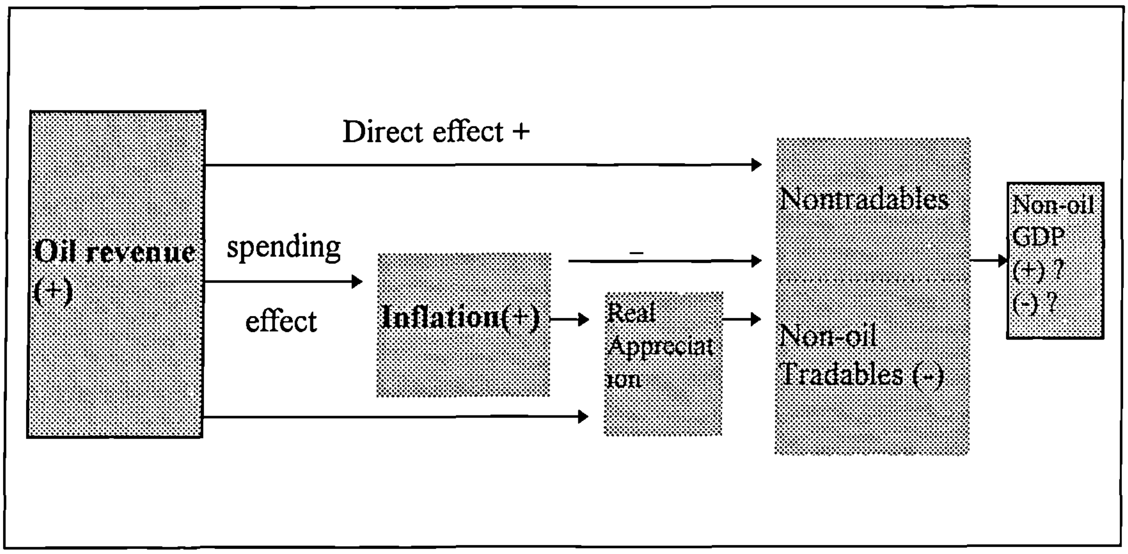
$$\Delta rnoy_t = \underset{(3.74)}{0.16} - \underset{(-3.62)}{0.25\Delta oil_{t-4}} - \underset{(-3.00)}{0.22DR} + \underset{(1.49)}{0.26\Delta re_{b(t-1)}}$$

$$\overline{R}^2 = 0.34,\ DW = 2.3,\ LM(1) = 0.57,\ LM(4) = 5.4$$

$$\Delta rnoy_t = \underset{(3.43)}{0.15} - \underset{(-3.34)}{0.23\Delta oil_{t-4}} - \underset{(-2.53)}{0.17DR}$$

$$\overline{R}^2 = 0.30, DW = 2.27, LM(1) = 0.45, LM(4) = 5.75$$

[19] We modelled the long-run trend in output as a simple trend, and also as a split trend in which the increments reflect the relative average growth rates before and after the revolution.



6.4.5 Foreign Inflation

We find that a rise in oil prices raises foreign prices, and that there is considerable inertia in the process. In the lon run a 10% rise in oil prices raises foreign inflation by just over 1%.

$$\Delta p^f = \alpha_0 + \sum_{i=1}^{4} \alpha_{1i} \Delta p^f{}_{t-i} + \sum_{i=0}^{4} \alpha_{2i} \Delta oilp_{t-i}$$

$$\Delta p_t^f = 0.01 + 0.67 \Delta p_{t-1}^f + 0.04 \Delta oilp$$
$$(3.14) \quad (8.58) \qquad (5.77)$$
$$LM(1) = 2.04; \; LM(4) = 5.01; \; A = 0.35; \; DW = 1.52; \; \overline{R}^2 = 0.82$$

6.5 Conclusion

A transitory (and in post-revolution, a persistent) rise in oil revenue suppresses inflationary pressure in Iranian economy. This finding is consistent with that of Mashayekhi (1991) and contradictory to the implications of core Dutch disease model. There is still the suspicion of possible inflationary effect of oil boom which can occur by overspending and monetisation of oil-induced foreign exchange into domestic economy. The significant coefficient of *dmy* or its equivalent in the obtained results in inflation equation may partly pronounce this possibility. At a given level of real output, money supply changes are the measure of excess demand and so this term implies that shifts in money supply will affect prices only if they cause output to rise above its long-run trend. We found that a long-run relationship for prices based upon Purchasing Power Parity is considerably more robust than the inverted long-run money demand equation. Hence, when the real exchange rate is overvalued, then inflation tends to fall.

We could not find any significant expansionary effect of oil boom on real non-oil GDP. Looney (1982), covering pre-Revolutionary period, found that non-oil real GDP did not respond significantly to the change in oil exports. Our results do not show any instantaneous oil effect on non-oil real GDP too. Yet we found a long-lagged contractionary effect of oil on that. There is no side effect from real depreciation on non-oil GDP. This confirms the finding of Edwards (1989) and contradict those of some other authors who find an expansionary effect (such as Gylfason and Schmid (1983), Dornbusch (1986)) or contractionary effect (such as Krugman, Taylor (1978) and Hanson (1983) and Gylfason and Radetzki (1991)).

Money market does not respond to foreign exchange increase induced by oil revenues in short-run, however, we come down with a small elasticity of real money balances to oil revenues in long-run.

Iranian economy has become more sensitive to the oil revenues in post-revolutionary period.

6.6 *Appendix 1*

Model (6.9) with gdp instead of non-oil gdp

LS // Dependent Variable is DRM

Sample: 1962 1990

Included observations: 29

Convergence achieved after 5 iterations

DRM=C(1)+C(3)*DR+C(6)*(RM(-1)-C(7)*y(-1))+C(8)*oil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-2.961282	0.813110	-3.641923	0.0013
C(3)	0.324313	0.089085	3.640483	0.0013
C(6)	-0.484041	0.083116	-5.823693	0.0000
C(7)	0.850988	0.115624	7.359986	0.0000
C(8)	0.093230	0.023406	3.983239	0.0005

R-squared	0.748102	Mean dependent var	0.086590
Adjusted R-squared	0.706119	S.D. dependent var	0.117290
S.E. of regression	0.063584	Akaike info criterion	-5.355209
Sum squared resid	0.097029	Schwarz criterion	-5.119468
Log likelihood	41.50132	F-statistic	17.81913
Durbin-Watson stat	2.286846	Prob(F-statistic)	0.000001

Model(6.9) but including the first observation which seems peculiar and so decreases the Rbar-sq. to 58%

LS // Dependent Variable is DRM

Sample (adjusted): 1961 1990

Included observations: 30 after adjusting endpoints

Convergence achieved after 5 iterations

DRM=C(1)+C(3)*DR+C(6)*(RM(-1)-C(7)*NOY(-1))+C(8)*Oil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-3.732350	0.985948	-3.785544	0.0009
C(3)	0.361967	0.112937	3.205028	0.0037
C(6)	-0.520880	0.105268	-4.948133	0.0000

C(7)	0.959463	0.118964	8.065123	0.0000
C(8)	0.092698	0.028898	3.207797	0.0036

R-squared	0.640407	Mean dependent var	0.077842
Adjusted R-squared	0.582872	S.D. dependent var	0.124815
S.E. of regression	0.080612	Akaike info criterion	-4.885194
Sum squared resid	0.162459	Schwarz criterion	-4.651661
Log likelihood	35.70975	F-statistic	11.13076
Durbin-Watson stat	2.081477	Prob(F-statistic)	0.000025

Model (6.9) including doil(-1) and drm(-1)

LS // Dependent Variable is DRM

Sample: 1962 1990

Included observations: 29

Convergence achieved after 5 iterations

DRM=C(1)+C(3)*DR+C(6)*(RM(-1)-C(7)*NOY(-1))+C(8)*Oil(-1)
+C(4)*DRM(-1)+C(5)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-3.053576	0.842726	-3.623451	0.0015
C(3)	0.335208	0.094951	3.530336	0.0019
C(6)	-0.520590	0.094515	-5.508027	0.0000
C(7)	0.808812	0.112653	7.179656	0.0000
C(8)	0.119120	0.029773	4.000991	0.0006
C(4)	-0.096200	0.114143	-0.842802	0.4084
C(5)	-0.027132	0.031232	-0.868717	0.3944

R-squared	0.757333	Mean dependent var	0.086590
Adjusted R-squared	0.691151	S.D. dependent var	0.117290
S.E. of regression	0.065183	Akaike info criterion	-5.254613
Sum squared resid	0.093474	Schwarz criterion	-4.924576
Log likelihood	42.04267	F-statistic	11.44319

Durbin-Watson stat	2.027139	Prob(F-statistic)	0.000008

Exchange rate premium as opportunity cost for holding money

LS // Dependent Variable is DRM

Sample(adjusted): 1961 1990

Included observations: 30 after adjusting endpoints

Convergence achieved after 6 iterations

DRM=C(1)+C(3)*DR+C(6)*(RM(-1)-C(7)*NOY(-1))+C(9)*(EB(-1)-EO(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-3.912936	1.084888	-3.606766	0.0013
C(3)	0.426234	0.125894	3.385673	0.0023
C(6)	-0.423366	0.118304	-3.578630	0.0014
C(7)	1.265589	0.092875	13.62686	0.0000
C(9)	-0.067278	0.031951	-2.105655	0.0454

R-squared	0.568862	Mean dependent var	0.077842
Adjusted R-squared	0.499880	S.D. dependent var	0.124815
S.E. of regression	0.088268	Akaike info criterion	-4.703738
Sum squared resid	0.194782	Schwarz criterion	-4.470205
Log likelihood	32.98792	F-statistic	8.246513
Durbin-Watson stat	2.051474	Prob(F-statistic)	0.000220

6.7 Appendix 2

Unrestricted PPP

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

Convergence achieved after 5 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*DMY(-1)+C(4)*(EB(-1)-C(8)*PD(-1)-C(9)*PF(-1)-C(5)*DROIL(-1))+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.929765	0.392465	-2.369039	0.0275
C(2)	1.028013	0.512479	2.005961	0.0579
C(3)	0.136203	0.074881	1.818935	0.0832
C(4)	0.088836	0.048010	1.850378	0.0784
C(8)	1.139515	0.641969	1.775031	0.0904
C(9)	-2.473582	1.408120	-1.756656	0.0935
C(5)	0.230550	0.086803	2.656021	0.0148
C(7)	-0.064272	0.018917	-3.397638	0.0027

R-squared	0.826988	Mean dependent var	0.103998
Adjusted R-squared	0.769317	S.D. dependent var	0.082448
S.E. of regression	0.039599	Akaike info criterion	-6.228940
Sum squared resid	0.032930	Schwarz criterion	-5.851755
Log likelihood	57.17041	F-statistic	14.33983
Durbin-Watson stat	2.164296	Prob(F-statistic)	0.000001

Wald Test:

Null Hypothesis: C(8)=1

F-statistic	0.047229	Probability	0.830054
Chi-square	0.047229	Probability	0.827956

Wald Test:

Null Hypothesis: C(9)=-1

F-statistic	1.095139	Probability	0.307232
Chi-square	1.095139	Probability	0.295335

Wald Test:

Null Hypothesis: C(8)=1 C(9)=-1

F-statistic	0.890152	Probability	0.425528
Chi-square	1.780303	Probability	0.410594

Wald Test:

Null Hypothesis: C(8)+C(9)=0

F-statistic	1.683192	Probability	0.208573
Chi-square	1.683192	Probability	0.194501

Imposing opposite coefficient restriction

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

Convergence achieved after 7 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*DMY(-1)+C(4)*(EB(-1)-C(8)*(PD(-1)-PF(-1))-C(5)*DROIL(-1))+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.480212	0.347953	-1.380107	0.1814
C(2)	1.653374	0.440147	3.756414	0.0011
C(3)	0.153450	0.079611	1.927504	0.0669
C(4)	0.100576	0.051001	1.972043	0.0613
C(8)	0.219185	0.707969	0.309597	0.7598
C(5)	0.187537	0.064091	2.926083	0.0078
C(7)	-0.078430	0.018838	-4.163415	0.0004

R-squared	0.792497	Mean dependent var	0.103998
Adjusted R-squared	0.735906	S.D. dependent var	0.082448
S.E. of regression	0.042370	Akaike info criterion	-6.116123
Sum squared resid	0.039495	Schwarz criterion	-5.786086
Log likelihood	54.53457	F-statistic	14.00380
Durbin-Watson stat	1.997371	Prob(F-statistic)	0.000002

Wald Test:

Null Hypothesis: C(8)=1

F-statistic	1.216375	Probability	0.281992
Chi-square	1.216375	Probability	0.270073

Unrestricted PPP: replacing dmy with residuals form money equation.(see the model in the inflation section in this chapter)

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 6 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))

+C(4)*(EB(-1)-C(8)*PD(-1)+C(9)*PF(-1)-C(5)*DROIL(-1))

+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.542380	0.297347	-1.824063	0.0831
C(2)	1.160563	0.378184	3.068776	0.0061
C(3)	0.376659	0.082927	4.542068	0.0002
C(4)	0.058020	0.033842	1.714456	0.1019
C(8)	0.874576	0.788554	1.109088	0.2806
C(9)	-1.979316	1.558770	-1.269794	0.2187
C(5)	0.270588	0.112425	2.406831	0.0259
C(7)	-0.084883	0.014291	-5.939699	0.0000

R-squared	0.895254	Mean dependent var	0.107712
Adjusted R-squared	0.858593	S.D. dependent var	0.081453
S.E. of regression	0.030630	Akaike info criterion	-6.736624
Sum squared resid	0.018763	Schwarz criterion	-6.355994
Log likelihood	62.58246	F-statistic	24.41975
Durbin-Watson stat	2.303843	Prob(F-statistic)	0.000000

Wald Test:

Null Hypothesis: C(8)=1

F-statistic	0.025299	Probability	0.875220
Chi-square	0.025299	Probability	0.873625

Wald Test:

Null Hypothesis: C(9)=-1

F-statistic	0.394710	Probability	0.536943
Chi-square	0.394710	Probability	0.529834

Wald Test:

Null Hypothesis: C(8)=1 C(9)=-1

F-statistic	0.693633	Probability	0.511384
Chi-square	1.387267	Probability	0.499757

Wald Test:

Null Hypothesis: C(8)+C(9)=0

F-statistic	1.044635	Probability	0.318951
Chi-square	1.044635	Probability	0.306746

Imposing opposite coefficient restriction

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 6 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(4)*(EB(-1)-C(8)*(PD(-1)-PF(-1))-C(5)*DROIL(-1))
+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.286147	0.232942	-1.228409	0.2329
C(2)	1.458122	0.312870	4.660479	0.0001
C(3)	0.410890	0.080454	5.107127	0.0000
C(4)	0.061494	0.034391	1.788058	0.0882
C(8)	0.136301	0.813751	0.167497	0.8686
C(5)	0.234317	0.089081	2.630391	0.0156
C(7)	-0.093393	0.013065	-7.148501	0.0000

R-squared	0.885750	Mean dependent var	0.107712
Adjusted R-squared	0.853107	S.D. dependent var	0.081453
S.E. of regression	0.031218	Akaike info criterion	-6.721202
Sum squared resid	0.020466	Schwarz criterion	-6.388151
Log likelihood	61.36655	F-statistic	27.13460
Durbin-Watson stat	2.215285	Prob(F-statistic)	0.000000

Wald Test:

Null Hypothesis: C(8)=1

F-statistic	1.126527	Probability	0.300572
Chi-square	1.126527	Probability	0.288517

Imposing unit restriction on price differentials

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 4 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(4)*(REB(-1)-C(5)*DROIL(-1))+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.523960	0.201691	-2.597836	0.0164
C(2)	1.320540	0.318620	4.144563	0.0004
C(3)	0.466955	0.077926	5.992260	0.0000
C(4)	0.088314	0.032566	2.711822	0.0127
C(5)	0.143524	0.028359	5.060985	0.0000
C(7)	-0.087011	0.013206	-6.588658	0.0000

R-squared	0.868033	Mean dependent var	0.107712
Adjusted R-squared	0.838041	S.D. dependent var	0.081453
S.E. of regression	0.032780	Akaike info criterion	-6.648469
Sum squared resid	0.023640	Schwarz criterion	-6.362997
Log likelihood	59.34829	F-statistic	28.94173
Durbin-Watson stat	1.774603	Prob(F-statistic)	0.000000

Breusch-Godfrey Serial Correlation LM(1) Test:

F-statistic	0.160736	Probability	0.692530
Obs*R-squared	0.212686	Probability	0.644670

Breusch-Godfrey Serial Correlation LM(4) Test:

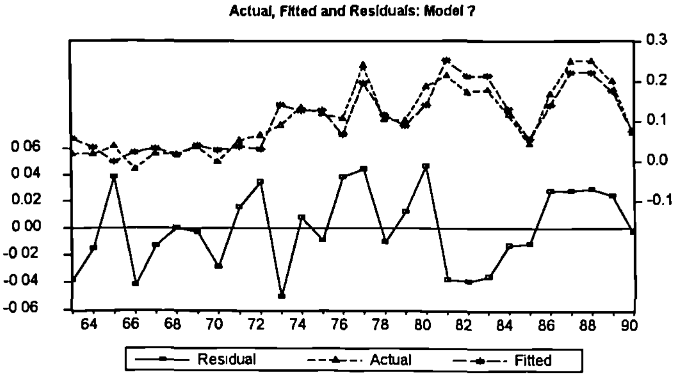
F-statistic	0.312427	Probability	0.865903
Obs*R-squared	1.817784	Probability	0.769227

Wald Test:

Null Hypothesis: C(7)=0

F-statistic	43.41042	Probability	0.000001

Chi-square	43.41042	Probability	0.000000



To test if the significance of C(3) in these models is related to AR(1) nature of DPD, I reestimated an unrestricted version of the final model as:

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 4 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*RESIDRM3(-1)+C(8)*DPD(-1)

+C(4)*(REB(-1)-C(5)*DROIL(-1))+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.508106	0.211847	-2.398463	0.0258
C(2)	1.289283	0.339757	3.794726	0.0011
C(3)	0.443035	0.109318	4.052713	0.0006
C(8)	0.490581	0.108686	4.513732	0.0002
C(4)	0.085591	0.034329	2.493290	0.0211
C(5)	0.146499	0.031134	4.705432	0.0001
C(7)	-0.086565	0.013557	-6.385389	0.0000

R-squared	0.868670	Mean dependent var	0.107712
Adjusted R-squared	0.831147	S.D. dependent var	0.081453
S.E. of regression	0.033470	Akaike info criterion	-6.581877

Sum squared resid	0.023525	Schwarz criterion	-6.248826
Log likelihood	59.41601	F-statistic	23.15043
Durbin-Watson stat	1.841900	Prob(F-statistic)	0.000000

Wald Test:

Null Hypothesis: C(3)=C(8)

F-statistic	0.101824	Probability	0.752804
Chi-square	0.101824	Probability	0.749651

The obtained results show that the AR(1) hypothesis of DPD is invalid and the restriction imposed on DPD plus RESID of DRM equation is valid.

Inflation Model 2: Inverted money demand function.

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

Convergence achieved after 22 iterations

DPD=C(1)+C(2)*DPD(-1)+C(3)*DMY(-1)+C(4)*(RM(-1)-C(5)*y(-1))
+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.216879	0.281753	-0.769748	0.4493
C(2)	0.348154	0.159833	2.178237	0.0399
C(3)	0.116717	0.061164	1.908258	0.0689
C(4)	0.022326	0.023155	0.964203	0.3450
C(5)	-0.831842	2.182008	-0.381228	0.7065
C(7)	-0.054583	0.016090	-3.392288	0.0025

R-squared	0.798620	Mean dependent var	0.103998
Adjusted R-squared	0.754841	S.D. dependent var	0.082448
S.E. of regression	0.040823	Akaike info criterion	-6.215037
Sum squared resid	0.038330	Schwarz criterion	-5.932148
Log likelihood	54.96881	F-statistic	18.24234
Durbin-Watson stat	2.074275	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 15 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(4)*(RM(-1)-C(5)*y(-1))+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.236617	0.255590	-0.925766	0.3646
C(2)	0.440835	0.270094	1.632156	0.1169
C(3)	0.408836	0.096157	4.251759	0.0003

C(4)	0.016598	0.017837	0.930534	0.3622
C(5)	-1.304500	2.960449	-0.440643	0.6638
C(7)	-0.073430	0.014716	-4.989789	0.0001

R-squared	0.853746	Mean dependent var	0.107712
Adjusted R-squared	0.820507	S.D. dependent var	0.081453
S.E. of regression	0.034509	Akaike info criterion	-6.545674
Sum squared resid	0.026199	Schwarz criterion	-6.260202
Log likelihood	57.90916	F-statistic	25.68466
Durbin-Watson stat	1.525184	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 4 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(4)*(RM(-1)-C(5)*NOY(-1))+C(7)*DOil(-1)+C(8)*Oil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.376506	0.252180	-1.493007	0.1503
C(2)	0.747239	0.307161	2.432727	0.0240
C(3)	0.354545	0.096213	3.684986	0.0014
C(4)	0.040662	0.021537	1.887994	0.0729
C(5)	-1.061977	1.047113	-1.014195	0.3220
C(7)	-0.057399	0.016557	-3.466710	0.0023
C(8)	-0.031657	0.017614	-1.797286	0.0867

R-squared	0.873656	Mean dependent var	0.107712
Adjusted R-squared	0.837558	S.D. dependent var	0.081453
S.E. of regression	0.032829	Akaike info criterion	-6.620582
Sum squared resid	0.022632	Schwarz criterion	-6.287531
Log likelihood	59.95788	F-statistic	24.20216
Durbin-Watson stat	1.820117	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

VINV = ***m - p - y***

DPD= C(1)+C(2)*DPD(-1)+C(3)*DRM(-1)+C(4)*DOil(-1)
+C(5)*VINV(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.278099	0.152588	1.822550	0.0809
C(2)	0.663253	0.155721	4.259249	0.0003
C(3)	0.212931	0.069572	3.060572	0.0054
C(4)	-0.055295	0.016099	-3.434582	0.0022
C(5)	0.039366	0.021777	1.807673	0.0832

R-squared	0.789951	Mean dependent var	0.103998
Adjusted R-squared	0.754943	S.D. dependent var	0.082448
S.E. of regression	0.040814	Akaike info criterion	-6.241856
Sum squared resid	0.039980	Schwarz criterion	-6.006115
Log likelihood	54.35769	F-statistic	22.56473
Durbin-Watson stat	1.867706	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(7)*DOil(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.022533	0.013867	1.625017	0.1172
C(2)	0.732215	0.248526	2.946231	0.0070
C(3)	0.532881	0.073806	7.220069	0.0000

