Causes of Inflation in The Iranian Economy 1972-1990

by

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بسم الله الرحمن الرحيم

In the name of God, the beneficent, the merciful

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Abstract

Inflation has been the focus of numerous investigations in recent decades, both for developed and developing countries. Although there is a general understanding about the consequences of inflation, its causes and cure are still controversial issues among economists. None of the two competitive views concerned with developing countries , Monetarism and Structuralism, provides a wholly successful theoretical model to explain price behaviour. This thesis attempts to suggest a synthesis for more appropriate modeling.

Empirically, the most commonly used modeling strategy has been to adapt a monetary model subject to some modifications for the developing countries, reflecting structural elements, which may be named an analytical model. This investigation considers much empirical evidence and points out the shortcomings of the models used and the econometric procedures carried out. In particular, several recent studies of inflation in the Iranian economy are evaluated. This evaluation indicates that the single equation estimation and/or ignorance of integration and cointegration in these researches are two features to be questioned.

This thesis uses a simultaneous equations model originally made for four non-oil developing countries. Adapting the model for Iran, a major oil exporting country, leads to a model containing three behavioural equations (price, government revenue and income) and two definitional equations (money and expected inflation). This model, treating income, money and government revenue as endogenous, attempts to take into account the special structural features of the economy beside monetary elements.

A vector autoregressive approach in a multiple cointegration context is the estimation procedure used in this study. The results generally confirm predicted price determination and indicate the importance of the oil sector in both government revenue and production.

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1 *Introduction*

1.1 Objective

For decades, the debate on the causes of inflation has been important as governments in almost all countries, in the developed or the developing worlds, have had to confront the socio-economic costs of continuous price rises. Most significant among them seem to be the effects on economic growth and redistribution of income from the poor to the rich which have led, in many cases, to social unrest. It is broadly accepted that the developing countries (DC's) are more liable to experience, and have indeed experienced, a wider range of inflation rates than the developed countries.

Despite general agreement about the consequences of inflation, when diagnosis of the problem and means of treatment come under scrutiny, inflation remains a controversial issue among economists. Inflation is treated as a monetary phenomenon by monetarists for whom control of money supply is the main policy prescription. By contrast, structuralists, whilst accepting that inflation is accompanied by money supply increases view it as an inevitable outcome of structural bottlenecks during the development process. Consequently, identification of the causes of inflation indicates the way to cure it.

The topic is vast and the literature voluminous. Concerning DC's, several authors have tried to provide a monetarist explanation of inflation. Most famous among them is Harberger (1963), whose model of Chilean inflation has been applied in numerous investigations for Latin America and elsewhere. Vogel (1974) considered inflation in sixteen Latin American DC's indicating a monetarist explanation of inflation. Nevertheless, the researcher reported contradictory conclusions on the monetarist-structuralist debate from the findings of several other investigations.

Edel (1969), using data of eight Latin American DC's, examined the structural hypothesis and found evidence supporting the structuralist view. Apart from a few successful cases, most of the investigations which used pure monetarist or structuralist models to explain inflation phases in DC's failed to provide reasonable outcomes. Argy (1970) and Saini (1982) are two examples which used a structural model for 22 DC's and a monetarist one for six Asian DC's. However, there are many studies which apply an analytical model to examine the different structural or monetary hypothesises: for example Aghevli and Khan (1978), Bhalla (1981), Arize (1987), Montiel (1989) and Noorbakhsh (1990).

Recently, there has been growing interest in newer econometric methods like cointegration to study inflation. Some examples are Alkhatib (1994), Ryan and Milne (1994), Moser (1995), Metin (1995) and Wang (1995). In these papers the model nests relevant factors (both structuralist and monetarist) characterizing the specific circumstances of individual DC's. These articles lend partial support to both views on inflation.

Many studies have also focused on causality between money supply and inflation to determine whether it is money which causes inflation (the monetarist view) or money supply rise is caused by inflation (the structuralist view) (Jones and Uri, 1987, Anderson et al, 1988, Quddus et al, 1989, Makinen and Woodward, 1989, Beltas and Jones, 1993, Kamas, 1995 and Ahumada, 1995). There are a variety of results, but they appear to provide no strong evidence to confirm exclusively each camp of thought.

Regarding Iran as an oil-exporting DC, several researchers have studied the causes of inflation during the two recent decades. Although a pure monetarist approach seems partially to be able to explain inflation in the Iranian economy in some studies (Ikani, 1987), most researchers have found analytical models, which nest the two kinds of factors, more appropriate (Aghevli and Sassanpour, 1991, Tayyebnia, 1993, and Bahmanee-Oskoee, 1995). These investigations used a single equation approach to estimate the models. However there are two investigations which have used simultaneous equation models (Makkian, 1991 and Tabatabaee-Yazdee, 1993). Although all of the studies result in more or less reasonable outcomes, there are some questionable issues:

1. Most studies have been conducted with a single-equation approach (OLS). An assumption in this approach is that the explanatory variables are exogenous. However, they themselves might well be influenced by the dependent variable, leading to biased estimates.