C(7)	-0.085135	0.013776	-6.180095	0.0000

R-squared	0.820990	Mean dependent var	0.107712
Adjusted R-squared	0.798613	S.D. dependent var	0.081453
S.E. of regression	0.036553	Akaike info criterion	-6.486433
Sum squared resid	0.032067	Schwarz criterion	-6.296118
Log likelihood	55.07978	F-statistic	36.69018
Durbin-Watson stat	1.318044	Prob(F-statistic)	0.000000

M2

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

Convergence achieved after 5 iterations

DPD= C(1)+C(2)*DPD(-1)+C(3)*DRM(-1)+C(4)*DOil(-1)

+C(5)*(RMQ(-1)-C(6)*y(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.119726	0.345074	0.346958	0.7318
C(2)	0.521572	0.185628	2.809762	0.0099
C(3)	0.167230	0.078932	2.118660	0.0451
C(4)	-0.055249	0.015617	-3.537691	0.0018
C(5)	0.042046	0.023104	1.819820	0.0818
C(6)	0.608943	0.747658	0.814467	0.4237

R-squared	0.806882	Mean dependent var	0.103998
Adjusted R-squared	0.764900	S.D. dependent var	0.082448
S.E. of regression	0.039977	Akaike info criterion	-6.256931
Sum squared resid	0.036757	Schwarz criterion	-5.974043
Log likelihood	55.57629	F-statistic	19.21965
Durbin-Watson stat	1.874506	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

DPD= C(1)+C(2)*DPD(-1)+C(3)*DRM(-1)+C(4)*DOil(-1)
+C(5)*(RMQ(-1)-y(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.313893	0.137142	2.288822	0.0312
C(2)	0.567693	0.167575	3.387687	0.0024
C(3)	0.190272	0.068558	2.775361	0.0105
C(4)	-0.054421	0.015356	-3.543930	0.0017
C(5)	0.047662	0.020944	2.275727	0.0321

R-squared	0.803709	Mean dependent var	0.103998
Adjusted R-squared	0.770994	S.D. dependent var	0.082448
S.E. of regression	0.039455	Akaike info criterion	-6.309601
Sum squared resid	0.037361	Schwarz criterion	-6.073860
Log likelihood	55.33999	F-statistic	24.56690
Durbin-Watson stat	1.839019	Prob(F-statistic)	0.000000

LS // Dependent Variable is DPD

Sample(adjusted): 1962 1990

Included observations: 29 after adjusting endpoints

DPD= C(1)+C(2)*DPD(-1)+C(3)*DRM(-1)+C(4)*DOil(-1)
+C(5)*(RMQ(-1)-NOY(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.304851	0.135156	2.255550	0.0335
C(2)	0.572473	0.167618	3.415345	0.0023
C(3)	0.189556	0.068841	2.753552	0.0111
C(4)	-0.054983	0.015336	-3.585256	0.0015
C(5)	0.046297	0.020647	2.242339	0.0344

R-squared	0.802689	Mean dependent var	0.103998
Adjusted R-squared	0.769804	S.D. dependent var	0.082448
S.E. of regression	0.039557	Akaike info criterion	-6.304417
Sum squared resid	0.037555	Schwarz criterion	-6.068677
Log likelihood	55.26483	F-statistic	24.40887
Durbin-Watson stat	1.844753	Prob(F-statistic)	0.000000

Oil and Inflation

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

DPD= C(1)+C(2)* DPD(-1)+C(3)* DPD(-2)+C(4)* DOIL +C(5)*DOIL(-1)+C(6)* DOIL(-2)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.037755	0.016939	2.228850	0.0364
C(2)	0.657868	0.213980	3.074436	0.0055
C(3)	0.083298	0.203360	0.409610	0.6861
C(4)	-0.015373	0.019953	-0.770463	0.4492
C(5)	-0.067623	0.019496	-3.468548	0.0022
C(6)	0.008639	0.024160	0.357574	0.7241

R-squared	0.688219	Mean dependent var	0.107712
Adjusted R-squared	0.617359	S.D. dependent var	0.081453
S.E. of regression	0.050385	Akaike info criterion	-5.788717
Sum squared resid	0.055850	Schwarz criterion	-5.503244
Log likelihood	47.31175	F-statistic	9.712452
Durbin-Watson stat	2.009171	Prob(F-statistic)	0.000053

Wald Test:

Null Hypothesis: C(4)=0 C(5)=0 C(6)=0

F-statistic	4.544114	Probability	0.012649
Chi-square	13.63234	Probability	0.003451

LS // Dependent Variable is DPD

Sample(adjusted): 1963 1990

Included observations: 28 after adjusting endpoints

Convergence achieved after 7 iterations

DPD=C(1)+C(2)*DPF(-1)+C(3)*(RESIDRM3(-1)+DPD(-1))
+C(4)*(REB(-1)-C(5)*DROIL(-1))+C(7)*DOIL(-1) +C(8)*DOIL
+C(9)*DOIL(-2)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.569844	0.210144	-2.711688	0.0134
C(2)	1.284572	0.323850	3.966566	0.0008
C(3)	0.516230	0.088207	5.852491	0.0000
C(4)	0.095847	0.033892	2.828013	0.0104
C(5)	0.151267	0.029427	5.140481	0.0000
C(7)	-0.088655	0.013542	-6.546842	0.0000
C(8)	-0.009110	0.014545	-0.626330	0.5382
C(9)	0.014197	0.017085	0.830921	0.4158

R-squared	0.877526	Mean dependent var	0.107712
Adjusted R-squared	0.834660	S.D. dependent var	0.081453
S.E. of regression	0.033120	Akaike info criterion	-6.580263
Sum squared resid	0.021939	Schwarz criterion	-6.199633
Log likelihood	60.39341	F-statistic	20.47143
Durbin-Watson stat	1.903365	Prob(F-statistic)	0.000000

Wald Test:

Null Hypothesis: C(7)=0 C(8)=0 C(9)=0

F-statistic	14.69099	Probability	0.000027
Chi-square	44.07298	Probability	0.000000

7

7. Simulation Results

7.1 Introduction

In the previous chapter we presented parameter estimates obtained, using single equation method. In that chapter we also argued that oil revenue changes do not appear to create disequilibrium in the money market. This indicates that to trace the oil revenues effects upon the economy we can exclude the money equation from the set of equations without a significant side effect on the final conclusion. Money demand equation, hence, was excluded and, then, in order to get more efficient results the other remaining equations (domestic inflation, growth rate, exchange rate, and foreign inflation) were estimated jointly using a system equation method (see next section). We found that the jointly estimated models appear more consistent and precise. Consequently, these results were chosen to undertake the simulation exercise. The simulation results plus plots for selected key variables are presented in the following subsections and in the appendices. The exercise considers several scenarios by making various assumptions on oil revenue changes (and its related oil prices) within and out of sample.

Despite obtaining satisfactory results, there is no guarantee that when simulated as a system of equations, the model will perform reasonably well in tracking the historical data. For the dynamic simulation exercise, any lagged endogenous variables are replaced by their respective simulated values, making it highly probable that the exercise may find evidence of stability which would otherwise have been undetected.

As the system of the equations is allowed to run further into the future, any systematic errors will be compounded, making the simulated values deviate progressively from the actual values. Since we have focused on the impact of oil and have ignored the effects of many variables that we deemed important it is likely that simulations will not provide a particularly close fit to the data. However, we should be concerned if the model fails to pick up major turning points or has systematically large errors. The examination of the model performance in tracking the historical data is presented in subsection 7.3.1

We then proceed to examine the response of our endogenous variables to different time paths for our exogenous variables, oil revenue and oil prices. We keep the oil price and oil revenue constant at the levels prior to the first oil shock (1973/74) and simulate the interested endogenous variables (**SM1**).

The current policy of spending of oil revenue in Iran is to inject the revenue in the domestic economy through budget deficits. By rising oil revenue the state would raise public expenditures but when oil revenues crash down it is difficult for the state to diminish the expenditures and so accepts a budget deficit policy. Through this policy all oil shocks would automatically be passed to the domestic economy. We simulate an alternative policy for spending oil revenues which could have been implemented by the authorities during 1974-1990. By this policy the state would not establish each year public expenditure based on the same year oil revenue, but base on a long run expectation of oil revenues. Rather than the government allowing the whole of a revenue shock to impact upon the economy, we assume the government took a larger term view and smoothed the flow of oil revenue into the economy, so that the extra demand should not greatly exceed the absorptive capacity. We simulate this by assuming a constant growth rate of oil revenue spending equal to the growth rate over the whole period. Oil prices are picked as the actual ones (**SM4**) (see appendix 1 for related table and graph of this projection).

In the previous chapter we argue that oil revenue changes do not appear to create disequilibrium in the money market. This conclusion would allow us to assume that after any oil shock the monetary diseqiulibrium could be ignored. We impose this conjecture by assuming $DMY=0$ in all simulation exercises except the tracking one

(**SM0**). Also we chose a '*base path*' defined as a dynamic simulation run of the model when this presumption (*DMY=0)* is imposed (**SM00**). Values obtained from this simulation represent the effect of oil revenue on the variables of interest, and are used to judge our simulation results obtained from different scenarios.

For out of sample cases (1991-1999) we implemented three alternative scenarios: No oil shock since 1990 (**SM5**); temporary oil shock in 1991 (**SM6**) and permanent oil shock in 1991 (**SM7**).

For convenience, the multiple-equation model we will use in the simulation exercise is presented below. For a full definition of the variables and coefficients refer to chapter 6.

7.2 System of equation method

To get more efficient results, all final models except money demand model taken from previous chapter were restimated using SUR (Seemingly Unrelated Regression) method[1]. Full results are reported below. All coefficients confirm the results obtained in previous chapter and appear more precisely with lower standard errors.

Equation:
$$\Delta p_t^d = \beta_1' + \beta_2' \Delta p^f{}_{t-1} + \beta_3' \Delta my_{t-1} + \beta_4' (re_b - \beta_3 DRoil)_{t-1} + \beta_5' \Delta oil_{t-1} + \beta_6' \Delta p_{t-1}^d + v_t$$

Observations: 29

R-squared	0.831412	Mean dependent var	0.103998
Adjusted R-squared	0.785434	S.D. dependent var	0.082448
S.E. of regression	0.038191	Sum squared resid	0.032088
Durbin-Watson stat	2.587987		

[1]In the case that the disturbances of the equations are correlated this method of estimation produces more efficient results compared with equation-by-equation method. (see Maddala 1992 for example) When each residual is regressed on the others only growth and foreign prices appear to be correlated. However, given our small samples we proceed to use SUR estimation. In fact the parameter estimates differ little between SUR and OLS.

Equation: $$\Delta e_{bt} = \alpha_0 + \alpha_{11}\Delta e_{t-1} + \alpha_{14}\Delta e_{t-4} + \alpha_4 DR_t + \alpha_7(re_b - \beta_3 DRoil)_{t-1} + \varepsilon_t$$

Observations: 26			
R-squared	0.921563	Mean dependent var	0.109057
Adjusted R-squared	0.901954	S.D. dependent var	0.193775
S.E. of regression	0.060676	Sum squared resid	0.073630
Durbin-Watson stat	1.821665		

Equation: $\Delta p_t^f = \eta_0 + \eta_1 \Delta p_{t-1}^f + \eta_2 \Delta oilp_t + \omega_t$

Observations: 29			
R-squared	0.835765	Mean dependent var	0.050829
Adjusted R-squared	0.823131	S.D. dependent var	0.030423
S.E. of regression	0.012795	Sum squared resid	0.004256
Durbin-Watson stat	1.458855		

Equation: $\Delta rnoy_t = \delta_1 + \delta_{54}\Delta oil_{t-4} + \delta_7 DR + \mu_t$

Observations: 26			
R-squared	0.322341	Mean dependent var	0.044243
Adjusted R-squared	0.263414	S.D. dependent var	0.155004
S.E. of regression	0.133031	Sum squared resid	0.407039
Durbin-Watson stat	1.932583		

Estimation Method: Iterative Seemingly Unrelated Regression
Sample: 1960 1990
Convergence achieved after 7 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
β'_1	-0.679942	0.214928	-3.163583	0.0021
β'_2	1.057036	0.345360	3.060680	0.0029
β'_3	0.173452	0.057049	3.040392	0.0031
β'_6	0.414753	0.102345	4.052510	0.0001
β'_4	0.113899	0.035020	3.252360	0.0016
β_3	0.156675	0.018742	8.359459	0.0000
β'_5	-0.071344	0.013145	-5.427686	0.0000
α_0	1.804874	0.223066	8.091208	0.0000
α_{11}	-0.437282	0.071702	-6.098573	0.0000
α_{14}	-0.597157	0.069192	-8.630446	0.0000
α_4	0.477238	0.038839	12.28748	0.0000
α_7	-0.309535	0.037831	-8.181994	0.0000
η_0	0.013518	0.003843	3.517293	0.0007
η_1	0.683284	0.066589	10.26129	0.0000
η_2	0.041075	0.006576	6.246393	0.0000
δ_1	0.103714	0.032726	3.169139	0.0021
δ_{54}	-0.175781	0.046426	-3.786292	0.0003
δ_7	-0.094920	0.046257	-2.052018	0.0430

Determinant residual covariance 4.97E-12

7.3 Within Sample Dynamic Simulations

7.3.1 Tracking of the model

In order to test the reliability of the model for tracking the movements of the endogenous variables, a *dynamic simulation* of the model was conducted over the period 1960-1990, using the parameters estimated obtained using SUR (seemingly unrelated regression) method (reported above) and the actual values of the exogenous variables. Under this simulation procedure the lagged endogenous variables are generated by the model and the errors are accumulated over time[2].

The results from the dynamic simulation of the four structural equations are presented in Tables 7.1 and 7.2. In addition we present graphical representations of the tracking performance of the model for both changes and levels of variables. To help the evaluation of the model performance, *RMS* (root-mean-square) *percent errors*, *mean simulation error* and *mean percent errors* are calculated for all of the endogenous variables[3]. Some of these errors are large (especially for non-oil output), but that is not surprising given the simplistic nature of the model (see Tables 7.3 and 7.4) and that in general short run models of growth do not perform well. In addition, actual and simulated values for the endogenous variables are plotted in Figures 7.1 to 7.10 for the historical simulation. The graphical representations, help us evaluate how well our proposed structural equations reproduce the turning points in the historical data.

Judging from the statistics presented in Tables 7.3 and 7.4, the tracking performance of the equations is reasonable. All the computed values for RMS% error in levels are small. The evidence points to the non-oil real gdp as the worst fitting equation, unsurprisingly perhaps. Looking at the graphic representation for the non-oil real gdp, there is a notable deviation of the simulated from the actual series during the 1970s.

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[2] This dynamic simulation can be contrasted to a static one, where the values of lagged endogenous variables are assumed to be exogenous given and, consequently, the errors are confined to a single period.

[3] See appendix 2 for an illustration of these criterion.

The exchange rate equation tracks the actual values during pre and post-revolution periods well. Except the non-oil real gdp growth rate equation, the remaining three equations, namely black market exchange rate, domestic prices and foreign prices, achieve impressive tracking records. Apart from a few data points, the equations reproduced the historical data with a high degree of precision. However, in several cases the turning points fail to be reproduced. Obviously, many of these failures are attributed to non-economic factors which affected the Iranian economy during the past two decades (see chapter 2).

Table 7-1 **Within Sample Simulations: Tracking of the model (levels): 1960 1990***

obs	e_b^a	e_b^s	noy^a	noy^s	p_d^a	p_d^s	re_b^a	re_b^s
1960	4.38	4.38	9.05	9.05	1.57	1.57	5.94	5.94
1961	4.46	4.46	9.08	9.08	1.59	1.59	6.00	6.00
1962	4.52	4.52	9.16	9.16	1.59	1.59	6.07	6.07
1963	4.52	4.52	9.22	9.22	1.61	1.61	6.06	6.06
1964	4.41	4.41	9.34	9.34	1.63	1.65	5.94	5.94
1965	4.39	4.38	9.47	9.44	1.67	1.65	5.91	5.93
1966	4.37	4.33	9.58	9.55	1.65	1.68	5.93	5.88
1967	4.34	4.33	9.64	9.63	1.67	1.72	5.91	5.89
1968	4.34	4.38	9.81	9.68	1.69	1.75	5.93	5.94
1969	4.35	4.34	9.94	9.78	1.72	1.79	5.97	5.91
1970	4.37	4.36	10.02	9.88	1.72	1.82	6.04	5.94
1971	4.37	4.32	10.10	9.91	1.77	1.86	6.03	5.90
1972	4.35	4.29	10.34	10.02	1.84	1.91	5.97	5.88
1973	4.27	4.31	10.42	10.11	1.93	2.04	5.86	5.83
1974	4.22	4.29	10.31	10.17	2.07	2.15	5.79	5.80
1975	4.22	4.33	10.16	10.20	2.19	2.24	5.75	5.85
1976	4.28	4.33	10.60	10.39	2.29	2.35	5.76	5.81
1977	4.31	4.32	10.71	10.45	2.53	2.53	5.62	5.70
1978	4.34	4.38	10.31	10.33	2.64	2.67	5.61	5.67
1979	4.85	4.85	10.26	10.24	2.74	2.81	6.13	6.09
1980	5.30	5.40	10.20	10.33	2.93	2.93	6.52	6.60
1981	5.71	5.73	10.21	10.34	3.14	3.12	6.81	6.81
1982	6.11	6.06	10.37	10.24	3.32	3.29	7.10	7.03
1983	5.90	6.07	10.54	10.27	3.50	3.43	6.74	6.94
1984	6.23	6.19	10.51	10.34	3.61	3.57	6.99	6.98
1985	6.39	6.41	10.56	10.35	3.66	3.64	7.15	7.17
1986	6.52	6.50	10.43	10.37	3.83	3.80	7.12	7.12
1987	6.91	6.79	10.44	10.42	4.08	4.06	7.30	7.18
1988	6.86	6.91	10.36	10.32	4.33	4.24	7.04	7.15
1989	7.15	7.06	10.37	10.44	4.53	4.44	7.17	7.15
1990	7.24	7.34	10.49	10.68	4.61	4.50	7.24	7.39

* 'a' and 's' denotes actual and simulated values respectively.

Table 7-2 Within Sample Simulations: Tracking of the model (changes): 1960 1990*

obs	Δre_b^a	Δre_b^s	Δp_d^a	Δp_d^s	Δe_b^a	Δe_b^s	Δp_f^a	Δp_f^s	Δnoy^a	Δnoy^s
1960	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1961	0.07	0.07	0.02	0.02	0.08	0.08	0.01	0.01	0.03	0.03
1962	0.07	0.07	0.00	0.00	0.06	0.06	0.01	0.01	0.08	0.08
1963	-0.01	-0.01	0.02	0.02	0.00	0.00	0.01	0.01	0.06	0.06
1964	-0.12	-0.12	0.02	0.04	-0.11	-0.11	0.01	0.02	0.12	0.12
1965	-0.04	-0.01	0.04	0.01	-0.02	-0.03	0.02	0.03	0.13	0.10
1966	0.03	-0.05	-0.02	0.03	-0.02	-0.05	0.03	0.03	0.10	0.11
1967	-0.03	0.00	0.02	0.04	-0.03	0.01	0.02	0.04	0.07	0.08
1968	0.02	0.06	0.02	0.02	0.00	0.04	0.04	0.04	0.17	0.05
1969	0.04	-0.03	0.04	0.04	0.02	-0.03	0.05	0.04	0.13	0.10
1970	0.07	0.03	0.00	0.03	0.02	0.02	0.06	0.04	0.08	0.10
1971	-0.01	-0.04	0.05	0.04	0.00	-0.05	0.04	0.05	0.08	0.03
1972	-0.06	-0.02	0.07	0.05	-0.02	-0.03	0.03	0.05	0.24	0.11
1973	-0.11	-0.05	0.09	0.13	-0.08	0.02	0.06	0.06	0.07	0.09
1974	-0.07	-0.02	0.14	0.11	-0.04	-0.02	0.11	0.11	-0.11	0.06
1975	-0.04	0.04	0.12	0.09	-0.01	0.04	0.09	0.09	-0.15	0.03
1976	0.01	-0.04	0.11	0.11	0.06	-0.01	0.06	0.08	0.44	0.19
1977	-0.15	-0.11	0.24	0.18	0.03	0.00	0.06	0.07	0.11	0.06
1978	0.00	-0.03	0.11	0.14	0.03	0.05	0.07	0.06	-0.40	-0.12
1979	0.51	0.41	0.10	0.13	0.51	0.48	0.11	0.07	-0.06	-0.09
1980	0.39	0.51	0.19	0.12	0.45	0.54	0.13	0.09	-0.05	0.09
1981	0.29	0.22	0.22	0.19	0.41	0.33	0.10	0.08	0.01	0.00
1982	0.29	0.22	0.17	0.16	0.40	0.33	0.06	0.06	0.16	-0.10
1983	-0.36	-0.09	0.18	0.15	-0.21	0.01	0.03	0.05	0.17	0.03
1984	0.26	0.04	0.12	0.13	0.33	0.12	0.04	0.05	-0.03	0.07
1985	0.15	0.19	0.04	0.07	0.16	0.22	0.04	0.05	0.05	0.01
1986	-0.02	-0.06	0.17	0.16	0.13	0.09	0.02	0.02	-0.13	0.01
1987	0.17	0.07	0.25	0.26	0.39	0.29	0.04	0.04	0.01	0.05
1988	-0.26	-0.03	0.25	0.19	-0.04	0.13	0.04	0.03	-0.09	-0.10
1989	0.13	-0.01	0.20	0.19	0.29	0.15	0.05	0.04	0.02	0.12
1990	0.07	0.25	0.07	0.07	0.09	0.27	0.05	0.04	0.12	0.24

* 'a' and 's' denotes actual and simulated values respectively.

Table 7-3 Evaluating the simulation results			
Criteria/variable[a]	e_b	p_d	**noy**
RMS error%	1.1	2.6	58.2
Mean simulation error	0.009	0.012	-7.4
Mean error%	0.2	1.1	-0.7
[a] For definitions of these criterion see appendix 2.			

Table 7-4 Evaluating the simulation results			
Criteria/variable[a]	Δe_b	Δp_d	**Δnoy**
RMS error%	24	58.7	169
Mean simulation error	0.003	-0.003	0.006
Mean error%	26	-5.5	-020.5
[a] For definitions of these criterion see appendix 2.			