2. Makkian and Tabatabaee-Yazdee investigated the problem in a simultaneous equation context but they used the model of Aghevli and Khan (1978), which is designed for non-oil-exporting countries. It seems that their work would have been more reliable if the authors had modified the model by characterizing the special features of the economy of Iran, a major oil-exporting DC. All previous analyses have paid too little attention to the dominance of oil in the Iranian economy.

3. Further (and probably more important) is that in none of the cases, except Bahmanee-Oskoee, do the authors apply the new econometric methodology regarding integration and cointegration. When a model deals with macroeconomic variables, estimation without integration and cointegration tests may well lead to spurious

regression. Bahmanee-Oskoee's work is an exception. However, besides employing a single-equation approach, he did not carry out complete cointegration tests.

Consequently it would be of interest to reexamine the causes of inflation in the Iranian economy in a context which captures the following features;

1. Establishing an analytical model focusing on the importance of the role of the oil sector in the economy, which combines all relevant monetarist as well as structuralist variables.

2. Using a simultaneous-equation estimation method permitting all probable interrelations among the variables to be considered.

3. Employing a complete set of integration and cointegration tests so as to avoid any misinterpretation of the results.

These are undertaken in the hope that this study will concentrate on aspects of time series analysis neglected in the previous investigations.

1.2 Plan

The plan of this study is as follows;

Chapter 2 represents a major part of the theoretical core of the thesis. This chapter, after a broad introduction of different views on inflation, employs the quantity theory of money and money market equilibrium to derive a monetary formulation of price generation. We show why monetarists argue that inflation occurs when money supply grows faster than money demand, and also how the expectation of inflation can aggravate this process. Likewise, the central bank balance sheet identity and the money market equilibrium are used to highlight the role of government budgetary performance and the foreign assets of the central bank.

The next section of this chapter deals with the structuralist perspective. First we provide a discussion about the main argument of this camp: the inevitability of inflation during the development process. Then an equilibrium analysis of the goods market is used to establish a model illustrating the role of relative prices. This model indicates how structural bottlenecks can lead to relative price changes resulting in general price increases. Thirdly, the role of internal and external constraints are considered. Finally, the case of oil-export-orientated economies is examined to point out that even with unlimited foreign exchange the structure of the economy may make it prone to inflation.

Following on from this, a critical discussion to reconcile the two views is provided. This part of chapter 2 attempts to illuminate the similarities and the differences between the two perspectives, in addition to their deficiencies, to explain DCs' inflation. This discussion leads to an analytical model combining relevant monetarist and structuralist factors. Chapter 2 ends with empirical work lending support to a synthesis of the two approaches.

The background part of the thesis is presented in chapter 3. This describes the Iranian economic outlook, focusing on inflation. The government budget and such relevant characteristics as banking performance, foreign trade and production are considered. The role of positive and negative oil price shocks is emphasized. Likewise, dividing the period into pre- and post-revolution eras, some attempts have been made to point out the function of the socio-political situation and in particular, the long lasting Iraq-Iran war. The conclusion shows that the Iranian economy has suffered from an oil/non-oil dualism, in addition to modern/traditional duality. An important consequence of these circumstances was a severe dependence of government revenue and foreign requirement of production on oil export proceeds. This high degree of dependence on the oil sector has made the economy prone to inflation.

Chapter 4 is devoted to addressing model selection issues. This begins with a typical analytical model, a single equation expanded from a conventional money demand function. Its shortcomings are then discussed, leading to a simultaneous equation model. Then, six of the latest studies concerning inflation in the Iranian economy are critically considered. The next part describes the model of Aghevli and Khan (1978) from which the model used in this investigation is derived. The final section of this chapter provides the procedure used to derive the equations of the model based on the relevant theories and the special features of the Iranian economy. The selected model consists of equations for prices, income, government revenue, money supply and expected inflation.

The econometric work in the thesis is set out in chapter 5. Following an introductory discussion about the nature of the time series, the database under consideration is described. Data definition, derivation of quarterly data from annual figures for a few series and missing observations are discussed. Expected inflation is discussed in the next part. Then, we conduct the first necessary step in time series analysis, stationarity tests. Different tests for units root and seasonal features of the series are accomplished. There follows a discussion of long-run vs short-run features of the model with respect to cointegration. In this section the error correction mechanism and different procedures for cointegration tests are described. Likewise, different aspects of the Johansen approach for multiple cointegration tests are discussed and conducted on the equations of interest.

Following on from these initial tests, the model is estimated by 3SLS and 2SLS, using a VAR procedure. The last part of the chapter is devoted to interpretation of the findings. Chapter 6 concludes the study.

2 *The Theory of Inflation in Developing Countries: A Critical Review of the Literature*

2.1 Introduction

2.2 Monetary Views on Inflation

2.3 Structural Views on Inflation

2.4 Monetarism VS Structuralism : A Reconciliation

2.5 Empirical Evidence

2.1 Introduction

This chapter's objective is to provide a critical review of the literature concerning the theory of inflation in developing countries (DCs).

In the simplest terms , inflation is a persistent upward trend in the general level of prices (Jackman *et al*, 1981: 1). This means that the value of goods (including services), in terms of money continuously rises, or equivalently, the value of a unit of money in terms of goods declines continually. Taking into account the different roles of money in the economy, the tight relation between inflation and money can be seen. Money has three roles: a means for transactions, a store of value, and an accounting unit. A necessary condition for money being an asset or a store of value is that it fulfills the exchange function. In other words, it is desirable as a means of transaction. Thus, if the value of money falls (inflation occurs), its effectiveness as a store of value starts to worsen. The third role, a unit of account, is also linked with this. While inflation decreases the value of money, it weakens the third role of money as well; consequently, inflation has a serious impact on credit markets because debt is accounted for by money (Laidler and Parkin, 1975: 741).

Although inflation is not a new phenomenon, in recent decades it has emerged as a persistent and worldwide problem, a problem which has become a major concern of governments of developed as well as developing countries (Maynard and Ryckeghem, 1976:1). Table 1 displays the movement of average rates of inflation in the recent two decades, for industrial and developing countries. This Table suggests that a conclusion of Kirkpatrick and Nixon (1987: 173) about the characteristics of inflation in DC's seems broadly acceptable. They conclude that: a) DC's are more liable to inflation, b) these countries experience a variety of inflation rates, and c) inflation fluctuates around the trend more widely than in developed countries.

Following Romer (1996: 389) a simple framework of aggregate demand and supply curves can be used to identify possible causes of inflation (Figure 1). This diagram implies that contractions of supply and/or expansions of aggregate demand lead to a higher price level. These contractions or expansions can occur for many reasons. A reduction in labour supplied (at any given wage rate), negative technological shocks, rising relative costs and any factors which shift the aggregate supply curve towards the left lead to inflation. Analogously, every rightward shift of aggregate demand curve, like a money stock increase, a money demand decrease or an increase in government expenditure, can cause inflation. Of course, many shocks have impacts on both curves.

Figure 1 : Aggregate Demand and Aggregate Supply Curves

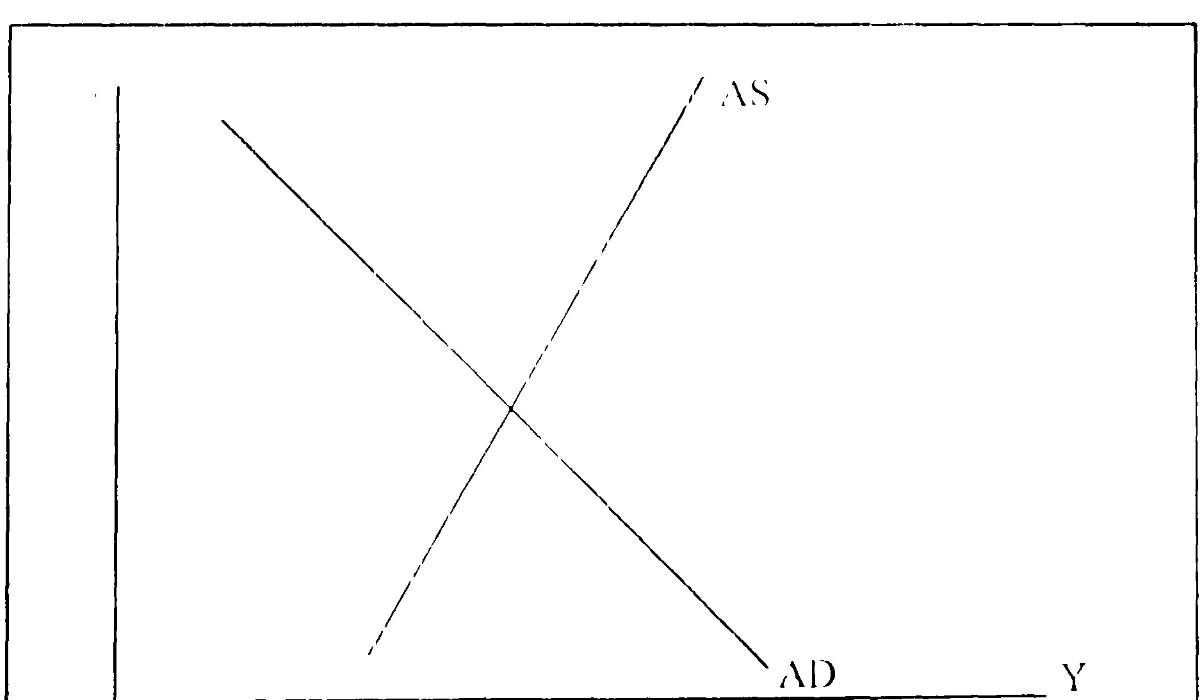

Table1: Trends in Inflation, 1969-1988(%)[1]