Figure 7-1 Historical simulation of black market exchange rate (BMER)

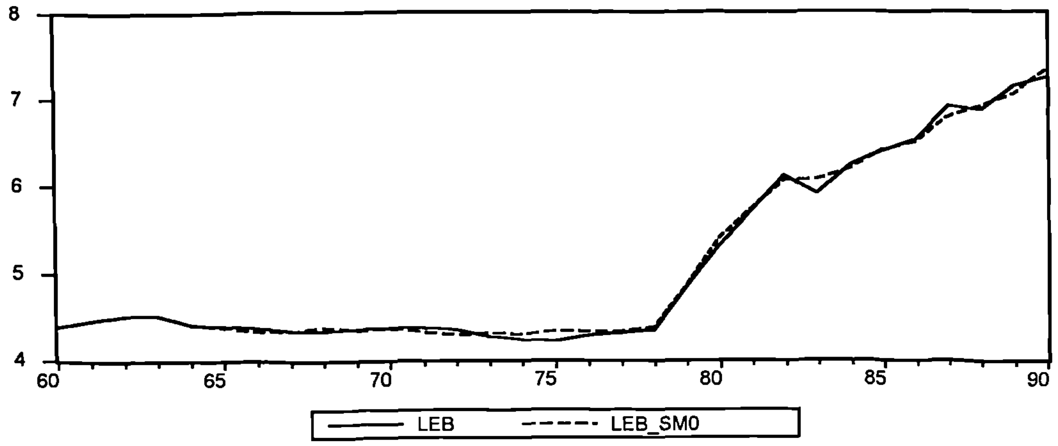


Figure 7-2 Historical simulation of domestic prices (CPI)

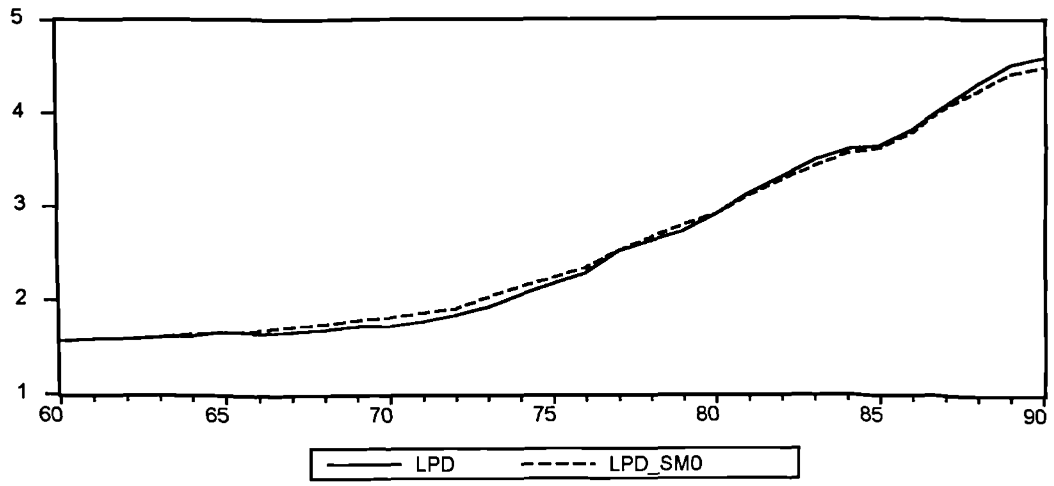


Figure 7-3 Historical simulation of non-oil real gdp

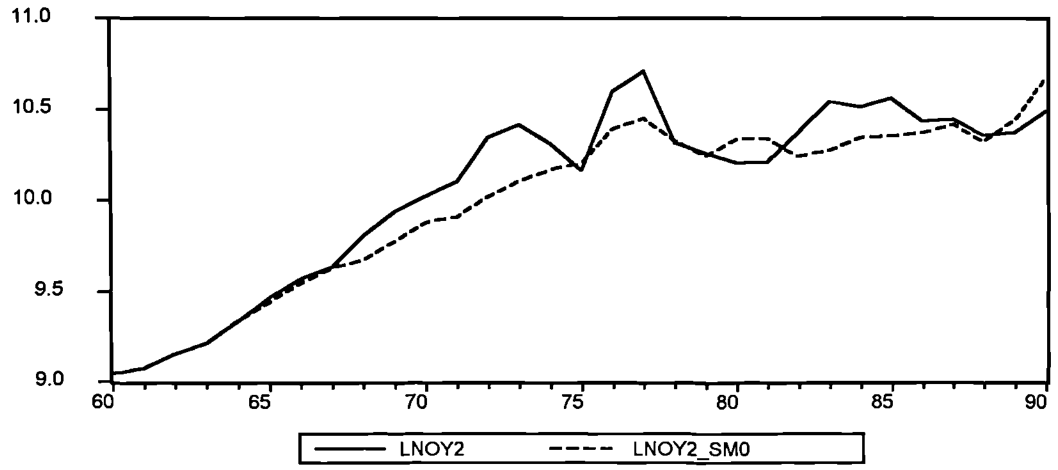


Figure 7-4 Historical simulation of foreign prices

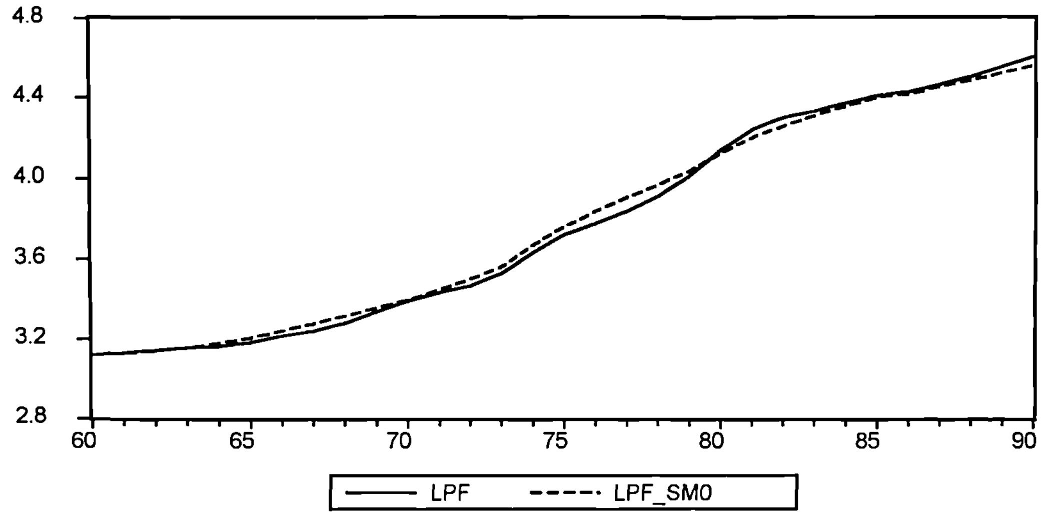


Figure 7-5 Historical simulation of real exchange rate

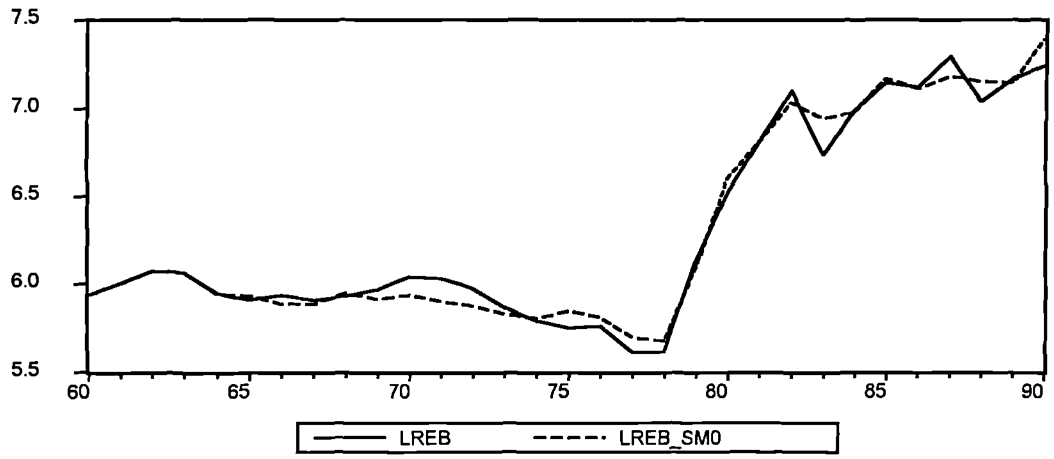


Figure 7-6 Historical simulation of depreciation of black market exchange rate

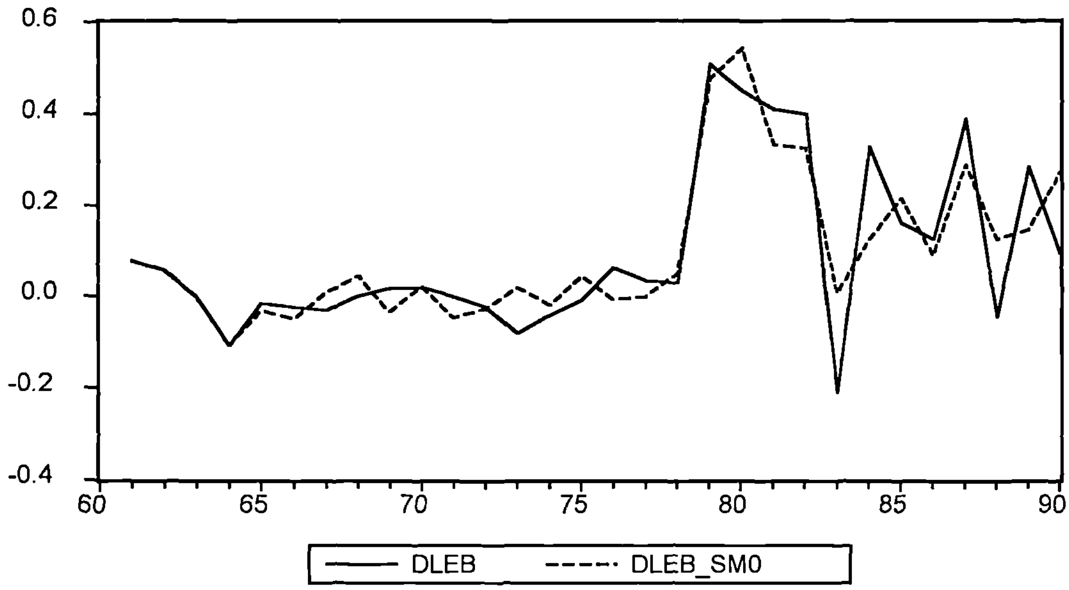


Figure 7-7 Historical simulation of domestic inflation

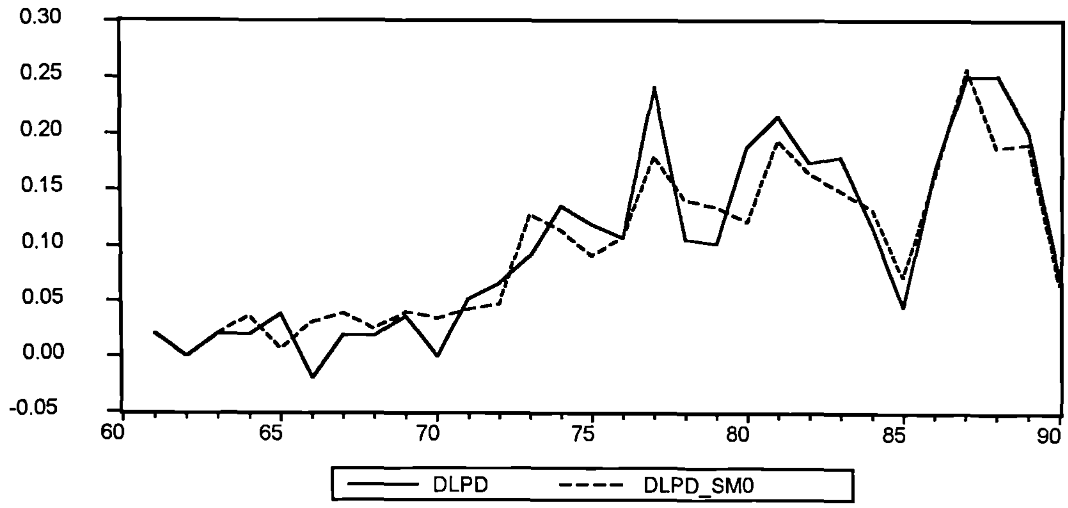


Figure 7-8 Historical simulation of foreign inflation

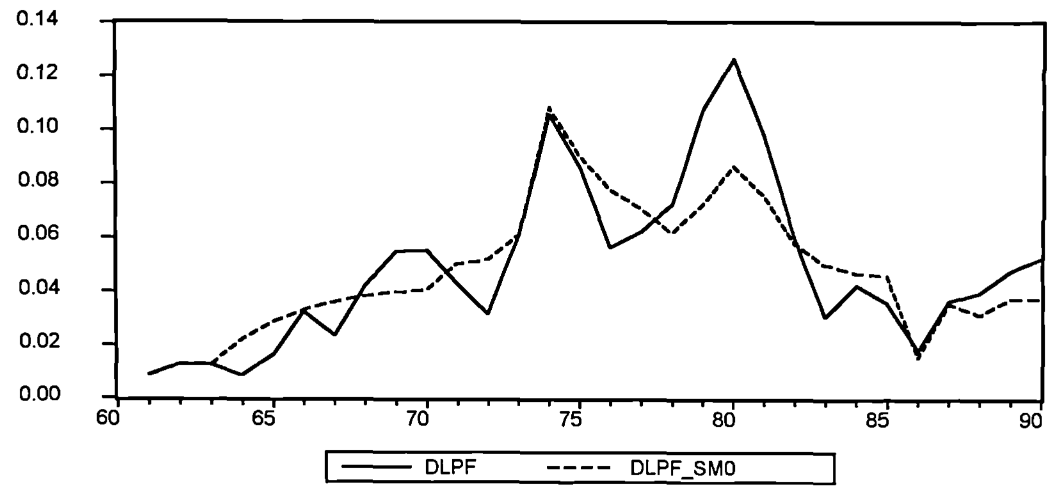


Figure 7-9 Historical simulation of growth rate of non-oil real gdp

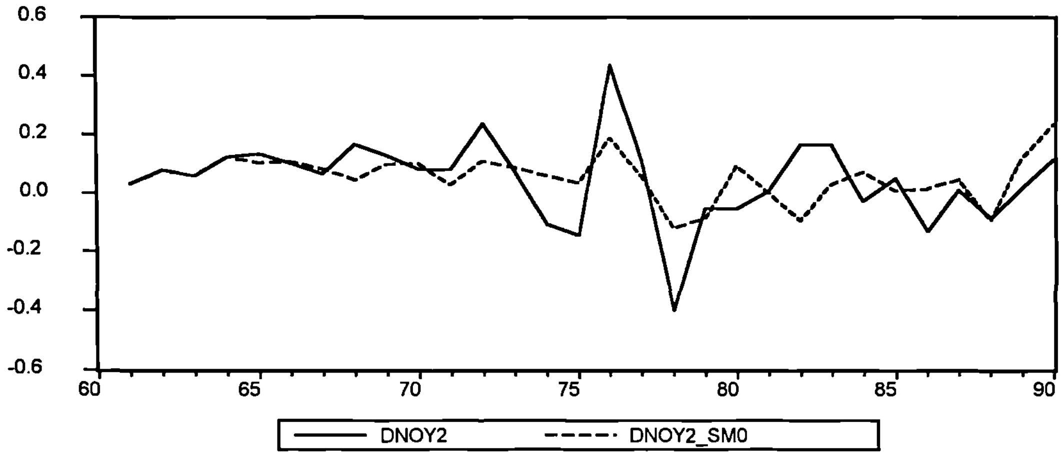
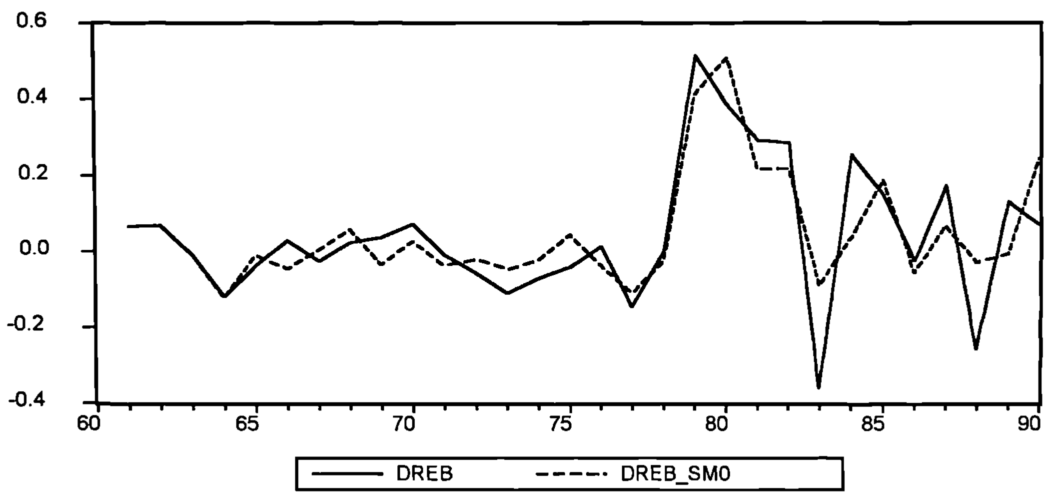


Figure 7-10 Historical simulation of depreciation of real exchange rate



7.3.2 Forecasting and Policy Analysis

We now use the model to perform some simple forecasting and policy experiments. In each experiment we simulate the model dynamically over the 1960-1990 period with a new assumption on oil revenues since 1974. We then concentrate on the results over 1974-1990 period so that we can compare the simulated results with the base path results in the same period. Our objective is to forecast the effects of alternative scenarios of oil revenues on black market exchange rate, domestic price and real non-oil output and their changes. In particular, we perform the following two simulation experiments:

1. *Lack of Oil Shock*. In this experiment, we generate a forecast under the assumption that oil revenues are kept constant at 1973's levels (before first oil shock) (see appendix 1 for table and graph of oil revenue and oil prices projection). (SM1)
2. *Constant growth in oil revenue*. Oil revenue grows at a steady growth rate over 1974 to 1990. We inject the same composed oil revenues absorbed in this period but at a constant rate of growth[4]. Our objective in this case is to test if the policy of expending obtained oil revenue is a matter on effecting endogenous variables (see appendix 1). (SM4)

The simulation results for these alternative scenarios, designated by SM1 and SM4 and their comparison with the previous dynamic simulation based on actual oil revenues (base path), enable us to isolate the impact of the oil shocks on the economy. The results of these experiments are shown in Figures 7.11 to 7.16 and Tables 7.5 to 7.6 (for SM1) and Figures 7.17 to 7.22 and Tables 7.7 to 7.8 (for SM4).

When the oil shocks since 1973/74 are removed, CPI moves approximately on the same trend as the *base path* (SM00) but at a lower level (Table 7.5 and figure 7.12), so that by the end of period the level of simulated prices are lower than the base path values. Comparing these two set of results emerges also that average inflation differ about 1% (10% against 11%; see Table 7.6). This is explained by the lower foreign inflation rate and that after the revolution the rial depreciates less.

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[4] In this experiment oil prices are the actual prices simply because this is not a necessary condition for changing the spending policy of oil revenue which is only a domestic policy.

These results indicate that the SM1 scenario, would result in a lower inflation. A similar argue is also compatible with the movements of BMER levels and the rates of devaluation (13% against 14%; Tables 7.5, 7.6 and Figures 7.11 and 7.14).

A comparison of SM1 and SM00 results reveals that an increase in oil revenues initially results in lower inflation rates without inducing higher rates of non-oil real gdp.