	Average[2] 1969-78	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Industrial countries[3]	7.8	8.1	9.3	8.8	7.3	5.0	4.3	3.8	3.4	2.9	3.4
Developing countries[4]	16.7	21.5	27.2	26.4	25.0	34.0	39.4	40.6	28.6	30.1	29.5
By region											
Africa	11.6	16.7	16.4	21.9	11.4	19.5	20.3	12.8	14.8	12.6	10.5
Asia	8.7	8.0	13.1	10.7	6.3	6.6	7.2	7.4	5.9	5.4	5.6
Middle East	10.8	11.7	16.8	15.2	12.7	12.3	14.9	12.2	11.1	11.1	9.9
Latin America	31.0	46.5	54.6	59.7	68.4	106.3	129.3	150.3	86.5	97.7	98.8
By analytical criteria											
Fuel exporters	11.3	12.1	15.6	16.1	17.6	25.0	19.8	13.4	19.4	22.2	15.3
Non-fuel exporers	19.0	25.7	32.5	31.3	28.8	38.9	50.4	55.9	33.1	33.8	35.6

1 As measured by changes in GNP deflators for industrial countries and changes in consumer prices for developing countries.

2 Compound average rates of change.

3 Average of percentage changes in GNP deflators for individual countries weighted by the average US dollar value of their respective GNPs over the preceding three years.

4 Percentage changes of geometric averages of indices of consumer prices for individual countries weighted by the average US dollar value of their respective GDPs over the preceding three years. Excluding China prior to 1978.

SOURCE : IMF, World Economic Outlook 1987 and 1996, Washington, D.C., IMF, TableA.8

Inflation in developed countries is frequently attributed to monetary reasons. However, in the developing world, there are two competing views about inflationary causes: commonly referred to as the monetarist and structuralist perspectives. Monetarism, as Ghatak (1995a: 96) summarizes, treats inflation as a monetary phenomenon, and control of the money supply is a necessary and sufficient condition to cure it. In contrast, Structuralism attributes inflation to certain structural features of DCs. These particular characteristics make DCs prone to inflation in the process of their development. Structuralists emphasise that treatment of inflation, holding development programme unchanged, requires a removal of the structural bottlenecks that are the underlying sources initiating and perpetuating inflation[1].

Whatever the sources of inflation, questions about its effects and costs are important. Inflation costs may be independent of the postulated causes. Of course, when the cure of the problem is being discussed there are likely to exist close relationships between hypothesized causes and policy recommendations to remove the problem (Artis, 1984: 167). Effects of inflation on growth, government revenue and redistribution of income from poor to rich, *inter alia*, are important. For a selective review of inflation costs see Briault (1995).

The remainder of this chapter is organized as follows: section 2.2 explains Monetarist views on inflation. Then Structuralist opinions are considered in section 2.3. Part 2.4 compares and contrasts the two views and tries to reconcile between them. Finally, in section 2.5 empirical evidence is provided.

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[1] Demand-pull and cost-push analyses to investigate inflation in DCs have been frequently criticized by economists. Demand-pull, associated with the Keynesian inflationary gap model, is relevant to an economy at or near full employment and implicitly assumes the economy to be fully elastic, while DCs are characterized with acute unemployment, under-utilized capital stock, and also with various rigidities. Analogously, the cost-push or wage-induced inflationary process does not seem relevant to DCs where a large proportion of labour works in agriculture sector and the industrial labour force is rarely well organized in trade unions due to the political interest of governments. In such circumstances, wage increases follow living costs rather than leading them (Hossian, 1988: 56-57). Even for developed countries, Laidler and Parkin (1975: 742) in their comprehensive survey *"find the cost-push, demand-pull distinction analytically unhelpful"* in classifying the developments associated with inflation. They believe inflation to be a macroeconomic phenomenon affecting the whole economy.

2.2 The Monetarist Perspective

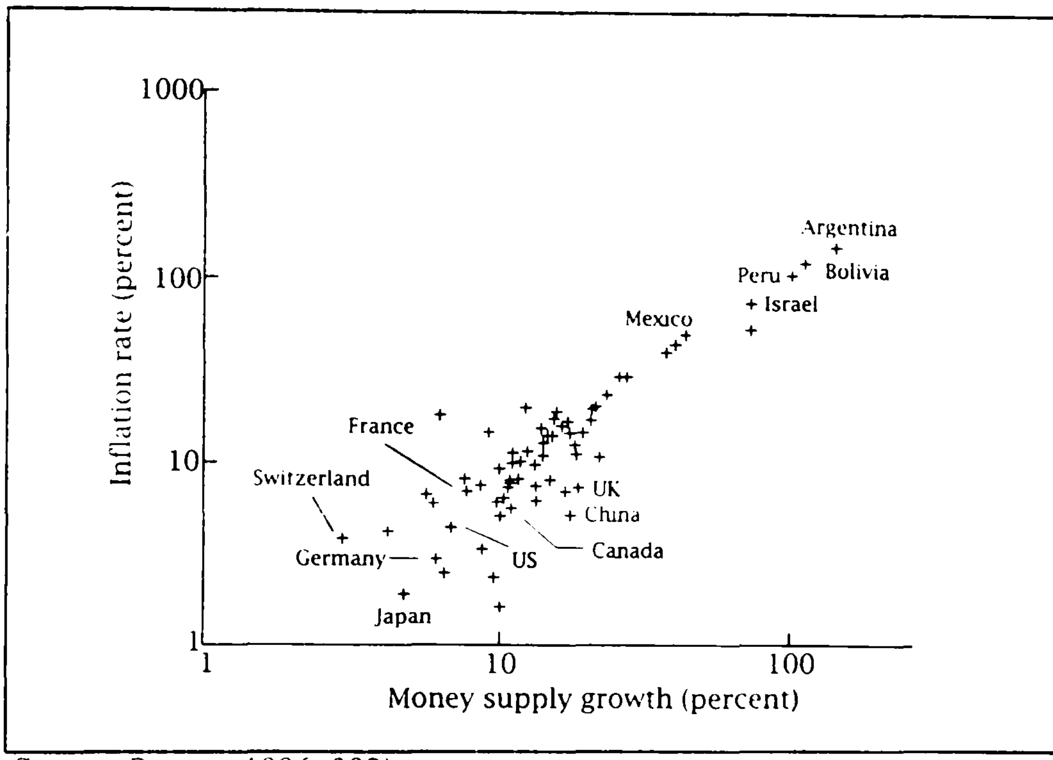
Monetarists view inflation as a completely monetary phenomenon perpetuated by expansionary fiscal and monetary policies. These expansionary policies are budget deficits, loose credit policy and exchange rate policy. In consequence, a necessary and sufficient condition for coping with inflation is keeping the rate of money supply growth consistent with money demand growth so as to stabilize prices. A reduction in the inflation rate requires the elimination of excess demand by the means of contractionary monetary and fiscal policies, wage control and abandonment of an over-valued exchange rate (Kirkpatrick and Nixon, 1987:177 and Ghatak, 1995a:96).

Romer(1996:390) argues that economists usually underline just the money supply growth to explain the movement of prices over the longer term. This is because other factors are unlikely to generate continuous rises in the price level. In other words, paying attention to Figure 1, it seems obvious that a continuous increase in prices requires either continuous rise in aggregate demand or repetitive contractions in aggregate supply. Repeated falls in aggregate supply, given progress in technology, seem improbable. Aggregate demand can rise repeatedly due to many factors with most of them somewhat limited like tax reductions; but money supply can vary at almost any rate, from large increases observed in hyperinflation eras to dramatic decreases experienced during deflation. Although money growth influences prices as directly as other factors do, empirical evidence suggests that most of the variations in aggregate demand can be explained by money growth variations. Figure 2 depicts the correlation between the average annual growth rate of money supply and prices for 65 countries in 1980s.

2.2.1 The Quantity Theory of Money

Monetarism, as Cagan(1992:720) states, stems from the quantity theory of money, which relates nominal aggregate expenditure (demand) , consisting of both output and price level, to money stock and the velocity of circulation of money. In the long-run, velocity experiences rather small changes induced partly by prior money stock changes. Likewise, over the long-run, physical output is determined by non-monetary factors. Thus, it is mainly prices that are influenced by changes in the money stock. The evident long-run relationship between money and prices suggests that money over-expansion results in inflation which can be cured by appropriate reductions in money supply growth.