Table 7-5 *Within sample* simulation (SM1)

	e_b			noy			p^d		
obs	**SM1 (1)**	**SM00 (2)**	**(1)/(2) (%)**	**SM1 (3)**	**SM00 (4)**	**(3)/(4) (%)**	**SM1 (5)**	**SM00 (6)**	**(5)/(6) (%)**
1973	4.30	4.30	100.00	10.11	10.11	100.00	1.99	1.99	100.00
1974	4.27	4.27	100.00	10.17	10.17	100.00	2.06	2.06	100.00
1975	4.31	4.29	100.38	10.20	10.20	100.00	2.13	2.10	101.40
1976	4.30	4.26	100.98	10.39	10.39	100.00	2.20	2.18	101.24
1977	4.30	4.24	101.51	10.45	10.45	100.00	2.26	2.32	97.75
1978	4.33	4.27	101.49	10.55	10.33	102.19	2.32	2.43	95.43
1979	4.78	4.73	101.06	10.56	10.24	103.15	2.37	2.48	95.59
1980	5.19	5.23	99.25	10.57	10.33	102.29	2.38	2.50	95.29
1981	5.48	5.52	99.32	10.58	10.34	102.35	2.42	2.60	92.95
1982	5.71	5.78	98.73	10.59	10.24	103.39	2.50	2.73	91.55
1983	5.66	5.74	98.56	10.60	10.27	103.17	2.62	2.88	91.10
1984	5.79	5.84	99.14	10.61	10.34	102.53	2.75	3.03	90.73
1985	5.90	6.04	97.76	10.62	10.35	102.54	2.88	3.11	92.69
1986	6.05	6.12	98.83	10.62	10.37	102.47	3.02	3.27	92.20
1987	6.33	6.40	99.00	10.63	10.42	102.08	3.16	3.50	90.26
1988	6.39	6.50	98.43	10.64	10.32	103.11	3.33	3.67	90.69
1989	6.58	6.62	99.47	10.65	10.44	102.00	3.50	3.84	91.17
1990	6.68	6.86	97.31	10.66	10.68	99.83	3.68	3.89	94.51

Table 7-6 *Within sample* simulation (SM1)

	deb			dnoy			dpd		
obs	**SM1 (1)**	**SM00 (2)**	**(1)/(2) (%)**	**SM1 (3)**	**SM00 (4)**	**(3)/(4) (%)**	**SM1 (5)**	**SM00 (6)**	**(5)/(6) (%)**
1973	0.02	0.02	100.00	0.09	0.09	100.00	0.09	0.09	100.00
1974	-0.03	-0.03	99.99	0.06	0.06	100.00	0.07	0.07	100.00
1975	0.04	0.03	165.90	0.03	0.03	100.00	0.07	0.04	169.25
1976	-0.01	-0.03	16.44	0.19	0.19	100.00	0.07	0.07	96.76
1977	0.00	-0.03	12.81	0.06	0.06	100.00	0.06	0.14	44.10
1978	0.03	0.03	98.91	0.10	-0.12	-84.64	0.06	0.11	48.42
1979	0.44	0.46	97.04	0.01	-0.09	-10.05	0.05	0.05	103.51
1980	0.42	0.51	82.30	0.01	0.09	9.29	0.01	0.01	41.32
1981	0.29	0.28	100.65	0.01	0.00	352.14	0.04	0.10	36.07
1982	0.23	0.27	86.54	0.01	-0.10	-9.21	0.08	0.13	63.66
1983	-0.05	-0.04	121.85	0.01	0.03	29.01	0.12	0.15	82.94
1984	0.13	0.10	133.37	0.01	0.07	12.04	0.13	0.15	83.53
1985	0.11	0.20	57.17	0.01	0.01	114.33	0.13	0.08	169.46
1986	0.15	0.08	178.08	0.01	0.01	59.28	0.14	0.16	82.95
1987	0.28	0.28	102.87	0.01	0.05	18.14	0.14	0.23	62.74
1988	0.06	0.10	60.91	0.01	-0.10	-9.19	0.17	0.17	99.60
1989	0.19	0.12	155.27	0.01	0.12	7.26	0.17	0.17	101.65
1990	0.09	0.24	38.78	0.01	0.24	3.73	0.18	0.05	332.39
Mean	13%	14%		3.6%	3.7%		10%	11%	

Figure 7-11 *Within sample* simulation (SM1): BMER (log level)

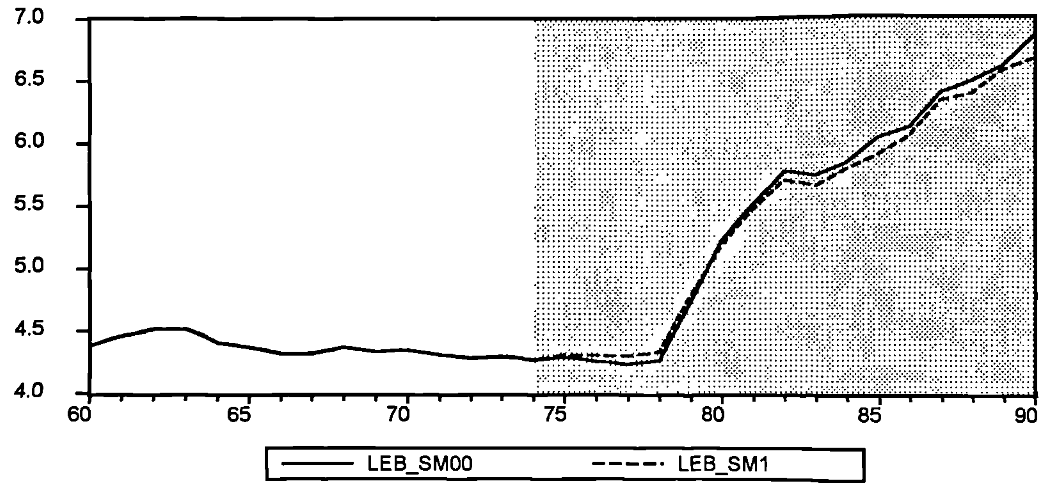


Figure 7-12 *Within sample* simulation (SM1): lack of oil shock since 1974, CPI (log level)

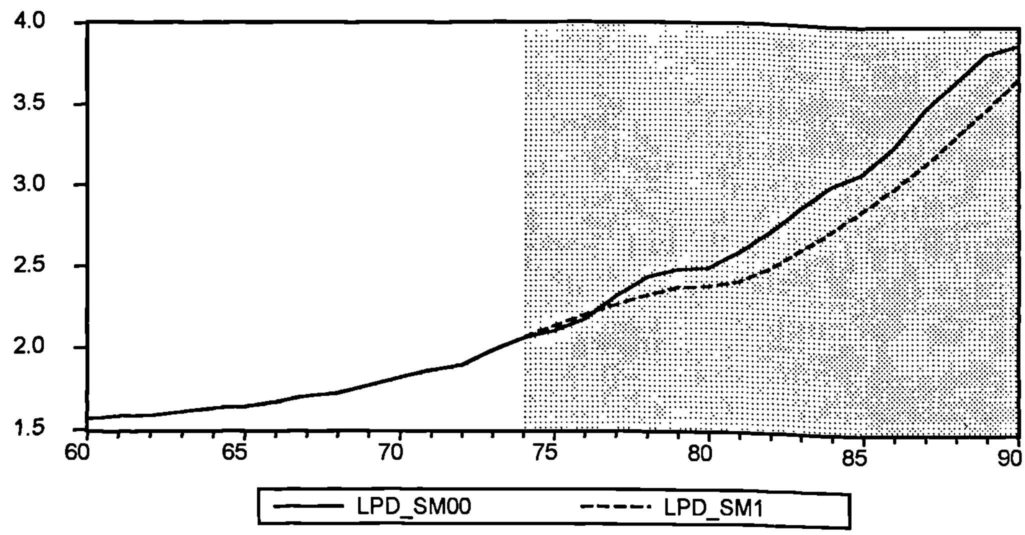


Figure 7-13 *Within sample* simulation (SM1): lack of oil shock since 1974, RBMER (log level)

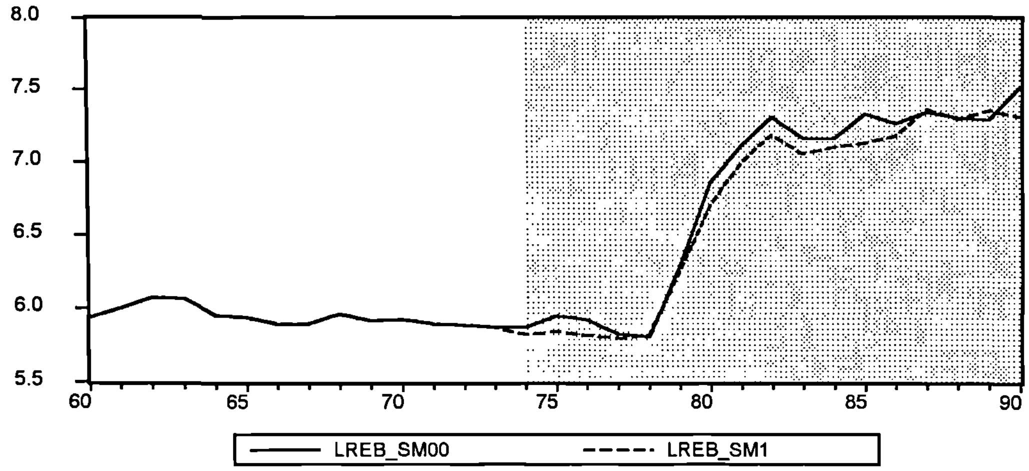


Figure 7-14 *Within sample* simulation (SM1): lack of oil shock since 1974, BMER (first difference)

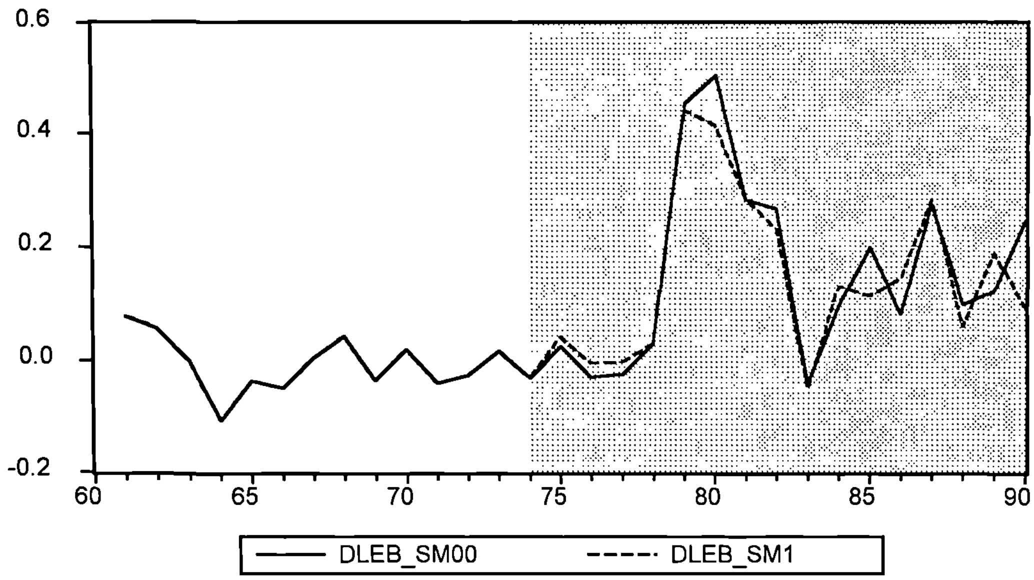


Figure 7-15 *Within sample* simulation (SM1): lack of oil shock since 1974, CPI (first difference)

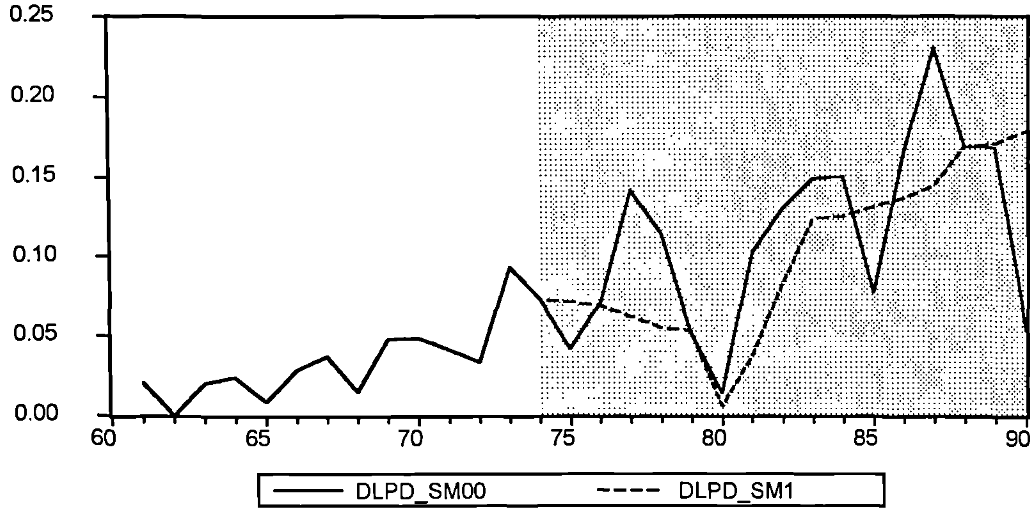
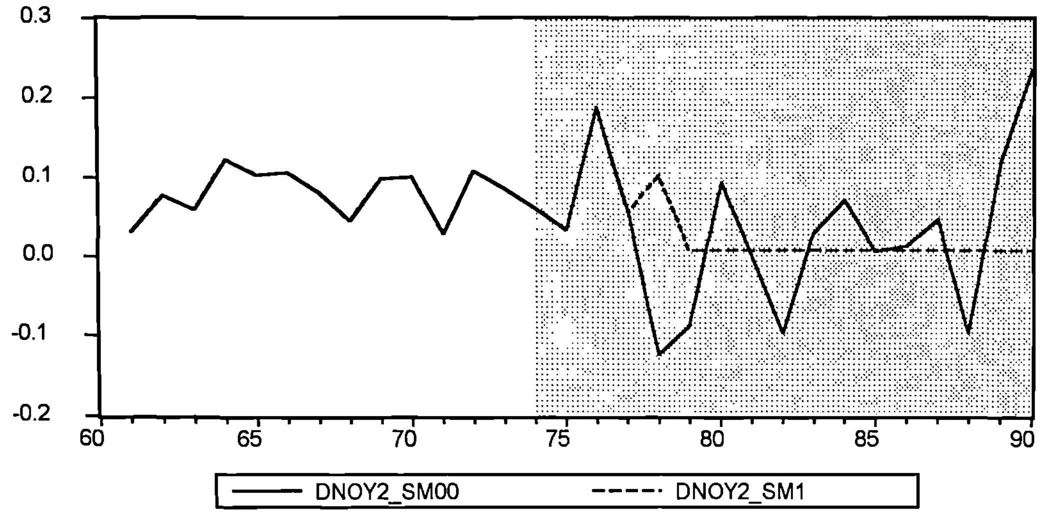


Figure 7-16 *Within sample* simulation (SM1): lack of oil shock since 1974, rate of growth of non-oil real gdp



Under the SM4 scenario, we inject the whole oil revenues absorbed in 1974-1990 period by a steady growth rate instead of observed volatile rates[5]. The intention concerned to this assumption is that if the state, instead of pursuing a year-to-year managed strategy - dependent on the oil fortune[6] and spending oil revenue based on annual earned revenue, follows a stable policy spending oil revenues during the whole respected period, what are the likely outcomes that would emerge[7]. Following implementing this policy inflation rate starts to slow down in 1979 after a jump in 1975 and 1976 (Table 7.8). This notable slow down in 1977 may be attributed to the earlier appreciation in rial value in 1976 and that the negative effect of oil revenue on inflation is spread over many periods. Another result to emerge from this simulation is that prices and exchange rates move appropriately so that changes in competitiveness (real exchange rate) are approximately the same in simulated and in the base path results. There is a huge fall in the value of rial in 1978 and consequently a gain in competitiveness during the five years (till 1983) after the accomplishment of this

[5]Within a 14-year period after the revolution, global oil market went from boom to bust , and bust to boom. Crude oil prices tripled during the first year of the revolution, fell to one-fifth of the early peak in 1986, and shot up again near the early 1980 level after the Persian Gulf war, before settling down to a mid-range between the two extremes.

[6]The necessity of pursuing a year-to-year *managed* strategy -dependent on the oil fortune- resulted in a public mode of action and policy formulation based on what may be called ' expedient discrimination '. This strategy manifested itself in : establishing a dozen different exchange rates for different categories of imports; granting various types and amounts of subsidies to domestic social-economic procedures; setting up different foreign exchange quotas for various industries, activities and institutions; designating different rates and volumes of foreign exchange surrender obligations for non-oil exports; offering different price subsidies to essential consumer goods; allowing different permissions to certain privileged business operators; and guaranteeing arbitrary protection of property rights belonging to different groups and individuals. (see chapter 2)

[7]Rajapatirana in his comments on Edwards (1986) argues that if an export boom is temporary, a fiscal policy through budget surpluses during the boom and through deficit during the slump to stabilise the economy is all the more important if export revenues accrue to the government and if monetary policy is ineffective. With aggregate expenditure policies, the government can aim directly at the source of the disturbance...[p. 265]

policy. The gain in competitiveness is sustained by the failures of prices to rise substantially to offset the fall in rial value. The simulated results indicate that utilising the oil revenues on a steady rate would result in smoother inflation, and non-oil real gdp growth (see Table 7.7 and 7.8). The level of non-oil real gdp, however, keeps higher in simulated results compared to the base path results for most of the respected period (Figure 7.18 and Table 7.8) Under the SM4 scenario a more gradual increase in oil revenues would result in a slower growth of non-oil real gdp; the average growth of non-oil real gdp would be 1.89% as compared to the base path of 3.6% (Table 7.8). The lower growth of output would be accompanied by a lower inflation rate; the average inflation in consumer price index would be 10%, as compared to the average base path of 11% (Table 7-8). Exchange rate depreciation does not show a significant deviation from its base path.

Table 7-7 *Within sample* simulation (SM4)

	e_b			p^d			noy		
obs	SM4 (1)	SM00 (2)	(1)/(2) (%)	SM4 (3)	SM00 (4)	(3)/(4) (%)	SM4 (5)	SM00 (6)	(5)/(6) (%)
1973	4.300	4.300	100.00	1.988	1.988	100.00	10.107	10.107	100.00
1974	4.268	4.268	100.00	2.061	2.061	100.00	10.169	10.169	100.00
1975	4.293	4.293	100.00	2.186	2.104	103.92	10.203	10.203	100.00
1976	4.288	4.263	100.59	2.312	2.175	106.29	10.392	10.392	100.00
1977	4.286	4.237	101.15	2.420	2.317	104.43	10.450	10.450	100.00
1978	4.324	4.269	101.29	2.507	2.432	103.10	10.531	10.327	101.96
1979	4.784	4.725	101.24	2.578	2.483	103.82	10.516	10.240	102.69
1980	5.232	5.231	100.03	2.597	2.498	103.99	10.502	10.335	101.62
1981	5.531	5.515	100.28	2.666	2.600	102.51	10.488	10.337	101.45
1982	5.783	5.783	99.991	2.775	2.731	101.62	10.473	10.242	102.26
1983	5.747	5.742	100.08	2.904	2.880	100.82	10.459	10.272	101.82
1984	5.886	5.840	100.79	3.016	3.030	99.540	10.445	10.345	100.96
1985	6.0219	6.0393	99.711	3.1248	3.1076	100.55	10.430	10.352	100.75
1986	6.1704	6.1209	100.80	3.2368	3.2724	98.912	10.416	10.367	100.47
1987	6.4756	6.3972	101.22	3.3217	3.5032	94.819	10.401	10.415	99.865
1988	6.5353	6.4953	100.61	3.4432	3.6727	93.751	10.387	10.320	100.65
1989	6.7199	6.6163	101.56	3.5696	3.8411	92.933	10.373	10.441	99.350
1990	6.8191	6.8606	99.395	3.7131	3.8949	95.332	10.359	10.676	97.024

Table 7-8 *Within sample* simulation (SM1)

	Δe_b			Δp^d			Δnoy		
obs	**SM4 (1)**	**SM00 (2)**	**(1)/(2) (%)**	**SM4 (3)**	**SM00 (4)**	**(3)/(4) (%)**	**SM4 (5)**	**SM00 (6)**	**(5)/(6) (%)**
1973	0.017	0.017	100.00	0.093	0.093	100.00	0.087	0.087	100.00
1974	-0.032	-0.032	99.991	0.073	0.073	100.00	0.062	0.062	100.00
1975	0.025	0.025	100.00	0.125	0.042	294.65	0.035	0.035	100.00
1976	-0.005	-0.030	16.119	0.126	0.072	176.19	0.188	0.188	99.999
1977	-0.002	-0.025	7.702	0.107	0.142	75.761	0.058	0.058	100.00
1978	0.038	0.031	120.67	0.087	0.115	76.296	0.081	-0.123	-65.807
1979	0.460	0.457	100.75	0.071	0.052	137.40	-0.014	-0.087	16.326
1980	0.448	0.506	88.683	0.019	0.014	134.26	-0.014	0.095	-15.083
1981	0.298	0.284	104.89	0.068	0.103	66.493	-0.014	0.002	-571.97
1982	0.252	0.268	94.027	0.109	0.130	83.919	-0.014	-0.095	14.957
1983	-0.036	-0.041	86.890	0.128	0.149	86.141	-0.014	0.030	-47.117
1984	0.139	0.097	142.60	0.113	0.150	74.961	-0.014	0.073	-19.558
1985	0.136	0.200	68.077	0.109	0.078	140.19	-0.014	0.008	-185.69
1986	0.149	0.082	181.87	0.112	0.165	67.956	-0.014	0.015	-96.275
1987	0.305	0.276	110.44	0.085	0.231	36.780	-0.014	0.048	-29.456
1988	0.060	0.098	60.861	0.121	0.169	71.663	-0.014	-0.096	14.921
1989	0.185	0.121	152.59	0.126	0.168	75.107	-0.014	0.121	-11.798
1990	0.099	0.244	40.631	0.143	0.054	266.47	-0.014	0.236	-6.064
Mean	14%	14%		10%	11%		1.89%	3.64%	
Max.	46%	51%		14%	23%		20%	23.6%	
Min.	-3.6%	-4.1%		2%	1.4%		-1.4%	-12%	

Figure 7-17 *Within sample* simulation (SM4): constant growth rate in oil revenue since 1974, BMER (log level)

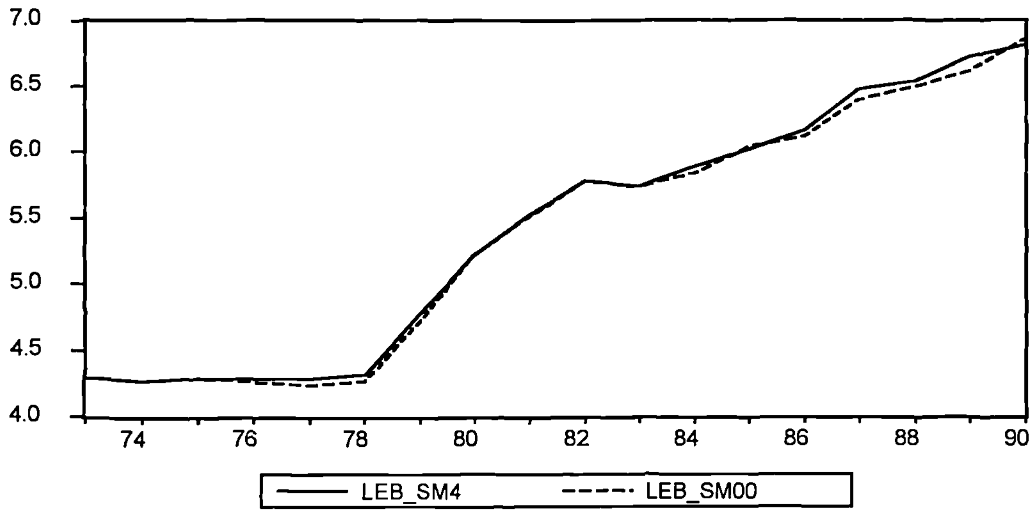


Figure 7-18 *Within sample* simulation (SM4): constant growth rate in oil revenue spending since 1974, real non-oil gdp (log level)

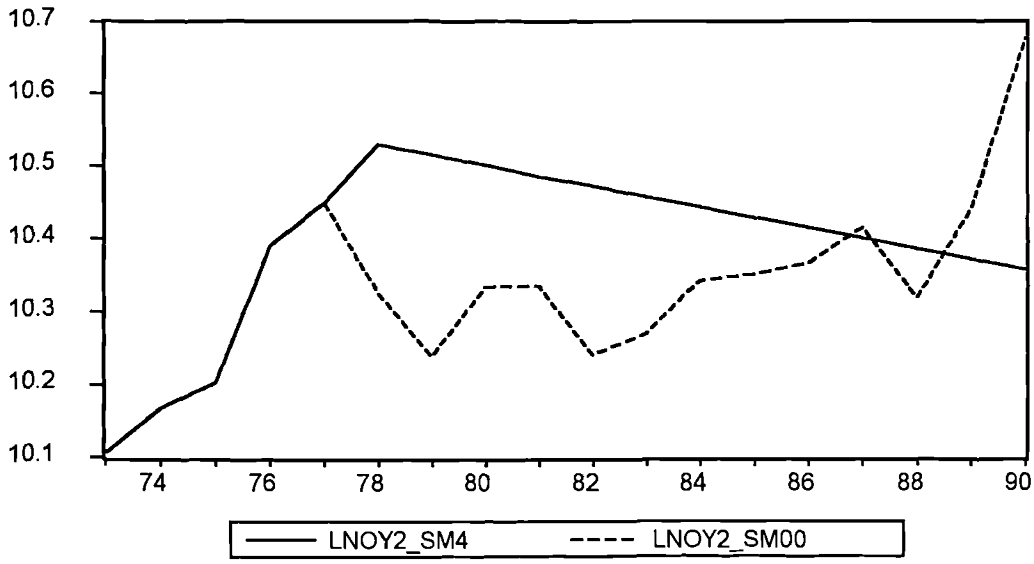


Figure 7-19 ***Within sample*** **simulation (SM4): constant growth rate in oil revenue since 1974, CPI (log level)**