Figure 2: Correlation Between Money and Inflation



Source: Romer (1996: 392)

In Friedman's (1992: 248) expression of the quantity theory of money, what holders of money are concerned with is the real amount rather than nominal quantity of money. And also everybody prefers a certain quantity of real money. Starting from a desired quantity of real money, an unexpected rise in the nominal money stock increases the cash balances held by individuals more than the amount that they prefer to hold. Then they try to return to their desired real balance by paying out a larger amount of money by purchasing goods, services and securities or repayment of debts. But the community as a whole fails because what one man spends another earns. Nevertheless, these efforts to dispose of the undesired balances will have significant outcomes. With flexible prices and incomes, these attempts increase nominal spending, in turn leading to higher prices and probably an increase in physical output, while if customs or governments fix prices, the excess money balance will either cause the output to rise or generate *shortages* and *queues*: this in turn, increasing effective prices, ultimately enforces a change in customary or authoritative prices. Friedman argues that it is extensively recognized that expansionary monetary and fiscal policies are, at best, a temporary stimulation of economic activities; if, however, they continue they would be mirrored primarily in inflation. He concludes:

> " ...*inflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in the output. Many phenomena can produce temporary fluctuations in the rate of inflation, but they can have lasting effects only insofar as they affect the rate of monetary growth* "
> (Friedman, 1992:261)

In symbols, this discussion can be illustrated as follows: the identity for the quantity of money is :

$$MV \equiv PY$$

where M = nominal money stock

V = number of times per period, on average, that the stock is used to pay for final goods and services

P = general price level

Y = real income (output)

Taking logarithms, then differentiation with respect to time gives:

$$\ln M + \ln V \equiv \ln P + \ln Y$$

$$\frac{d\ln M}{dt} + \frac{d\ln V}{dt} \equiv \frac{d\ln P}{dt} + \frac{d\ln Y}{dt}$$

$$\frac{dM/dt}{M} + \frac{dV/dt}{V} \equiv \frac{dP/dt}{P} + \frac{dY/dt}{Y}$$

$$\dot{M} + \dot{V} \equiv \dot{P} + \dot{Y}$$

$$\dot{P} \equiv \dot{M} + \dot{V} - \dot{Y}$$

where the dot over the letters refers to the rate of change over time.

There are three propositions on which the monetarist view is based:

1. The stability[2] of the velocity of circulation, V.
2. Although monetary factors may affect real income in the short-run, in the longer-term real factors such as technology and population determine the level of real income.
3. The money supply is exogenous and is under government control (or, at least different factors determine it).

Proposition 1 implies V is constant, so $\dot{V} = 0$. According to proposition 2, in the long-run income is near or at full employment, hence its implication is that $\dot{Y} = 0$. In consequence, there is just one exogenous variable controlled by the government, the money supply, which determines the price level (Jackman *et al*, 1981:114-5). In the short-run (characterized by $\dot{V} = 0$ and $\dot{Y} \neq 0$), the desired inflation rate can be achieved by increasing the money supply growth such that its discrepancy from the income growth target equals the inflation rate, as the equation below implies:

$$\dot{P} = \dot{M} - \dot{Y}$$

2.2.2 Money Market Equilibrium

Money market equilibrium can also be used to show the importance of the money supply in inflation determination. The real money demand function is specified as an increasing function of income and decreasing function of interest rates. This is because when output rises the real amount of money needed for transaction purposes increases and if the nominal interest rate rises the opportunity cost of money holding will increase, so individuals decrease their real cash balances. Money supply, M^S, is determined exogeneously, so for equilibrium we require :

$$(M/P)^s = \frac{M}{P}$$

$$L = L(i, Y) \qquad L_i < 0, L_Y > 0$$

[2] Stability, as Monetarism claims, means that "*successive residual errors are generally offsetting and do not accumulate.*" (Cagan, 1992:724)

$$(M/P)^s \equiv L$$
$$\frac{M}{P} = L(i, Y)$$
$$P = \frac{M}{L(i, Y)} \qquad (2.2)$$

where M = nominal money supply

P = price level

L = demand for real money

i = nominal interest rate

Y = real income

Defining the real interest rate as the difference between the nominal interest rate and the expected rate of inflation ($r \equiv i - \pi$) and bearing in mind that in equilibrium the real interest rate and income are constant, it will be seen that :

$$P = \frac{M}{L(\bar{r} + \pi \ , \bar{Y})} \qquad \text{(Romer, 1996:199, 392)}^3$$

or in growth rates :

$$\dot{P} = \dot{M} - \Delta \ln L \qquad L_\pi < 0$$

This equation implies that the rate of inflation increases at the same rate at which money supply growth exceeds the rate of desired real money balances. Since with increasing anticipated inflation individuals decrease their real balances to economize their money wealth, a higher rate of expected inflation leads to higher actual inflation, at any given rate of money supply growth.

2.2.3 Major Monetary Sources of Inflation

The money supply definition and money market equilibrium condition may be used to explain some important aspects of the Monetarist view of

[3] Even if the real interest rate is independent of expected inflation in some circumstances, the nominal rate, and consequently, the demanded real money balances is affected by expectations (McCallum, 1992: 402).

inflation, including the government budget deficit and changes in the current account.

The money supply, M^s, is defined as the product of the money supply multiplier, m which reflects the behaviour of banking system and holders of assets, and high-powered money, H :

$$M^s = mH$$

The stock of high-powered money or monetary base consists of the international reserve stock in terms of domestic currency, eR, and net domestic assets of the central bank, D:

$$H = eR + D$$

where the international reserve stock, R, is in terms of foreign currency, so it is multiplied by e, the exchange rate, in order to be in domestic currency value[4], therefore :

(2.3) $$M^s = m (eR + D)$$

Substituting M^s from (2.3) into equation 2.2 entails a long-run equilibrium :

(2.4) $$P\, L(i, Y) = m (eR + D)$$ (Blejer and Frenkel, 1992: 725)

Assuming an economy with a fixed exchange rate and at or near full employment, several implications emerge from this equation :

- Government financing by money creation and/or easing of credit policy increases the money supply through rises in D, central bank assets. If this increase is not offset by an equal reduction in foreign reserves, eR, the price level will increase[5].
- An increase in foreign reserves via international aid (or cheap foreign credit) or an export commodity boom (in particular, in oil

[4] The exchange rate is defined as the price of one unit of foreign currency in terms of domestic currency.

[5] The national income identity (injection = leakage) can be used to show that at a given level of income, constant net saving, and constant price, the budget deficit may be financed only by current account deficit (or foreign reserve reduction) :

$$G + I + (X-M) = S + T$$
$$(G - T) = (S - I) + (M - X)$$

Budget deficit = net saving + current account deficit. (Fischer and Easterly, 1990:129. Also see Mirier, 1989: 217) exporting developing countries) increases money supply and leads to inflation[6].

- As Fischer and Easterly (1990:133) state, although the use of foreign exchange reserves or external borrowing to finance a budget deficit appreciates the domestic currency and lowers monetary expansion, which itself squeezes the inflationary process, it worsens current account difficulties and usually leads to devaluation and consequent inflationary pressure.
- Purchasing power parity implies :

$$e = P / P^*$$

or

$$\dot{e} = \dot{P} - \dot{P}^*$$

where e is defined as above, P and P^* stand respectively, for domestic and foreign price levels. With fixed exchange regime ($\dot{e} = 0$), the domestic price level relates directly to world inflation while with flexible exchange rates, an increase in world inflation should be offset by an increase in the exchange rate and/or domestic inflation (Jackman *et al*, 1981:136)[7]. Thus, another implication of equation 2.4 is that in a fixed exchange regime world inflation increases domestic inflationary pressure (depending on the share of imports in the domestic market) and with a flexible exchange rates, it affects domestic inflation directly and via the expansion of money supply.

Blejer and Frenkel (1992:726) state that although this model (eq. 2.4) portrays the long-run characteristics of the economy effectively, with a sluggish international capital flow and a high share of non-tradable goods in GNP, the adjustment speed of foreign reserve to monetary imbalances will be reduced. This in turn, leads to an excess money supply, which in the short-run affects prices, output and the interest rates. The importance of these effects

[6] For a typical oil economy discussion in this context see Hagen (1973).
[7] Jackman *et al* define the exchane rate inversely.

varies due to various factors such as the degree of openness of the economy, the exchange rate regime, the share of tradable and non-tradable goods in GNP, the degree of resource utilization, and the degree of rigidity of nominal and real wages.

According to Kirkpatrick and Nixon (1987:184), this new version of the monetary approach pays more attention to price adjustment and distinguishes between tradable and non-tradable goods in considering price changes. It more realistically accepts that surplus demand induced by an initial money supply increase (an increase in domestic credit creation) is accommodated partly by changes in domestic production. Bearing in mind that output is at or near the full employment level, non-tradable goods prices rise, which in turn leads to reallocation of resources from the tradable sector to the non-tradable sector, reducing the supply of exports and worsening the current account. If the increase in the price of non-tradable goods ends up as an increase in wages, the upward pressure on the general level of prices will be greater. Although these descriptions of the process by monetarists are new, the policy prescription is the old one : inflation and the external deficit will be removed by a reduction in money supply via reduction in domestic credit creation : a purely monetary treatment.

2.3 The Structuralist Perspective

Structuralism stems from Raul Prebisch's idea about the essential difference between the structure of production in developed countries and developing countries. This idea views the developed economy as homogeneous and diversified and the developing economy as heterogeneous and specialized. By heterogeneity and specialization he means that the economy of the periphery is composed of a relatively advanced enclave export sector with few backward and forward linkages and other sectors which operate at low productivity. This important structural difference lies behind the different functioning of the two kinds of economies (Palma, 1987:529).