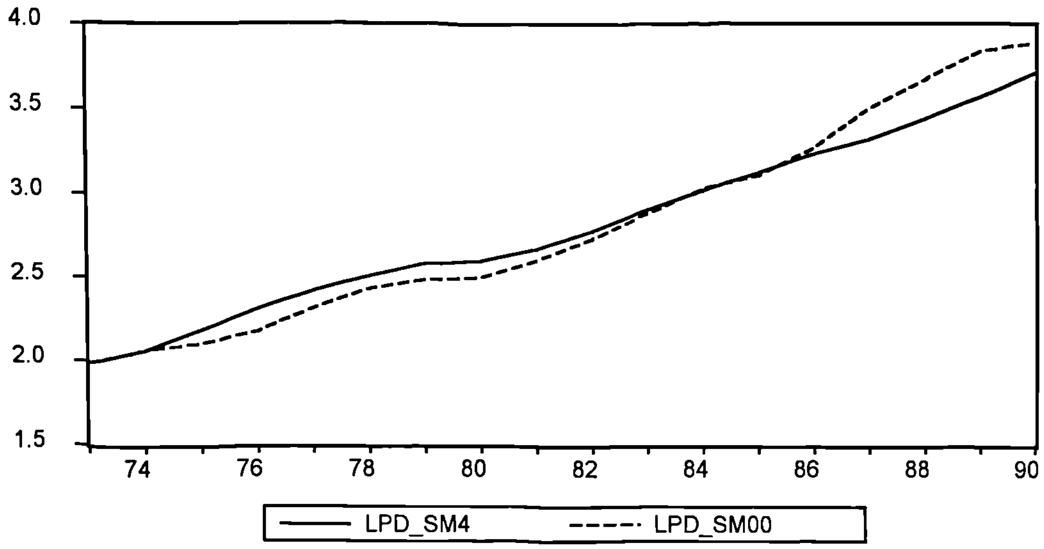


Figure 7-20 ***Within sample*** **simulation (SM4): constant growth rate in oil revenue since 1974, BMER (first difference)**

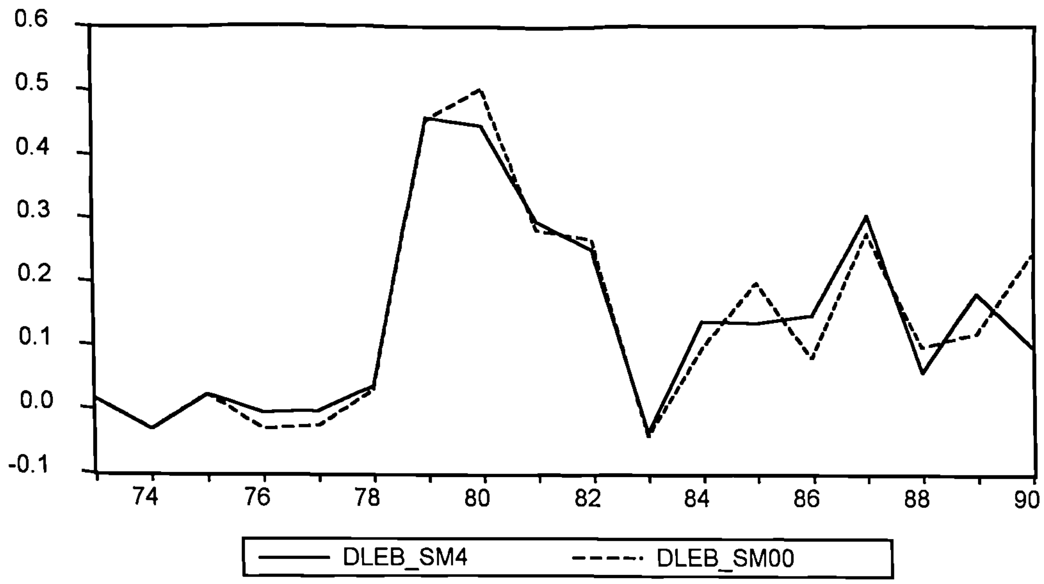


Figure 7-21 ***Within sample*** **simulation (SM4): constant growth rate in oil revenue since 1974, rate of growth of non-oil real gdp.**

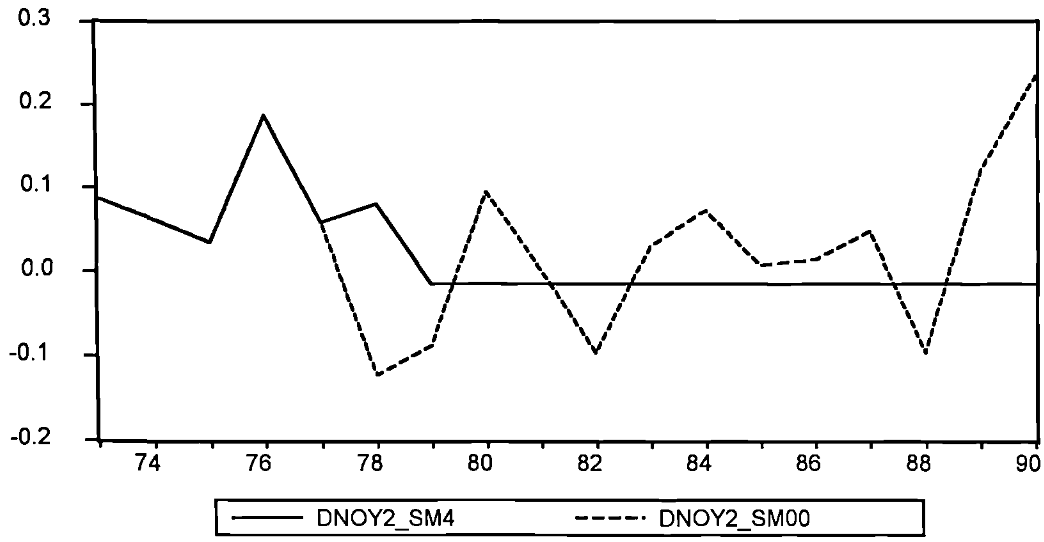
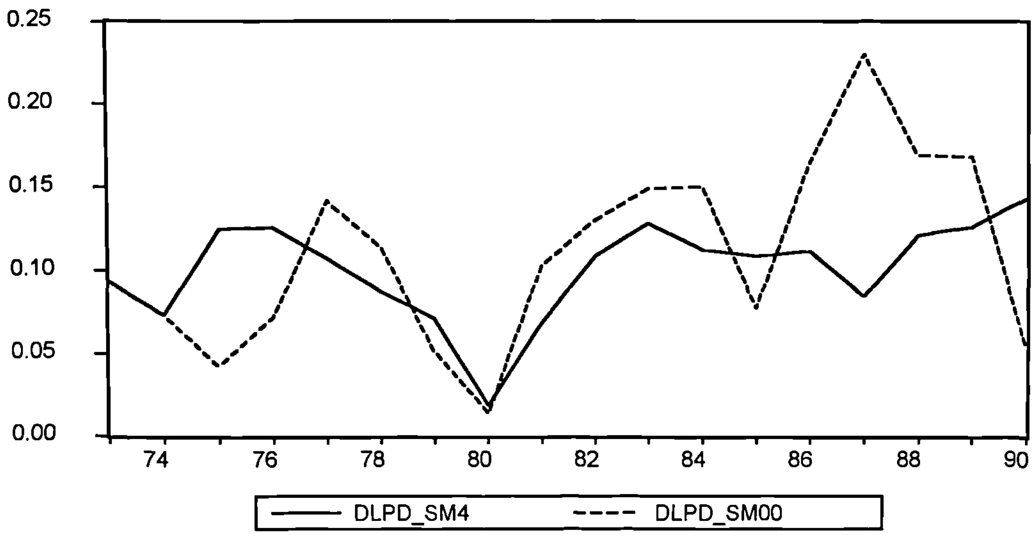


Figure 7-22 ***Within sample*** **simulation (SM4): constant growth rate in oil revenue since 1974, CPI (first difference)**



7.4 Out of Sample Dynamic Simulation (ex ante simulation)

We experimented with three alternative scenarios from the year 1991. The three alternatives are: a 100% increase in oil revenue and oil prices, sustained throughout the simulation run (1999) (SM7); a 100% increase in oil revenue and prices in 1991 which dies out gradually so that in the end of the simulation period oil revenue and oil price take the values of 1990 (SM6); and finally oil revenues and oil prices are kept constant at 1990 values during the simulation run (SM5). We imposed these scenarios through following expressions:

1. **SM5**. No oil shock since 1990. (oil revenues and oil prices constant at 1990 levels)
2. **SM6**. Temporary oil shock since 1990. *oil(sm6) = (1+(9-t)/8)*oil(90); oilp(sm6) = (1+(9-t)/8)*oilp(90);* where *t* shows the trend
3. **SM7**. Permanent oil shock since 1990. *oil(sm7) = 2*oil(90); oilp(sm7) = 2*oilp(90).*

Following a 100% increase in revenue and price of oil (SM6 and SM7), CPI increases by about 9% in 1992 compared to 12% concerned to no oil shock case (SM5) (Table 7.9). But after 3 years (from 1993) inflation rates in SM6 and SM7 cases exceeds the inflation rate in SM5 scenario (Table 7.9). This is explained by the negative effects of oil revenue on inflation in the early years, being dominated by the effects on foreign prices in later years. On average the no oil shock produce the best growth performance.

Table 7-9 Out of *sample* simulation (SM5, SM6 and SM7)

	de_b			dp^d			dnoy		
obs	**SM5**	**SM6**	**SM7**	**SM5**	**SM6**	**SM7**	**SM5**	**SM6**	**SM7**
1991	0.087	0.087	0.087	0.112	0.112	0.112	-0.044	-0.044	-0.044
1992	0.343	0.368	0.368	0.122	0.094	0.094	0.032	0.032	0.032
1993	-0.049	-0.059	-0.057	0.156	0.167	0.164	-0.208	-0.208	-0.208
1994	0.288	0.293	0.295	0.151	0.170	0.168	0.027	0.027	0.027
1995	0.089	0.087	0.089	0.170	0.186	0.185	0.009	-0.113	-0.113
1996	0.035	0.023	0.026	0.173	0.183	0.184	0.009	0.020	0.009
1997	0.322	0.340	0.342	0.163	0.167	0.168	0.009	0.021	0.009
1998	-0.067	-0.079	-0.074	0.182	0.183	0.186	0.009	0.022	0.009
1999	0.286	0.293	0.297	0.167	0.165	0.167	0.009	0.023	0.009
Mean	0.148	0.150	0.152	0.155268	0.158463	0.158589	-0.016501	-0.024420	-0.030039
Max.	0.343	0.368	0.367	0.182359	0.185698	0.185548	0.031976	0.031976	0.031976
Mini.	-0.067	-0.079	-0.074	0.112220	0.093745	0.093745	-0.207815	-0.207815	-0.207815

Table 7-10 Out of *sample* simulation (SM5, SM6 and SM7)

	e_b			p^d			noy			re_b		
obs	**SM5**	**SM6**	**SM7**	**SM5**	**SM6**	**SM7**	**SM5**	**SM6**	**SM7**	**SM5**	**SM6**	**SM7**
1991	7.33	7.33	7.33	4.72	4.72	4.72	10.56	10.56	10.56	7.25	7.28	7.28
1992	7.67	7.70	7.70	4.84	4.81	4.81	10.60	10.60	10.60	7.52	7.62	7.62
1993	7.63	7.64	7.64	5.00	4.98	4.98	10.39	10.39	10.39	7.36	7.44	7.45
1994	7.91	7.93	7.94	5.15	5.15	5.14	10.42	10.42	10.42	7.54	7.61	7.63
1995	8.00	8.02	8.03	5.32	5.33	5.33	10.42	10.30	10.30	7.50	7.56	7.59
1996	8.04	8.04	8.05	5.49	5.52	5.51	10.43	10.32	10.31	7.40	7.43	7.48
1997	8.36	8.38	8.39	5.65	5.68	5.68	10.44	10.34	10.32	7.60	7.64	7.70
1998	8.29	8.30	8.32	5.84	5.87	5.87	10.45	10.36	10.33	7.40	7.41	7.48
1999	8.58	8.60	8.62	6.00	6.03	6.03	10.46	10.39	10.34	7.56	7.57	7.66

Figure 7-23 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

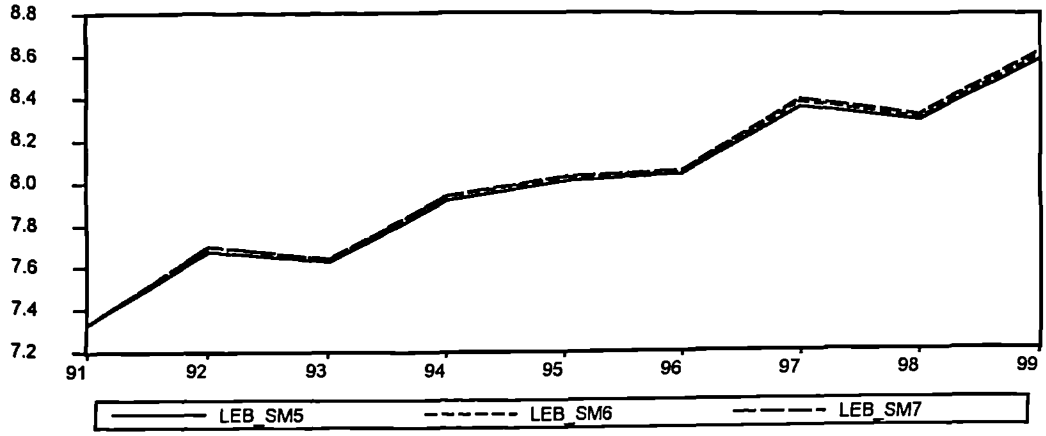


Figure 7-24 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

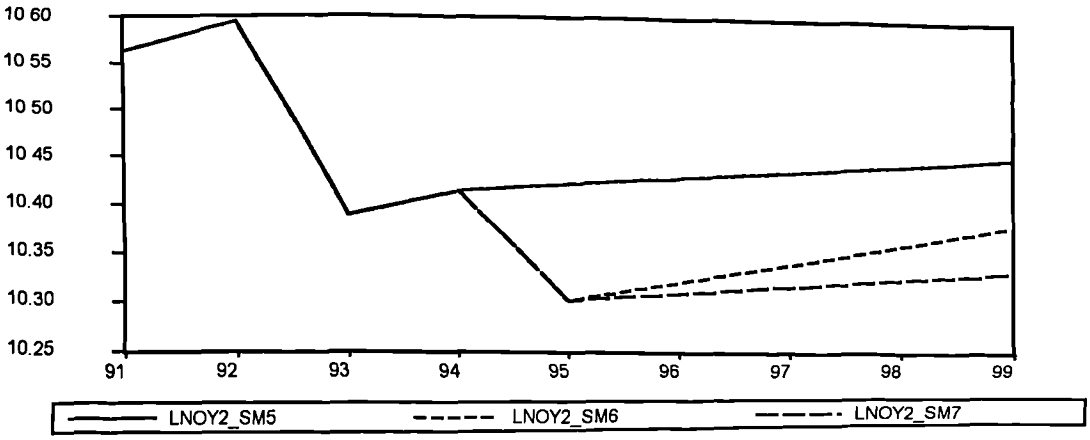


Figure 7-25 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

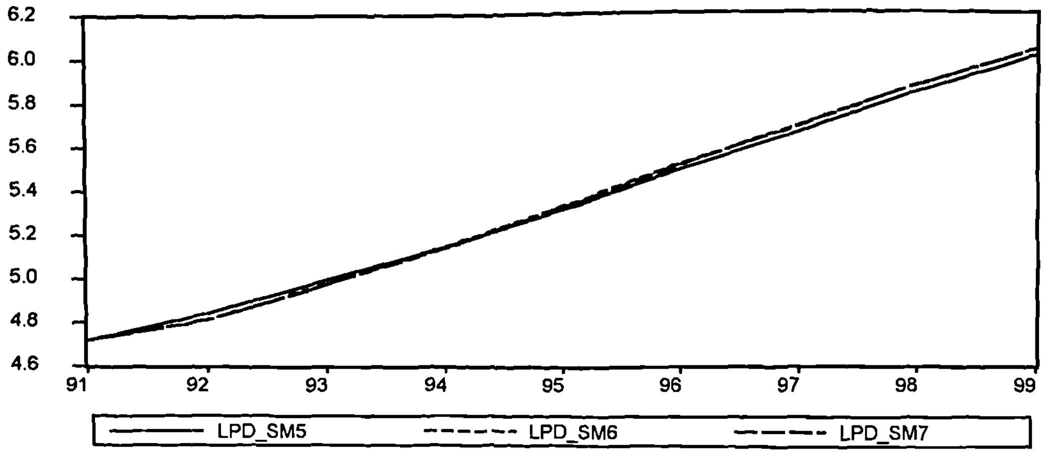


Figure 7-26 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

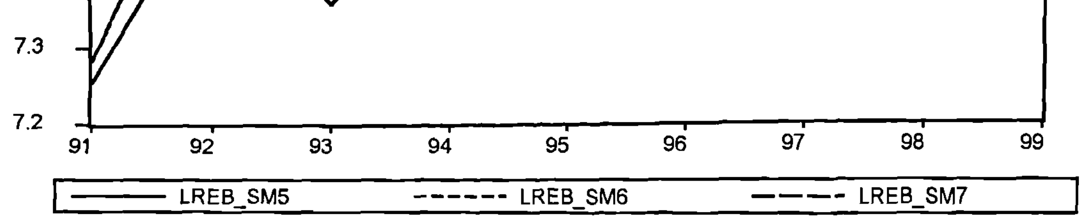


Figure 7-27 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

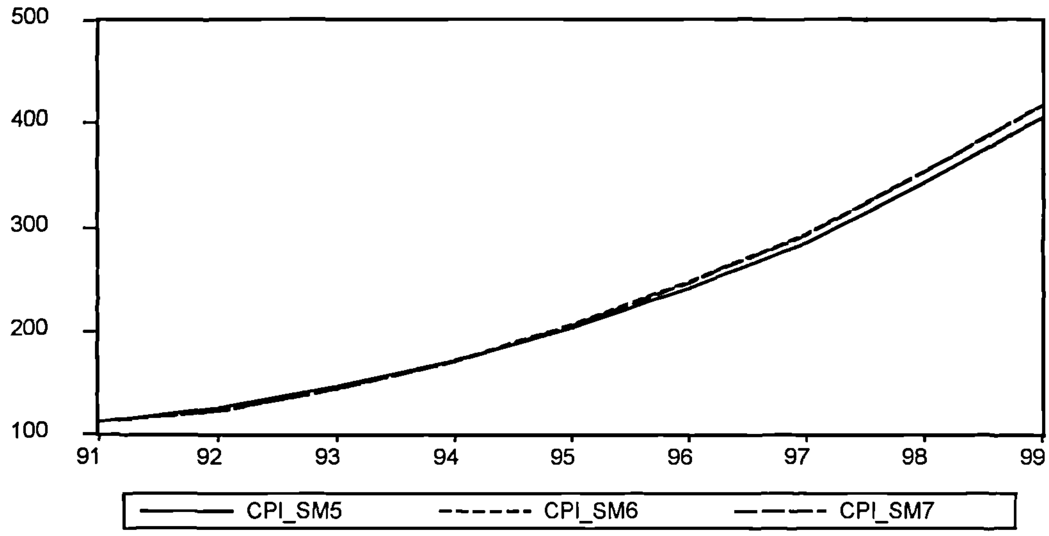


Figure 7-28 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

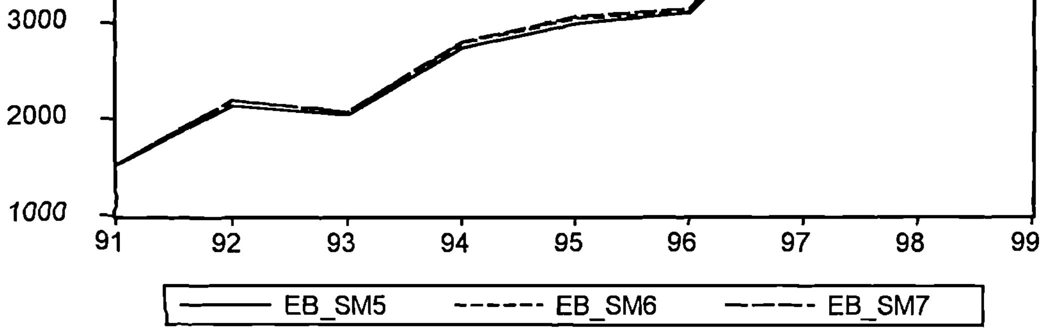


Figure 7-29 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

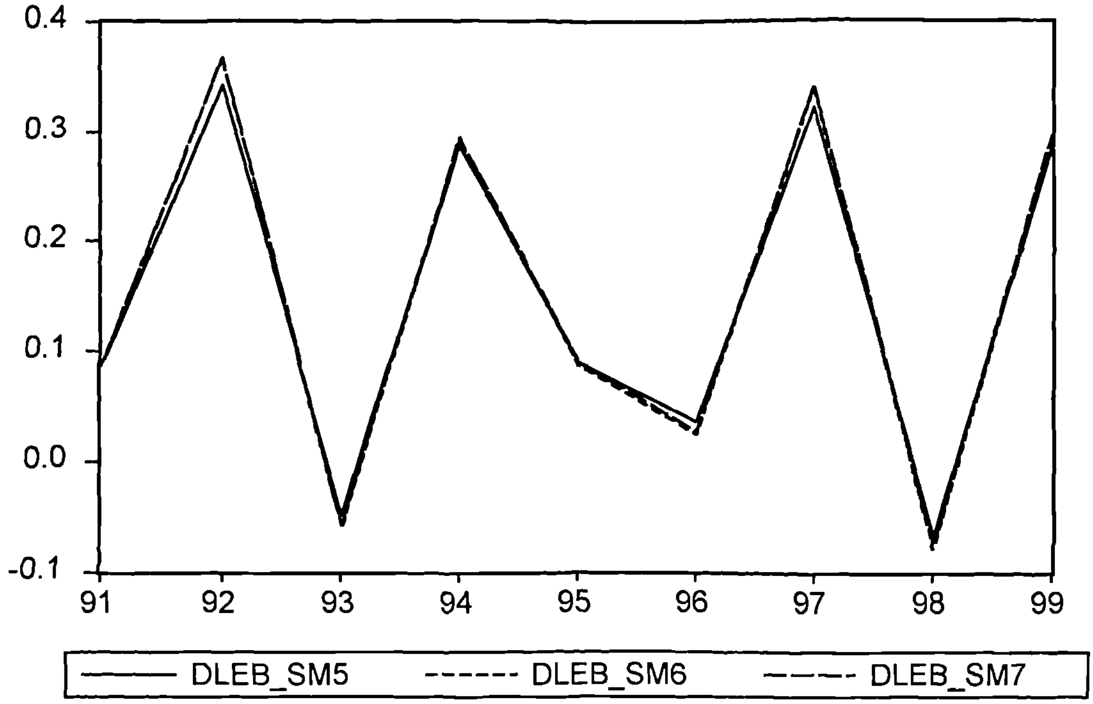


Figure 7-30 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.

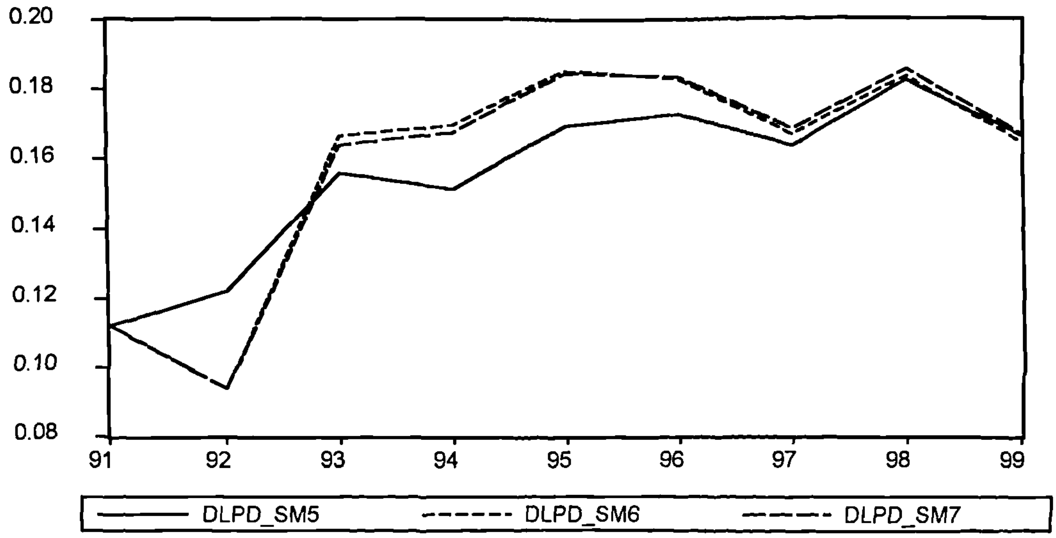
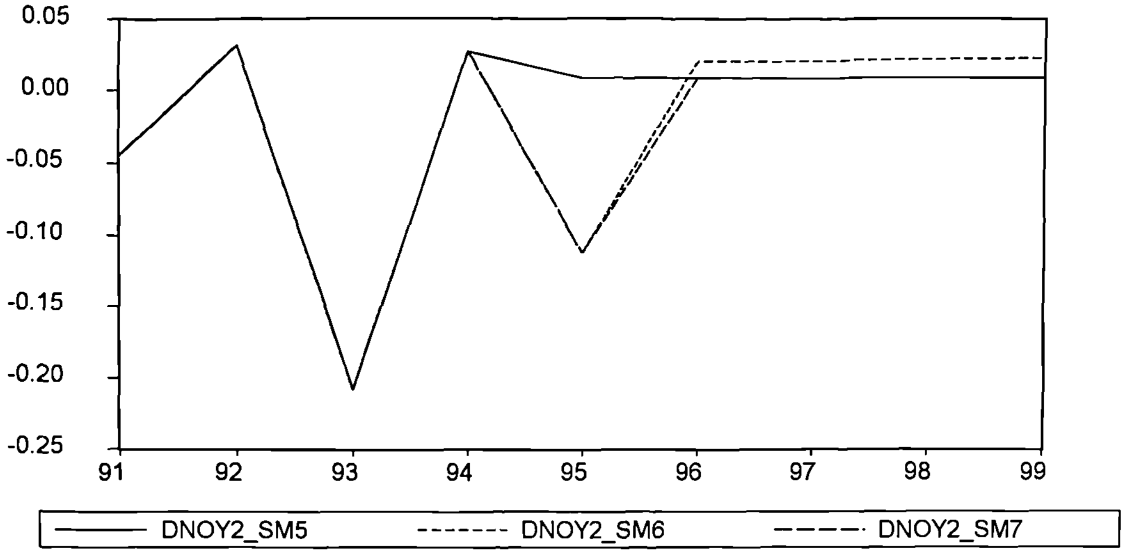


Figure 7-31 Out of sample dynamic simulation 1991 1999: absence, temporary and permanent oil shocks since 1990.



7.5 Conclusion

Restimating of the complete model as a system (excluding money demand equation) using SUR (seemingly unrelated regression) method produced more precise results. We found that the jointly estimated models appear more precise with mainly lower standard errors. Consequently, these results were chosen to undertake the simulation exercise. Judging from the tracking performance of the model and the simulation exercise, we concluded that the proposed framework does not suffer from any serious degree of misspecification.

The tracking performance of the equations seems reasonable. RMS (root-mean-square) percent error, mean simulation error and mean percent errors were calculated for all the endogenous variables and are generally indicative of the sensible performance of the models. The evidence points to the non-oil real gdp as the worst fitting equation, unsurprisingly perhaps. Looking at the graphic representation for the non-oil real gdp, there is a notable deviation of the simulated from the actual series during the 1970s. The remaining three equations, namely black market exchange rate, domestic and foreign prices, achieved impressive tracking records. The exchange rate equation tracks the actual values during pre and post-revolution periods well. Apart from a few data points, the equations reproduced the historical data with a high degree of precision. However, in several cases the turning points fail to be reproduced. Obviously, many of these failures are attributed to non-economic factors which affected the Iranian economy during the past two decades (see chapter 2).

Simulation results for alternative *within sample* scenarios, designated by 'no oil shock since 1973' (SM1) and 'smoothed oil revenue spending' (SM4) and their comparison with the previous dynamic simulation based on actual oil revenues (base path), enable us to isolate the impact of the oil shocks on the economy. The results of these experiments are shown in Figures 7.11 to 7.16 and Tables 7.5 to 7.6 (for SM1) and Figures 7.17 to 7.22 and Tables 7.7 to 7.8 (for SM4).

Following the removal of oil shocks since 1973/74, CPI moves approximately on the same trend as the *base path* (SM00) but at a lower level, so that by the end of period the level of simulated prices are lower than the base path values. Comparing these two set of results emerges also that average inflation differ about 1% (10% against 11%;

see Table 7.6). This is explained by the lower foreign inflation rate and that after the revolution the Rial depreciates less. A comparison of SM1 and SM00 results also revealed that an increase in oil revenues initially results in lower inflation rates without inducing higher rates of non-oil real gdp.

By smoothing the spending of oil revenue since 1973 (SM4), inflation rate starts to slow down in 1977 after a jump in 1975 and 1976 (Table 7.8; Figure 7.22). This notable slow down in 1977 may be attributed to the earlier appreciation in Rial value in 1976 and that the negative effect of oil revenue on inflation is spread over many periods. There is a huge fall in the value of Rial in 1978 and consequently a gain in competitiveness during the five years (till 1983) after the accomplishment of this policy. The gain in competitiveness is sustained by the failures of prices to rise to offset the fall in value of the Rial.

The simulated results indicate that utilising the oil revenues at a steady rate (SM4) would result in smoother inflation, and non-oil real gdp growth (see Table 7.7 and 7.8). The level of non-oil real gdp, however, stays higher in simulated results compared to the base path results for most of the period (Figure 7.18 and Table 7.8). From 1988, base path values exceed the simulated values very fast. A policy of 'more stable spending of oil revenue', hence, would lead to a lower inflation rate (10% against 11%) accompanied with a lower growth rate of non-oil real gdp (1.9% against 3.6%).

Three alternatives *out of sample* simulation (1991-1999) scenarios: '*no oil shock since 1990*' (SM5); '*temporary oil shock in 1991*' (SM6) and '*permanent oil shock in 1991*' (SM7), were conducted. Following a 100% increase in revenue and price of oil, temporarily or permanently (SM6 and SM7), CPI increases by about 9% in 1992 compared to 12% in no oil shock case (SM5) (Table 7.9). But from 1993 inflation is lowest in SM5 (Table 7.9). This is explained by the negative effects of oil revenue on inflation in the early years, being dominated by the effects on foreign prices and a depressed exchange rate in later years.

These confirm our previous conclusion that an oil boom would alleviate inflation in short run, in a longer horizon, however, opposite forces, namely higher foreign inflation and exchange rate depreciation generated by oil boom, put upward pressure on inflation.

7.6 Appendix 1

Table 7-11 projection of oil revenues and oil prices: actual values against SM1 and SM4 alternatives

obs	Index of Oil prices			Oil Revenues: B. rials		
	Actual	**SM1**	**SM4**	**Actual**	**SM1**	**SM4**
1960	5.4000	5.4000	5.4000	54.8000	54.8000	54.8000
1961	5.4000	5.4000	5.4000	54.7000	54.7000	54.7000
1962	5.4000	5.4000	5.4000	53.5000	53.5000	53.5000
1963	5.4000	5.4000	5.4000	60.5000	60.5000	60.5000
1964	5.4000	5.4000	5.4000	84.0000	84.0000	84.0000
1965	5.4000	5.4000	5.4000	86.2000	86.2000	86.2000
1966	5.4000	5.4000	5.4000	87.0000	87.0000	87.0000
1967	5.4000	5.4000	5.4000	132.4000	132.4000	132.4000
1968	5.4000	5.4000	5.4000	127.9000	127.9000	127.9000
1969	5.4000	5.4000	5.4000	140.7000	140.7000	140.7000
1970	5.4000	5.4000	5.4000	178.6000	178.6000	178.6000
1971	6.7000	6.7000	6.7000	264.7000	264.7000	264.7000
1972	7.4000	7.4000	7.4000	163.8000	163.8000	163.8000
1973	9.9000	9.9000	9.9000	212.0000	212.0000	212.0000
1974	36.3000	9.9000	36.3000	767.9200	211.9999	241.7436
1975	38.9000	9.9000	38.9000	1328.0000	211.9999	275.6602
1976	41.4000	9.9000	41.4000	814.6300	211.9999	314.3354
1977	45.6000	9.9000	45.6000	844.3400	211.9999	358.4366
1978	45.6000	9.9000	45.6000	1528.2000	211.9999	408.7253
1979	68.9000	9.9000	68.9000	1352.1000	211.9999	466.0694
1980	121.9000	9.9000	121.9000	938.2000	211.9999	531.4590
1981	130.0000	9.9000	130.0000	944.1000	211.9999	606.0226
1982	109.2000	9.9000	109.2000	912.2000	211.9999	691.0476
1983	101.2000	9.9000	101.2000	727.8000	211.9999	788.0016
1984	99.3000	9.9000	99.3000	1319.0000	211.9999	898.5582
1985	100.0000	9.9000	100.0000	696.4000	211.9999	1024.6260
1986	48.9000	9.9000	48.9000	191.7000	211.9999	1168.3810
1987	64.4000	9.9000	64.4000	259.0000	211.9999	1332.3048
1988	55.1000	9.9000	55.1000	227.0000	211.9999	1519.2272
1989	58.4000	9.9000	58.4000	778.4000	211.9999	1732.3748
1990	56.0000	9.9000	56.0000	700.0000	211.9999	1975.4270

Figure 7-32 projection of oil revenues: actual values against SM1 and SM4 alternatives

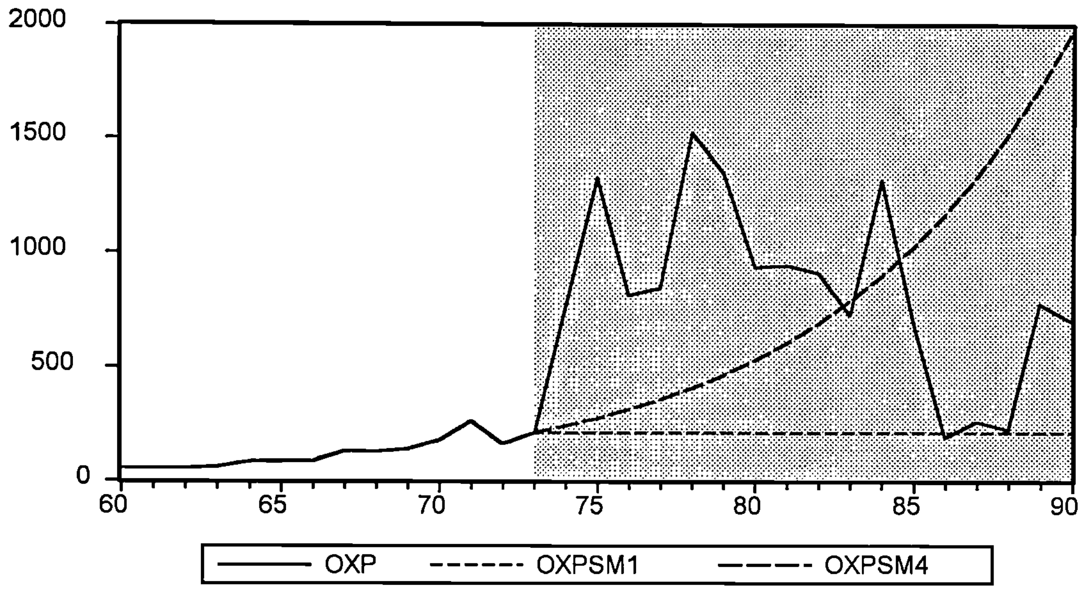
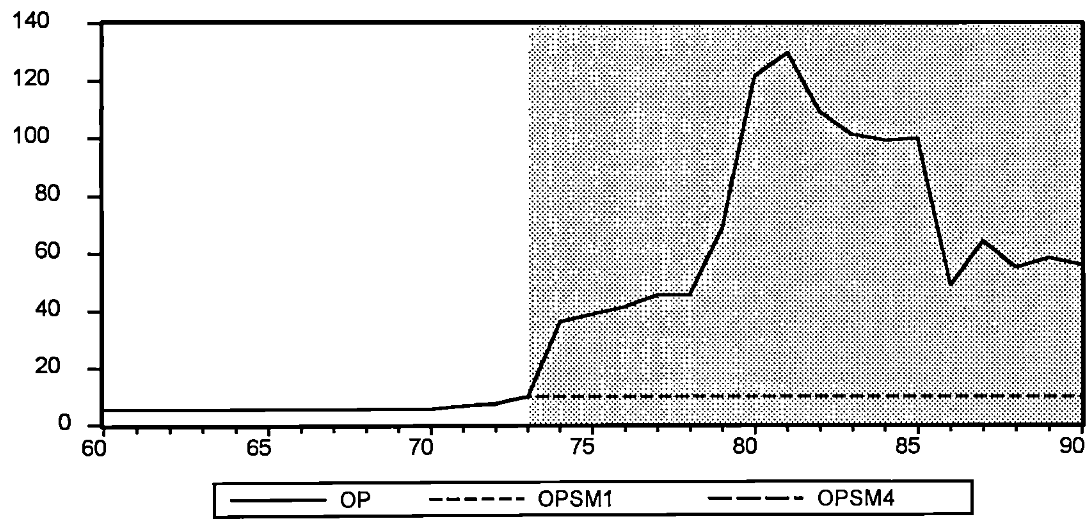


Figure 7-33 projections of oil prices: actual, SM1 and SM4[8]



[8] Oil prices for SM4 case are set equal to actual values. In fact what we propose in this case is redistribution of the same oil revenues absorbed during 1974-1990 period.

Table 7-12 projections of oil revenues and oil prices: actual, SM5, SM6 and SM7								
obs	**Index of Oil prices**				**Oil Revenues B. rials**			
	Actual	**SM5**	**SM6**	**SM7**	**Actual**	**SM5**	**SM6**	**SM7**
1990	56.00	56.00	56.00	56.00	700.00	700.00	700.00	700.00
1991	NA	56.00	112.00	112.00	NA	700.00	1400.00	1400.00
1992	NA	56.00	105.00	112.00	NA	700.00	1312.50	1400.00
1993	NA	56.00	98.00	112.00	NA	700.00	1225.00	1400.00
1994	NA	56.00	91.00	112.00	NA	700.00	1137.50	1400.00
1995	NA	56.00	84.00	112.00	NA	700.00	1050.00	1400.00
1996	NA	56.00	77.00	112.00	NA	700.00	962.50	1400.00
1997	NA	56.00	70.00	112.00	NA	700.00	875.00	1400.00
1998	NA	56.00	63.00	112.00	NA	700.00	787.50	1400.00
1999	NA	56.00	56.00	112.00	NA	700.00	700.00	1400.00

Figure 7-34 projection of oil revenues: SM5, SM6 and SM7

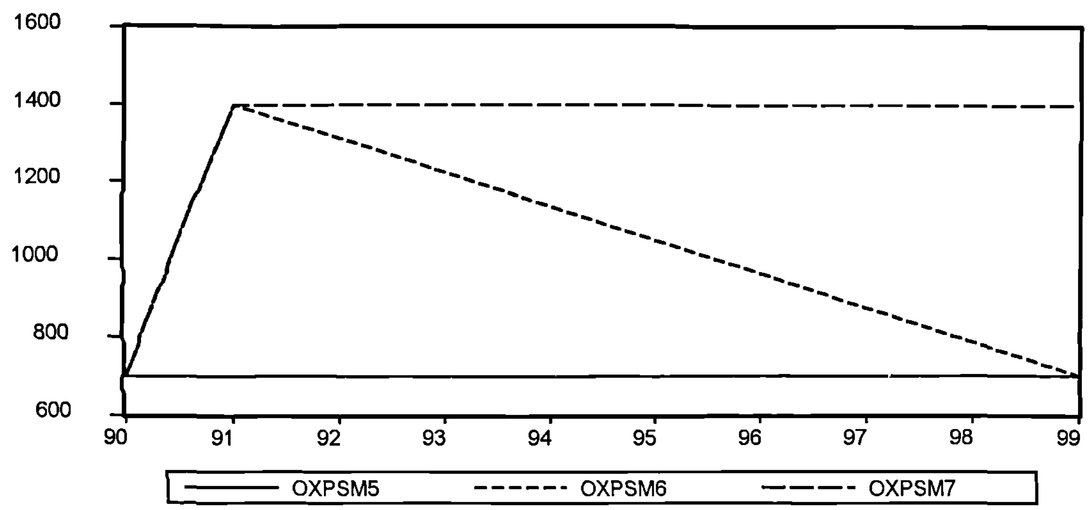


Table 7-13 projection of growth rates of oil revenues and oil prices: actual values against SM1 and SM4 alternatives

obs	Growth rates of oil prices			Growth rates of oil revenue		
	Actual	**SM1**	**SM4**	**Actual**	**SM1**	**SM4**
1960	NA	NA	NA	NA	NA	NA
1961	0.0000	0.0000	0.0000	-0.0018	-0.0018	-0.0018
1962	0.0000	0.0000	0.0000	-0.0222	-0.0222	-0.0222
1963	0.0000	0.0000	0.0000	0.1230	0.1230	0.1230
1964	0.0000	0.0000	0.0000	0.3282	0.3282	0.3282
1965	0.0000	0.0000	0.0000	0.0259	0.0259	0.0259
1966	0.0000	0.0000	0.0000	0.0092	0.0092	0.0092
1967	0.0000	0.0000	0.0000	0.4199	0.4199	0.4199
1968	0.0000	0.0000	0.0000	-0.0346	-0.0346	-0.0346
1969	0.0000	0.0000	0.0000	0.0954	0.0954	0.0954
1970	0.0000	0.0000	0.0000	0.2385	0.2385	0.2385
1971	*0.2157*	*0.2157*	*0.2157*	*0.3934*	*0.3934*	0.3934
1972	0.0994	0.0994	0.0994	-0.4800	-0.4800	-0.4800
1973	0.2911	0.2911	0.2911	0.2579	0.2579	0.2579
1974	1.2993	0.0000	1.2993	1.2871	0.0000	0.1313
1975	0.0692	0.0000	0.0692	0.5477	0.0000	0.1313
1976	0.0623	0.0000	0.0623	-0.4887	0.0000	0.1313
1977	0.0966	0.0000	0.0966	0.0358	0.0000	0.1313
1978	0.0000	0.0000	0.0000	0.5933	0.0000	0.1313
1979	0.4127	0.0000	0.4127	-0.1224	0.0000	0.1313
1980	0.5705	0.0000	0.5705	-0.3655	0.0000	0.1313
1981	0.0643	0.0000	0.0643	0.0063	0.0000	0.1313
1982	-0.1744	0.0000	-0.1744	-0.0344	0.0000	0.1313
1983	-0.0761	0.0000	-0.0761	-0.2258	0.0000	0.1313
1984	-0.0190	0.0000	-0.0190	0.5946	0.0000	0.1313
1985	0.0070	0.0000	0.0070	-0.6387	0.0000	0.1313
1986	-0.7154	0.0000	-0.7154	-1.2900	0.0000	0.1313
1987	0.2753	0.0000	0.2753	0.3009	0.0000	0.1313
1988	-0.1560	0.0000	-0.1560	-0.1319	0.0000	0.1313
1989	0.0582	0.0000	0.0582	1.2323	0.0000	0.1313
1990	-0.0420	0.0000	-0.0420	-0.1062	0.0000	0.1313

Table 7-14 projections of growth rates of oil revenues and oil prices: actual, SM5, SM6 and SM7

obs	Growth rates of oil prices				Growth rates of oil revenue			
	Actual	**SM5**	**SM6**	**SM7**	**Actual**	**SM5**	**SM6**	**SM7**
1990	-0.0420	-0.0420	-0.0420	-0.0420	-0.1062	-0.1062	-0.1062	-0.1062
1991	NA	0.0000	0.6931	0.6931	NA	0.0000	0.6931	0.6931
1992	NA	0.0000	-0.0645	0.0000	NA	0.0000	-0.0645	0.0000
1993	NA	0.0000	-0.0690	0.0000	NA	0.0000	-0.0690	0.0000
1994	NA	0.0000	-0.0741	0.0000	NA	0.0000	-0.0741	0.0000
1995	NA	0.0000	-0.0800	0.0000	NA	0.0000	-0.0800	0.0000
1996	NA	0.0000	-0.0870	0.0000	NA	0.0000	-0.0870	0.0000
1997	NA	0.0000	-0.0953	0.0000	NA	0.0000	-0.0953	0.0000
1998	NA	0.0000	-0.1054	0.0000	NA	0.0000	-0.1054	0.0000
1999	NA	0.0000	-0.1178	0.0000	NA	0.0000	-0.1178	0.0000

7.6.1 Alternative Simulation Programmes

SM0**: Tracking of the Model (Dynamic Simulation)

Imposed Restrictions: No restriction

ASSIGN @ALL _sm0

```
leb=dleb+leb(-1)
lpd=dlpd+lpd(-1)
lpf=dlpf+lpf(-1)
'cpi=exp(lpd)
'cpif=exp(lpf)
'eb=exp(leb)
lreb=leb-lpd+lpf
dreb=lreb-lreb(-1)

DLPD=-0.67994249+1.0570361*DLPF(-1)+0.17345207*DMY(-1)+0.41475324*DLPD(-1)+0.11389866*(LREB(-1)-0.15667481*DROIL(-1))-0.071344454*DLOXP(-1)

DLEB=1.8048741-0.43728169*DLEB(-1)-0.59715697*DLEB(-4)+0.47723785*DRV-0.30953455*(LREB(-1)-0.15667481*DROIL(-1))

DLPF=0.013517596+0.68328436*DLPF(-1)+0.041074887*DLOP

DNOY2=0.10371432-0.17578099*DLOXP(-4)-0.094920177*DRV
```

** OXP = Oil Revenue; OP = Oil Price; 'D' in the bigining of each vrible stands for 'first difference'; 'L' stands for natural logarithm

SM00**: Base Path Model

Imposed Restrictions: *DMY* = 0

ASSIGN @ALL _sm00

'dmy=0

leb=dleb+leb(-1)

lpd=dlpd+lpd(-1)

lpf=dlpf+lpf(-1)

'cpi=exp(lpd)

'cpif=exp(lpf)

'eb=exp(leb)

lreb=leb-lpd+lpf

dreb=lreb-lreb(-1)

DLPD=-0.67994249+1.0570361*DLPF(-1)+0.17345207*(0)+0.41475324*DLPD(-1)+0.11389866*(LREB(-1)-0.15667481*DROIL(-1))-0.071344454*DLOXP(-1)

DLEB=1.8048741-0.43728169*DLEB(-1)-0.59715697*DLEB(-4)+0.47723785*DRV-0.30953455*(LREB(-1)-0.15667481*DROIL(-1))

DLPF=0.013517596+0.68328436*DLPF(-1)+0.041074887*DLOP

DNOY2=0.10371432-0.17578099*DLOXP(-4)-0.094920177*DRV

** OXP = Oil Revenue; OP = Oil Price; 'D' in the bigining of each vrible stands for 'first difference'; 'L' stands for natural logarithm

SM1**: no oil shock since 73:

Imposed Restrictions: *DMY* = 0; OXP=OXP(73); OP=OP(73)

ASSIGN @ALL _sm1

'dmy = 0

leb = dleb + leb(-1)

lpd = dlpd + lpd(-1)

lpf = dlpf + lpf(-1)

cpi = exp(lpd)

'cpif = exp(lpf)

eb = exp(leb)

lreb = leb-lpd + lpf

'dreb = lreb-lreb(-1)

DLPD = -0.68002252 + 1.0571841*DLPF(-1) + 0.1734386*(0) + 0.41471359*DLPD(-1) + 0.11391168*(LREB(-1)-0.1566687*DROILsm1(-1))-0.07134532*Doilsm1(-1)

DLEB = 1.8048741-0.43727427*DLEB(-1)-0.59714997*DLEB(-4) + 0.47724576*DRV-0.30953446*(LREB(-1)-0.1566687*DROILsm1(-1))

DLPF = 0.013517568 + 0.6832854*DLPF(-1) + 0.041074317*DLOPsm1

DNOY2 = 0.10371421-0.17577828*Doilsm1(-4)-0.094919634*DRV

** OXP = Oil Revenue; OP = Oil Price; 'D' in the bigining of each vrible stands for 'first difference'; 'L' stands for natural logarithm

SM4[**]: injection of oil revenues in the economy at a smooth rate

Imposed Restrictions: *DMY* = 0; OXPsm4$_{t+1}$ = (1+r)OXPsm4$_t$. 'r' is determined so that $\sum$ OXPsm4 = $\sum$ OXP; Opsm4 = actual OP

'original op

```
ASSIGN @ALL _sm4

'dmy=0

leb=dleb+leb(-1)
lpd=dlpd+lpd(-1)
lpf=dlpf+lpf(-1)
lnoy2=dnoy2+ lnoy2(-1)
'cpi=exp(lpd)
'cpif=exp(lpf)
eb=exp(leb)
lreb=leb-lpd+lpf

'dreb=lreb-lreb(-1)

DLPD=-0.68002252+1.0571841*DLPF(-1)+0.1734386*(0)+0.41471359*DLPD(-
1)+0.11391168*(LREB(-1)-0.1566687*DROILsm4(-1))-0.07134532*Dloilsm4(-1)

DLEB=1.8048741-0.43727427*DLEB(-1)-0.59714997*DLEB(-4)+0.47724576*DRV-
0.30953446*(LREB(-1)-0.1566687*DROILsm4(-1))

DLPF=0.013517568+0.6832854*DLPF(-1)+0.041074317*DLOP

DNOY2=0.10371421-0.17577828*Dloilsm4(-4)-0.094919634*DRV
```

[**] OXP = Oil Revenue; OP = Oil Price; 'D' in the beginning of each variable stands for 'first difference'; 'L' stands for natural logarithm

SM5**: No oil shock since 1990 till 1999:

Imposed Restrictions: *DMY* = 0; OXP and OP constant at 1990

ASSIGN @ALL _sm5

```
'dmy=0

leb=dleb+leb(-1)
lpd=dlpd+lpd(-1)
lpf=dlpf+lpf(-1)
lnoy2=dnoy2+ lnoy2(-1)
cpi=exp(lpd)
'cpif=exp(lpf)
eb=exp(leb)
lreb=leb-lpd+lpf

'dreb=lreb-lreb(-1)

DLPD=-0.68002252+1.0571841*DLPF(-1)+0.1734386*(0)+0.41471359*DLPD(-
1)+0.11391168*(LREB(-1)-0.1566687*DROILsm5(-1))-0.07134532*Dloilsm5(-1)

DLEB=1.8048741-0.43727427*DLEB(-1)-0.59714997*DLEB(-4)+0.47724576*DRV-
0.30953446*(LREB(-1)-0.1566687*DROILsm5(-1))

DLPF=0.013517568+0.6832854*DLPF(-1)+0.041074317*DLOPsm5

DNOY2=0.10371421-0.17577828*Dloilsm5(-4)-0.094919634*DRV
```

** OXP = Oil Revenue; OP = Oil Price; 'D' in the beginning of each variable stands for 'first difference'; 'L' stands for natural logarithm

SM6: 'Temporary oil shock, 1990-1999.**

Imposed Restrictions: *DMY* = 0; OXPsm6=(1+(9-t)/8)*OXP(90); *OPsm6=(1+(9-t)/8)*OP(90)*

```
ASSIGN @ALL _sm6

'dmy=0

leb=dleb+leb(-1)
lpd=dlpd+lpd(-1)
lpf=dlpf+lpf(-1)
lnoy2=dnoy2+ lnoy2(-1)
cpi=exp(lpd)
'cpif=exp(lpf)
eb=exp(leb)
lreb=leb-lpd+lpf

'dreb=lreb-lreb(-1)

DLPD=-0.68002252+1.0571841*DLPF(-1)+0.1734386*(0)+0.41471359*DLPD(-
1)+0.11391168*(LREB(-1)-0.1566687*DROILsm6(-1))-0.07134532*Dloilsm6(-1)

DLEB=1.8048741-0.43727427*DLEB(-1)-0.59714997*DLEB(-4)+0.47724576*DRV-
0.30953446*(LREB(-1)-0.1566687*DROILsm6(-1))

DLPF=0.013517568+0.6832854*DLPF(-1)+0.041074317*DLOPsm6

DNOY2=0.10371421-0.17577828*Dloilsm6(-4)-0.094919634*DRV
```

** OXP = Oil Revenue; OP = Oil Price; 'D' in the beginning of each variable stands for 'first difference'; 'L' stands for natural logarithm

SM7: 'Permanent oil shock, 1990-1999.**

Imposed Restrictions: *DMY* = 0; OXPsm7=2*OXP(90); OPsm7=2*OP(90)

ASSIGN @ALL _sm7

'dmy=0

leb=dleb+leb(-1)

lpd=dlpd+lpd(-1)

lpf=dlpf+lpf(-1)

lnoy2=dnoy2+ lnoy2(-1)

cpi=exp(lpd)

'cpif=exp(lpf)

eb=exp(leb)

lreb=leb-lpd+lpf

'dreb=lreb-lreb(-1)

DLPD=-0.68002252+1.0571841*DLPF(-1)+0.1734386*(0)+0.41471359*DLPD(-1)+0.11391168*(LREB(-1)-0.1566687*DROILsm7(-1))-0.07134532*Dloilsm7(-1)

DLEB=1.8048741-0.43727427*DLEB(-1)-0.59714997*DLEB(-4)+0.47724576*DRV-0.30953446*(LREB(-1)-0.1566687*DROILsm7(-1))

DLPF=0.013517568+0.6832854*DLPF(-1)+0.041074317*DLOPsm7

DNOY2=0.10371421-0.17577828*Dloilsm7(-4)-0.094919634*DRV

** OXP = Oil Revenue; OP = Oil Price; 'D' in the beginning of each variable stands for 'first difference'; 'L' stands for natural logarithm

7.7 Appendix 2

Pindyck and Rubinfeld (1991)[9] introduces some measures to evaluate the performance of a collection of results obtained from running a simulation procedure. Among them are:

$$\text{RMS Percent Error} = \sqrt{\frac{1}{T}\sum_{T=1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)^2}$$

$$\text{Mean Simulation Error} = \frac{1}{T}\sum_{T=1}^{T}\left(Y_t^s - Y_t^a\right)$$

$$\text{Mean Percent Error} = \frac{1}{T}\sum_{T=1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)$$

The problem with mean simulation error is that they may be close to 0 if large positive errors cancel out large negative errors... In this case rms simulation error would be a better measure of the simulation performance.

Low rms simulation errors are only one desirable measure of simulation fit. Another important criterion is how well the model simulates turning points. The ability to duplicate turning points or rapid changes in the data is indicative of the goodness of a model.

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[9] Pindyck, Robert S. and Daniel L.Rubinfeld (1991), "Econometric models and economic forecasts", 3rd ed., New York : McGraw-Hill

8

8. Summary and Conclusion

The premise underlying the whole contribution of this work is that it provides a careful analysis with empirical evidence of the issue of the macroeconomic effects of oil revenue (and price) fluctuations on key economic variables set in a Dutch Disease framework for the Iranian economy.

The analysis examined the relationships between money demand, domestic and foreign prices, exchange rate, non-oil gdp growth and oil revenue fluctuations in short and long-run analyses, using the best current econometric methods given the limitation in the data. The time period analysed (1960-1990) includes at least 4 major international oil shocks, in 1973/74, 1979, 1986 and 1990 and other domestic oil shocks which resulted mostly from changes in oil production policies, since the revolution and war with Iraq.

The small number of observations is a cause for concern, but the period covered seems satisfactory from a purely economic slant in that the main adjustments to the economic fundamentals as a consequence of major 'oil boom and bust' should have worked through the economy.

The analysis also helps to provide an insight into the exchange rate effects of oil revenue and also the interactions between official and free market exchange rates before and after the revolution.

One of the contributions of this thesis is that it provides further empirical results relating to the PPP approach to the exchange rates determination. It further extends the PPP approach to take into consideration oil revenue fluctuations and to discuss the macroeconomic consequences.

We tried to carefully pass all the necessary stages in building our econometric models such as testing the degree of integration in our variables, considering cointegrating relationships, estimating short-run adjustments through error-correction models and diagnostic testing.

The **review of Iranian economy** revealed that:

1. By the end of 1970s the Iranian economy was an 'excessively' import-dependent economy operating in an 'excessively' protected environment financed through oil revenues accruing to the state. Iran, therefore, at the end of 1970s was more dependent on oil than it had been at the beginning of 1960s.
2. The main influences on the economy since the revolution arose from political factors, principally the continuing adverse effects of the Iran-Iraq war and 1991 Persian Gulf war. Effects of the Iran-Iraq war have been made more damaging by the losses sustained during the revolution. The effects of disinvestment brought on by eight years of economic dislocation were apparent in low and sluggish rates of growth, especially in industry and even the oil sector. Economic and political sanctions and the lack of any alternative source of foreign currency (foreign aids, etc.) since the revolution made oil revenue the only source of foreign exchange. Overall, the Iranian economy has become more sensitive to the oil revenues in post-revolutionary period.

As a theoretical framework, **Dutch Disease review** showed that:

3. According to the core model of Dutch Disease two main effects are expected: *resource movement effect* and *spending effect*. The former effect is the movement of mobile factors from the non-boom economy into the boom sector which gives rise to de-industrialisation, and the latter refers to the excess demand caused by the boom which creates a real exchange rate appreciation and hence the contraction of the non-boom tradable sector.

4. Some authors argue that different outcomes can emerge in various circumstances. For instance, when the boom sector does not show a strong participation in the domestic factor market, resource movement effect would not be relevant.

5. Monetary aspects of the boom are parallel forces by which the boom revenue is accommodated into the domestic economy (Edwards, 1986), and which reinforce the real effects. However, the extent of any change in the domestic money supply depends on the extent of foreign exchange receipts from boom sector exports and the extent to which the monetary authorities sterilise these proceeds to neutralise their effect on the domestic money supply.

6. In oil exporting countries, once the oil boom has settled down in the domestic economy, we expect an expansion in the non-traded goods and a stagnation in the lagged sectors (agriculture and traditional manufacturing in oil exporting developing countries and non-oil industry in oil exporting developed countries). The overall effect on non-oil gdp, however, is ambiguous and can not be identified beforehand.

7. The economic movements outlined in this study reveal that the 'spending effect' due to the real revaluation of the exchange rate has worked strongly in the period 1953-55; though the 'resource movements effect' has not been observed in that situation. While some Dutch Disease effects are perceptible during 1974-79, we could not judge on these effects in the post-revolutionary period. Perhaps it is difficult to isolate a number of effects during 1980-1990 which includes oil crash, war and revolution shocks.

Review of econometrics methods convinced us that:

8. Two-stage Engle-Granger method for estimating an underlying cointegrated relationship is a popular and superconsistent method when the data observations are sufficiently available. Nevertheless, in finite samples, it has been shown that bias is a problem. To avoid this problem, non-linear one-step estimation method was preferred. Our starting point in constructing a model in most cases has been a general unrestricted model. Any interesting and sensible restrictions are imposed if they are found to be valid.

The principal findings in **exchange rate modelling** can be outlined as :

9. Purchasing Power Parity, as a key building-block for exchange rate modelling, may have relevance to the long-run determination of exchange rates, in the short-run, however, other factors dominate the movement of exchange rates. In explaining deviations from PPP several studies have shown that this theory can be appropriately adjusted to produce better empirical results by adding other explanatory variables (Officer, 1976) and by using more efficient estimation techniques[1].

10. The relevance of simple economic models to the determination of the official and black market Rial/Dollar exchange rate was considered. This analysis is also intended to illustrate how the behaviour of these exchange rates differed before and after the revolution. The Principal finding suggests that Purchasing Power Parity is a relevant model of both exchange rates in the pre-Revolutionary period, but applies only to the black market rate after the revolution.

Further assessment of the black market exchange rate over the whole period established that:

11. PPP is a valid model of the long-run black market exchange rate in Iran, conditional on a shift in the real exchange rate and the asymmetric long-run effects of higher oil revenue. What is perhaps most interesting in this study is that once this asymmetry is taken into account we find evidence of a long run economic relationship despite the tremendous shocks and changes the Iranian economy has been subjected to. However, this is not surprising within such an import-dependent economic structure, given that oil revenue has been an exclusive source of providing foreign currency[2] on one hand and a war-induced increase in demand for foreign currency after the 1979 revolution on the other hand.

12. We found that oil revenue only appears significantly in the equation when it is allowed to interact with the post revolution dummy variable. We believe this is due to a reduction in the ability of the economy to absorb the increased demand which greater oil revenue generates and also due to war-induced production stagnation.

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[1]Related literature discusses various reasons to explain the deviation from PPP. For more detail see chapter 5.

[2] Since the revolution, Iran has not benefited from any aids and grants provided by foreign countries.

We found no evidence of any other pre- and post-revolution asymmetries in the slope parameters. There is reason to believe that the effect of oil revenue on the black market exchange rate has been asymmetric. During the pre-revolution boom the black market rate seems to have been insensitive to oil revenue, but as the economy stagnated following the revolution and war so the black market rate became sensitive to oil revenue. Since the revolution higher oil revenue appears to have generated extra demand for imports and deflected domestic production away from exports, so that in the long run the exchange rate tended to depreciate. This finding is contrary to the standard DD model.

Modelling of domestic and foreign **prices, money demand and non-oil gdp** are the next empirical works conducted in this thesis. Principal findings are:

13. A rise in oil revenue suppresses inflationary pressure in the Iranian economy. Growth in oil revenue is found to reduce *inflation*, after a one year lag (there is no contemporaneous effect of oil on inflation). This finding is consistent with that of Mashayekhi (1991) and inconsistent with the implications of core Dutch Disease model.
14. A long-run relationship for prices based upon Purchasing Power Parity is considerably more robust than the inverted long-run money demand equation. Hence, when the real exchange rate is overvalued, then inflation tends to fall. Therefore, starting from an equilibrium position, our results show that after an oil boom domestic inflation tends to fall in short run which put the economic situation in a diseqilibrium position. However, in longer term, a more depressed exchange rate and higher foreign inflation induced by oil boom would dominate and put an upward pressure on the domestic inflation, until a new equilibrium position emerges.
15. We failed to detect any significant *expansionary* effect of an oil boom on real *non-oil gdp*. This may appear to be a controversial result, but Looney (1982), covering only pre-Revolutionary period, found that non-oil real gdp did not respond significantly to the change in oil exports. Our results do not show any instantaneous oil effect on non-oil real gdp too. We did find a contractionary effect of oil revenue on growth but after a long lag.

16. There is no significant effect from the real exchange rate on non-oil gdp. This confirms the finding of Edwards (1989) and contradict those authors who find an expansionary effect (such as Gylfason and Schmid (1983) and Dornbusch (1986)) or contractionary effect (such as Krugman, Taylor (1978) and Hansen (1983) and Gylfason and Radetzki (1991)). Real exchange rate depreciation causes inflation to rise but has no effect on output.

The failure to explain a significant proportion of the non-oil gdp growth rate movements is a bit worrying; however, and one could attribute it to factors that are difficult to quantify. For example, the dominance of shocks such as revolution and eight years war and 1980s oil crash accompanied with some other minor political shocks especially in post-revolutionary period might have seriously changed the real pattern of this variable. Also this may reflect the fact that in general short run models of growth do not perform well.

17. We found strong supportive evidence for conventional model of real money balances, with the addition of a small long run oil revenue elasticity and conditioned on an upward shift in money demand since the revolution.

The complete model as a system (excluding money demand equation[3]) was estimated using SUR (seemingly unrelated regression) method to get more efficient results. We found that the jointly estimated models appear more precise with mainly lower standard errors. Consequently, these results were chosen to undertake the simulation exercise. Judging from the tracking performance of the model and the simulation exercise, we concluded that the proposed framework does not suffer from any serious degree of misspecification.

18. The tracking performance of the equations was reasonable. RMS (root-mean-square) percent error, mean simulation error and mean percent errors were calculated for all the endogenous variables and are generally indicative of the sensible performance of the models. The evidence points to the non-oil real gdp as the worst fitting equation, unsurprisingly perhaps. Looking at the graphic representation for the non-oil real gdp, there is a notable deviation of the simulated

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[3]See chapter 7 for explanation.

from the actual series during the 1970s. The remaining three equations, namely black market exchange rate, domestic and foreign prices, achieved impressive tracking records. The exchange rate equation tracks the actual values during pre and post-revolution periods well. Apart from a few data points, the equations reproduced the historical data with a high degree of precision. However, in several cases the turning points fail to be reproduced. Obviously, many of these failures are attributed to non-economic factors which affected the Iranian economy during the past two decades (see chapter 2).

Simulation results for alternative *within sample* scenarios, designated by 'no oil shock since 1973' (SM1) and 'smoothed oil revenue spending' (SM4) and their comparison with the previous dynamic simulation based on actual oil revenues (base path), enable us to isolate the impact of the oil shocks on the economy. The results of these experiments are shown in Figures 7.11 to 7.16 and Tables 7.5 to 7.6 (for SM1) and Figures 7.17 to 7.22 and Tables 7.7 to 7.8 (for SM4).

19. When the oil shocks since 1973/74 are removed, CPI moves approximately on the same trend as the *base path* (SM00) but at a lower level, so that by the end of period the level of simulated prices are lower than the base path values. Comparing these two set of results emerges also that average inflation differ about 1% (10% against 11%; see Table 7.6). This is explained by the lower foreign inflation rate and that after the revolution the Rial devalues less.

A comparison of SM1 and SM00 results also revealed that an increase in oil revenues initially results in lower inflation rates without inducing higher rates of non-oil real gdp.

20. If the spending of oil revenue had been smoothed since 1973 (SM4), inflation rate starts to slow down in 1977 after a jump in 1975 and 1976 (Table 7.8; Figure 7.22). This notable slow down in 1977 may be attributed to the earlier appreciation in Rial value in 1976 and that the negative effect of oil revenue on inflation is spread over many periods. There is a huge fall in the value of Rial in 1978 and consequently a gain in competitiveness during the five years (till 1983) after the accomplishment of this policy. The gain in competitiveness is sustained by the failures of prices to rise to offset the fall in value of the Rial.

21. The simulated results indicate that utilising the oil revenues at a steady rate (SM4) would result in smoother inflation, and non-oil real gdp growth (see Table 7.7 and 7.8). The level of non-oil real gdp, however, stays higher in simulated results compared to the base path results for most of the period (Figure 7.18 and Table 7.8). From 1988, base path values exceed the simulated values very fast. A policy of 'more stable spending of oil revenue', hence, would lead to a lower inflation rate (10% against 11%) accompanied with a lower growth rate of non-oil real gdp (1.9% against 3.6%).

22. For *out of sample* simulation (1991-1999) we implemented three alternative scenarios: '*no oil shock since 1990*' (SM5); '*temporary oil shock in 1991*' (SM6) and '*permanent oil shock in 1991*' (SM7). Following a 100% increase in revenue and price of oil, temporarily or permanently (SM6 and SM7), CPI increases by about 9% in 1992 compared to 12% in no oil shock case (SM5) (Table 7.9). But from 1993 inflation is lowest in SM5 (Table 7.9). This is explained by the negative effects of oil revenue on inflation in the early years, being dominated by the effects on foreign prices and a depressed exchange rate in later years.

These confirm our previous conclusion that an oil boom would alleviate inflation in short run, while in a longer horizon, however, opposite forces, namely higher foreign inflation and exchange rate depreciation generated by oil boom, put upward pressure on inflation.

8.1 Limitations and Future Extension

The most restricting element in this study has been the limited numbers of data observations, particularly for the black market exchange rate. We failed to find any reliable observation on this variable beyond 1990, and (according to our knowledge) no other works implemented in this area could cover a longer period. If in the future quarterly or monthly data become available this would greatly improve the reliability of a study such as ours.

The time period under consideration covers some heavy turbulence resulting from various social-political movements such as revolution, the eight-year war, political and economic sanctions, etc. These facts made a reliable investigation more complex and hard to conclude quantitatively. There is hope that by extending the time period some of these difficulties remove. Extending the empirical framework employed in this work to similar episodes in other OEDCs would seem to be a useful way to assess the general applicability of our findings.

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General Appendix: Samples of TSP programming (UNIX version)

```
FREQ A; SMPL 1960 1990;
IN YTP0;              ?this file is taken from paper1801.tsp + noily.tsp
TREND T;
NNOILY=NGDP-OXP;
NOLY=(NNOILY/CPI)*100;
PLOT NOLY;
SMPL 1960 1977;
T2=T*T;

OLSQ NOLY C T;

OLSQ NOLY C T2;

GENR GAP1=@RES;

SMPL 1978 1990;
T2=T*T;
GENR YP = 29.7327 + 1.0362*T2;
PLOT YP;
GENR GAP2 = NOLY - YP;

SMPL 1960 1977; GAP=GAP1; SMPL 1978 1990; GAP=GAP2;
SMPL 1960 1990; PLOT GAP; DGAP=GAP-GAP(-1);
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
PRE=LEB-LEO; REO=LEO+LPF-LPD; DREO=REO-REO(-1); DRVOIL=DREV*LOXP;
DRVDOIL=DREV*DLOXP;  DPDF=DLPD-DLPF;

? non-linear estimation method

FRML EB DLEB = A0 + A1*DLEB(-1) + A3*DLEB(-3) + A4*DLEB(-4) + A8*DPDF(-3)
+ A9*DPDF(-4) + A26*GAP(-1) + A27*DGAP(-1) + A28*DGAP(-2) + A29*DGAP(-
3) + A30*DGAP(-4)
+ A17*DRVOIL(-1) + A18*DRVDOIL + A20*DREV + A22*DREO(-1)
+ A25*(LEB(-1) - B1*LPD(-1) - B2*LPF(-1));
PARAM A0-A30 B1, 1.75 , B2, -1.49 ; SMPL 1965 1990;

FRML EB1 B1 + B2;
FRML EB2 B1 - 1;
FRML EB3 B2 + 1;

LSQ(TOL=.001, MAXIT=100)EB;

ANALYZ EB1;
ANALYZ EB2;
ANALYZ EB3;

OLSQ DLEB C DLEB(-1) DLEB(-3) DLEB(-4) DPDF(-3) DPDF(-4) LOXP(-1) DLOXP
DREV DREO(-1) LEB(-1) LPD(-1) LPF(-1);

END;
```

```
****?NAME M1133.TSP
FREQ A; SMPL 1960 1990;
IN YTPO;
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
DRVOIL=DREV*LOXP; VINV=LM-LPD-LGDP; DLM=LM-LM(-1); DLPD=LPD-LPD(-1);
DRVDOIL=DREV*DLOXP; DDEF=DEF-DEF(-1); DDP=DLPD-DLPD(-1); DLEO=LEO-
LEO(-1);REB=LEB+LPF-LPD; DLOP=LOP-LOP(-1);

FRML RM DLRM = A0 + A7*LOXP(-1) + A11*DREV + A20*(LRM(-1) - B1*LGDP(-1))
;
PARAM A0-A25 B1, 1.00 ;  SMPL 1962 1990;

FRML RM1 B1 - 1 ;
LSQ(TOL=.001, MAXIT=100) RM ;

ANALYZ RM1;

OLSQ DLRM  C   LOXP(-1) LRM(-1) LGDP(-1) DREV;

FRML M DLM = A0 + A1*DLOXP + A2*DLOXP(-1) + A3*DLOP + A4*DLOP(-1) +
A5*DRVDOIL +
A6*DRVDOIL(-1) + A11*DREV  + A20*(LRM(-1) - .851*LGDP(-1) - .18*LOXP(-1)) ;
PARAM A0-A25 B1, 1.00, B2 ;  SMPL 1962 1990;

FRML M1 B1 - 1 ;

LSQ(TOL=.001, MAXIT=100) M ;
?ANALYZ M1;

? final model for above model

FRML M DLM = A0 + A3*DLOP + A11*DREV + A20*(LRM(-1) - .851*LGDP(-1) -
.18*LOXP(-1)) ;
PARAM A0-A25 B1, 1.00, B2 ;  SMPL 1962 1990;

FRML M1 B1 - 1 ;

LSQ(TOL=.001, MAXIT=100) M ;
?ANALYZ M1;

? long-run expression for money eq. taken from the first LSQ.

ECM1=LRM-.851*LGDP-.18*LOXP;

OLSQ DLPD C DLPD(-1) DLPD(-2) DLGDP(-1) DLGDP(-2) DLRM(-1) DLRM(-2)
DLEO(-1) DLEO(-2) DLEB(-1) DLEB(-2) ECM1(-1) REB(-1) DLOXP DLOXP(-1);

? final model for above eq. WITH intercept.

OLSQ DLPD C DLPD(-1) DLRM(-1)  DLEO(-1) ECM1(-1) REB(-1) DLOXP(-1);

? final model for above eq. WITHOUT intercept.

OLSQ DLPD DLPD(-1) DLRM(-1)  DLEO(-1) ECM1(-1) REB(-1) DLOXP(-1);
```

```
? above eq. without REB(-1).

OLSQ DLPD DLPD(-1)  DLRM(-1)  DLEO(-1) ECM1(-1) DLOXP(-1);
END;
```

```
***?NAME NOILY92320.TSP ? modelling non-oil gdp
FREQ A; SMPL 1960 1990;
IN YTP0;
TREND T;

NNOILY=NGDP-OXP; ?nominal non-oil gdp = nominal gdp-nomianl oil exports.
RNOLY=(NNOILY/CPI)*100; ? real non-oil gdp = nominal non-oil gdp/consumer price
In.
PLOT RNOLY;
LRNOY=LOG(RNOLY);PLOT LRNOY;

SMPL 1960 1977;
T2=T*T;
OLSQ LRNOY C T;
OLSQ LRNOY C T2;
GENR GAP1=@RES;

SMPL 1978 1990;
T2=T*T;
GENR LYP = 4.0653 + .00622795*T2;
PLOT LYP;
GENR GAP2 = LRNOY - LYP;

SMPL 1960 1977; GAP=GAP1; SMPL 1978 1990; GAP=GAP2;
SMPL 1960 1990; PLOT LRNOY,A,LYP,F;  PLOT GAP;

? see gdp4.tsp for using in this file.

TREND T;

SMPL 1960 1974;
T1=T;

SMPL 1975 1990;
T1=T1(-1) + .1; ?trend in 1974.
SMPL 1960 1990; PRINT T1; PLOT T1;
PLOTS; OLSQ LRNOY C T1;
DV=@RES;


TREND T;
SMPL 1960 1990;
DRT=DREV*T;
OLSQ LRNOY C T DRT DREV;
GAP=@RES;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
PRE=LEB-LEO; REO=LEO+LPF-LPD; DREO=REO-REO(-1); DRVOIL=DREV*LOXP;
DRVDOIL=DREV*DLOXP;  DPDF=DLPD-DLPF; DPF=LPD-LPF;

DLRNOY=LRNOY-LRNOY(-1);
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

FRML NOILY DLRNOY = A0 + A1*DLRNOY(-1) + A2*DLRNOY(-2) + A3*DLRM(-1) +
A4*DLRM(-2) + A5*DLREB(-1) + A6*DLREB(-2) + A7*DLOXP + A8*DLOXP(-1) +
A9*LOXP(-1) + A10*DRVDOIL + A11*DRVDOIL(-1) + A12*DRVOIL(-1) +
A13*DREV(-1) + A20*LREB(-1) + A25*(LRM(-1)-LRNOY(-1));
```

```
PARAM A0-A25; SMPL 1963 1990;

LSQ(TOL=.001, MAXIT=100) NOILY;

SMPL 1960 1990;
OLSQ DLRNOY C  LPD(-1) LOXP(-1) GAP GAP(-1);
END;
```

```
NAME DP110.TSP
FREQ A; SMPL 1960 1990;
IN YTPO;
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
DRVOIL=DREV*LOXP; VINV=LM-LPD-LGDP; DLM=LM-LM(-1); DLPD=LPD-LPD(-1);
DRVDOIL=DREV*DLOXP; DDEF=DEF-DEF(-1);

FRML P DLPD = A0 + A1*DLM(-1) + A2*DLM(-2) + A3*DLPD(-1) + A4*DLPD(-2) +
A5*DLGDP(-1) + A6*DLGDP(-2) + A7*LOXP(-1) + A8*DLOXP(-1) + A9*DRVOIL(-1)
+
A10*DRVDOIL(-1) +
A11*DREV + A20*(LM(-1) - B1*LPD(-1) - B2*LGDP(-1)) ;
PARAM A0-A25 B1, 1.00, B2, 1.00 ;   SMPL 1963 1990;

FRML M1 B1 - 1 ;
FRML M2 B2 - 1;
?FRML EB3 B2 + 1;

LSQ(TOL=.001, MAXIT=100) P ;

ANALYZ M1;
ANALYZ M2;
?ANALYZ EB3; SMPL 1960 1990;

OLSQ DLPD C DLM(-1) DLM(-2) DLPD(-1) DLPD(-2) DLGDP(-1) DLGDP(-2)
LOXP(-1) DLOXP(-1) VINV(-1)  LPD(-1) DREV;
END;
```

```
NAME DP15.TSP
FREQ A; SMPL 1960 1990;
IN YTP0;
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
DRVOIL=DREV*LOXP; VINV=LM-LPD-LGDP; DLM=LM-LM(-1); DLPD=LPD-LPD(-1);
DRVDOIL=DREV*DLOXP; DDEF=DEF-DEF(-1);  LREB=LEB+LPF-LPD;

FRML P DLPD = A0 + A1*DLM(-1) + A2*DLM(-2) + A3*DLPD(-1) + A4*DLPD(-2) +
A5*DLGDP(-1) + A6*DLGDP(-2) + A7*LOXP(-1) + A8*DLOXP(-1) +
A11*DREV + A20*(LEB(-1) - LPD(-1) + LPF(-1)) + A21*LPD(-1)  ;
PARAM A0-A25 B1, 1.00 ;   SMPL 1963 1990;

?FRML M1 B1 - 1 ;
?FRML EB2 B1 - 1;
?FRML EB3 B2 + 1;

LSQ(TOL=.001, MAXIT=100) P ;

?ANALYZ M1;
?ANALYZ EB2;
?ANALYZ EB3; SMPL 1960 1990;

OLSQ DLPD C DLM(-1) DLM(-2) DLPD(-1) DLPD(-2) DLGDP(-1) DLGDP(-2)
LOXP(-1) DLOXP(-1) LREB(-1) LPD(-1) DREV;

END;
```

```
NAME DP176.TSP
FREQ A; SMPL 1960 1990;
IN YTPO;
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
DRVOIL=DREV*LOXP; VINV=LM-LPD-LGDP; DLM=LM-LM(-1); DLPD=LPD-LPD(-1);
DLPF=LPF-LPF(-1); LREB=LEB+LPF-LPD; LEQTRM=LREB-0.18*DRVOIL;
DRQTRM=DREV*LEQTRM; DRVNV=DREV*VINV;
DRVDOIL=DREV*DLOXP; DDEF=DEF-DEF(-1); DPDF=DLPD-DLPF; DLEO=LEO-LEO(-
1);

FRML P DLPD = A0 + A3*DLEO(-1) + A4*DLEO(-2) + A8*DLOXP(-1) +
A10*DRVDOIL(-1) +
A13*DLPF(-2) + A21*VINV(-1) ;
PARAM A0-A25 B1, 1.00 ;  SMPL 1963 1990;

?FRML M1 B1 - 1 ;
?FRML EB2 B1 - 1;
?FRML EB3 B2 + 1;

LSQ(TOL=.001, MAXIT=100) P ;

?ANALYZ M1;
?ANALYZ EB2;
?ANALYZ EB3; SMPL 1960 1990;

OLSQ DPDF C DPDF(-1) DPDF(-2) DLEO(-1) DLEO(-2) DLEB(-1) DLEB(-2)
LOXP(-1) DLOXP(-1) DREV LEQTRM(-1) ;

END;
```

```
M1170.TSP
FREQ A; SMPL 1960 1990;
IN YTPO;
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
DRVOIL=DREV*LOXP; VINV=LM-LPD-LGDP; DLM=LM-LM(-1); DLPD=LPD-LPD(-1);
DRVDOIL=DREV*DLOXP; DDEF=DEF-DEF(-1);

FRML M DLM = A0 + A1*DLM(-1) + A2*DLM(-2) + A3*DLPD(-1) + A4*DLPD(-2) +
A5*DLGDP(-1) + A6*DLGDP(-2) + A7*LOXP(-1) + A8*DLOXP(-1) + A9*DRVOIL(-1)
+
A10*DRVDOIL(-1) + A11*DEF(-1) +A12*DDEF(-1) + A13*DREV +
A20*(LM(-1) - B1*LPD(-1) - B2*LGDP(-1)) ;
PARAM A0-A25 B1, 1.00, B2 ;   SMPL 1963 1990;

FRML M1 B1 - 1 ;
FRML M2 B2 - 1;
?FRML EB3 B2 + 1;

LSQ(TOL=.001, MAXIT=100) M ;

ANALYZ M1;
ANALYZ M2;
?ANALYZ EB3;  SMPL 1960 1990;

OLSQ DLM  C DLGDP(-1)   LOXP(-1) VINV(-1)   ;

END;
```

```
***?NAME NOILY9921.TSP ? modelling non-oil gdp
FREQ A; SMPL 1960 1990;
IN YTPO;
TREND T;
NNOILY=NGDP-OXP; ?nominal non-oil gdp =nominal gdp-nomianl oil exports.
RNOLY=(NNOILY/CPI)*100; ? real non-oil gdp = nominal non-oil gdp/consumer price
In.
PLOT RNOLY;
LRNOY=LOG(RNOLY);PLOT LRNOY;

SMPL 1960 1977;
T2=T*T;
OLSQ LRNOY C T;
OLSQ LRNOY C T2;
GENR GAP1=@RES;

SMPL 1978 1990;
T2=T*T;
GENR LYP = 4.0653 + .00622795*T2;
PLOT LYP;
GENR GAP2 = LRNOY - LYP;

SMPL 1960 1977; GAP=GAP1; SMPL 1978 1990; GAP=GAP2;
SMPL 1960 1990; PLOT LRNOY,A,LYP,F;  PLOT GAP;


? see gdp4.tsp for using in this file.

TREND T;
SMPL 1960 1974;
T1=T;
SMPL 1975 1990;
T1=T1(-1) + .1; ?trend in 1974.
SMPL 1960 1990; PRINT T1; PLOT T1;
PLOTS; OLSQ LRNOY C T1;
DV=@RES;


TREND T;
SMPL 1960 1990;
DRT=DREV*T;
OLSQ LRNOY C T DRT DREV;
GAP=@RES;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
PRE=LEB-LEO; REO=LEO+LPF-LPD; REB=LEB+LPF-LPD;DREO=REO-REO(-1);
DRVOIL=DREV*LOXP;
DRVDOIL=DREV*DLOXP;  DPDF=DLPD-DLPF; DPF=LPD-LPF;DRREO=DREV*REO;
DRDREO=DREV*DREO; DREB=REB-REB(-1);DRREB=DREV*REB;
DRDREB=DREV*DREB; DLRNOY=LRNOY-LRNOY(-1);
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

FRML NOILY DLRNOY = A0 + A1*DLRNOY(-1) + A2*DLRNOY(-2) + A3*DLRM(-1) +
A4*DLRM(-2) + A5*DLREB(-1) + A6*DLREB(-2) + A7*DLOXP + A8*DLOXP(-1) +
A9*LOXP(-1) + A10*DRVDOIL + A11*DRVDOIL(-1) + A12*DRVOIL(-1) +
A13*DREV(-1) + A20*LREB(-1) + A25*(LRM(-1)-LRNOY(-1));
PARAM A0-A25; SMPL 1963 1990;
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LSQ(TOL=.001, MAXIT=100) NOILY;

SMPL 1960 1990;
OLSQ DLRNOY C DLPD(-2)   LM(-1) LPD(-1)  GAP GAP(-1);
END;
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NAME NOILY502.TSP
FREQ A; SMPL 1960 1990;  ?testing short and log-run simult.
IN YTP0;
TREND T;
NNOILY=NGDP-OXP; ?nominal non-oil gdp  =nominal gdp-nomianl oil exports.
RNOLY=(NNOILY/CPI)*100; ? real non-oil gdp = nominal non-oil gdp/consumer price
In.
PLOT RNOLY;
LRNOY=LOG(RNOLY);PLOT LRNOY;
SMPL 1960 1977;
T2=T*T;
OLSQ LRNOY C T;
OLSQ LRNOY C T2;
GENR GAP1=@RES;
SMPL 1978 1990;
T2=T*T;
GENR LYP = 4.0653 + .00622795*T2;
PLOT LYP;
GENR GAP2 = LRNOY - LYP;
SMPL 1960 1977; GAP=GAP1; SMPL 1978 1990; GAP=GAP2;
SMPL 1960 1990; PLOT LRNOY,A,LYP,F;  PLOT GAP;

DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
PRE=LEB-LEO; REO=LEO+LPF-LPD; DREO=REO-REO(-1); DRVOIL=DREV*LOXP;
DRVDOIL=DREV*DLOXP;  DPDF=DLPD-DLPF; DPF=LPD-LPF;

? see gdp4.tsp for using in this file.

TREND T;
SMPL 1960 1990;
DRT=DREV*T;
OLSQ LRNOY C T DRT DREV;
DV=@RES;


DLRNOY=LRNOY-LRNOY(-1);
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

FRML NOILY DLRNOY =
A12*DRVOIL(-1) +
A13*DREV(-1) + A14*DV(-1) ;
PARAM A0-A20; SMPL 1963 1990;
LSQ(TOL=.001, MAXIT=100) NOILY;



OLSQ DV C DV(-1) LOXP(-1)   ;



END;
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NAME NOILY961.TSP
FREQ A; SMPL 1960 1990;  ?testing short and log-run simult.
IN YTPO;
TREND T;
NNOILY=NGDP-OXP; ?nominal non-oil gdp =nominal gdp-nomianl oil exports.
RNOLY=(NNOILY/CPI)*100; ? real non-oil gdp = nominal non-oil gdp/consumer price
In.
PLOT RNOLY;
LRNOY=LOG(RNOLY);PLOT LRNOY;
SMPL 1960 1977;
T2=T*T;
OLSQ LRNOY C T;
OLSQ LRNOY C T2;
GENR GAP1=@RES;
SMPL 1978 1990;
T2=T*T;
GENR LYP = 4.0653 + .00622795*T2;
PLOT LYP;
GENR GAP2 = LRNOY - LYP;
SMPL 1960 1977; GAP=GAP1; SMPL 1978 1990; GAP=GAP2;
SMPL 1960 1990; PLOT LRNOY,A,LYP,F;  PLOT GAP;


? see gdp4.tsp for using in this file.

TREND T;
SMPL 1960 1974;
T1=T;
SMPL 1975 1990;
T1=T1(-1) + .1; ?trend in 1974.
SMPL 1960 1990; PRINT T1; PLOT T1;
PLOTS; OLSQ LRNOY C T1;
DV=@RES;



DLOXP=LOXP-LOXP(-1); DWR=DUM2; DWROIL=DWR*LOXP;
DWRDOIL=DWR*DLOXP; DREV=DUM1;
PRE=LEB-LEO; REO=LEO+LPF-LPD; DREO=REO-REO(-1); DRVOIL=DREV*LOXP;
DRVDOIL=DREV*DLOXP;  DPDF=DLPD-DLPF; DPF=LPD-LPF;

DLRNOY=LRNOY-LRNOY(-1);
REGOPT(PVPRINT, STARS, LMLAGS=4, QLAGS=4, NOSHORT) ALL;

FRML NOILY DLRNOY = A0 + A1*DLRNOY(-1) + A2*DLRNOY(-2) + A3*DLRM(-1) +
A4*DLRM(-2) + A5*DLREB(-1) + A6*DLREB(-2) + A7*DLOXP + A8*DLOXP(-1) +
A9*LOXP(-1) + A10*DRVDOIL + A11*DRVDOIL(-1) + A12*DRVOIL(-1) +
A13*DREV(-1) + A20*LREB(-1) + A25*(LRM(-1)-LRNOY(-1));
PARAM A0-A25; SMPL 1963 1990;
LSQ(TOL=.001, MAXIT=100) NOILY;

SMPL 1960 1990;
OLSQ DLRNOY C DLPD(-2)  DLOXP(-4) LM(-1)
LPD(-1) LGDP(-1)  DREV;
END;
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