In fact, as Bevan, *et al* (1990: 1) emphasise, the structures of developing and developed countries are so different that applying modern macroeconomics, originated mainly in the United States, for DCs poses severe problems. In DCs, there is no notable financial market, the economies are small, open and periodically depressed by transitory shocks, while most of them are heavily controlled by government regulations, characteristics completely unfamiliar in developed countries, in particular the United States.

Structuralists, as Wachter (1976: 4) states, view some fundamental *structural* factors as responsible for the inflationary process. They believe that the basic source for inflation is generally, " *the pressure of economic growth on an underdeveloped social and economic structure* ".

2.3.1 Development and Inevitable Inflation

DCs are transforming from an inefficient, mismatched and underdeveloped situation, normally dependent on a primary product, to a diversified economy with reasonable intersectoral relationships. Thus, they need sustainable growth and structural changes. However, a developing country has some structural bottlenecks which make it prone to a continual inflation. As Kirkpatrick and Nixon (1987:176) state, these bottlenecks characterize the fundamental features of the institutional economic and socio-political structure of the country which in different ways prevent development. As a consequence, fundamental changes are required for economic development. However these changes, contrary to developed countries, cannot be fulfilled by the price mechanism because markets are very imperfect with respect to resource mobility. Hence deficiencies and disequilibria emerge. The important bottlenecks addressed by structuralists are :

1. Food supply inelasticity
2. Fiscal constraints of the government
3. Foreign exchange constraints

Relative price changes are viewed as a main factor in the determination of inflation. The development programme, directed usually towards urban areas, increases income and subsequently, demand for food. These excess demands must be met by more supply via either domestic production or imports or both. Otherwise, the price of food will rise. But due to inelastic agricultural supply and foreign exchange constraints the relative price of goods usually increases. As Natalegawa (1988:11) describes, the downward rigidity of prices (and wages) prevents the upward movement of food price from being offset with corresponding decreases in other prices, therefore, the relative price rises and leads to upward pressure on the general level of prices. Natalegawa argues that the situation in factor markets is also the same[8]. Moreover, even in equilibrium in aggregate, sub-market inflation will arise and lead to whole-market inflation. The reason is that the market which faces excess demand cannot meet needs due to the reasons mentioned above and in the market with excess supply, stickiness prevents prices from falling. In consequence, the general level of prices increase.

Canavese (1982:524) suggests a formalization which explains this process. Suppose goods are classified into two aggregates: agricultural and industrial goods and $P_R = P_A / P_I$ refers to relative prices of agricultural to industrial goods. Assuming that the growth rate of demand for agricultural output (δ) is greater than their supply growth rate (σ), $\delta > \sigma$, and that industrial goods' prices are downwardly rigid, $\dot{P}_I \geq 0$ (dot refers to rate of change), equilibrium analysis of the relative price time path drives the result. Equality of supply, S, and demand, D, is a requirement for equilibrium :

$$S(P_R, t) = D(P_R, t)$$

Partial derivatives with respect to time give :

$$\frac{\partial S}{\partial P_R} \cdot \frac{dP_R}{dt} + \frac{\partial S}{\partial t} = \frac{\partial D}{\partial P_R} \cdot \frac{dP_R}{dt} + \frac{\partial D}{\partial t}$$

Multiplying both sides respectively by P_R / S and P_R / D (bearing in mind that D=S) and rearranging :

[8] There is no difference, whether the relative change occurs in the prices of outputs, production factors or outputs and factors. In any case an increase in relative prices in these circumstances leads to a net increase of the general price level (Olivera, 1979:549).

$$\frac{\partial S}{\partial P_R}\cdot\frac{P_R}{S}\cdot\frac{dP_R}{dt}+\frac{\partial S}{\partial t}\cdot\frac{P_R}{S}=\frac{\partial D}{\partial P_R}\cdot\frac{P_R}{D}\cdot\frac{dP_R}{dt}+\frac{\partial D}{\partial t}\cdot\frac{P_R}{D}$$

In terms of the elasticities of supply of and demand for food (respectively ε and η) and the rates of aggregate growth, the rate of change in relative prices is defined as :

$$\frac{dP_R}{dt}\cdot\varepsilon + P_R\cdot\frac{\partial S/\partial t}{S} = -\frac{dP_R}{dt}\cdot\eta + P_R\cdot\frac{\partial D/\partial t}{D}$$

$$\frac{dP_R}{dt}(\varepsilon+\eta) = P_R(\delta-\sigma)$$

$$\frac{dP_R/dt}{P_R} = \frac{(\delta-\sigma)}{(\varepsilon+\eta)}$$

$$\dot{P}_R = \frac{(\delta-\sigma)}{(\varepsilon+\eta)}$$

The definition of relative price gives :

$$\dot{P}_R = \dot{P}_A - \dot{P}_I$$

(2.5) $$\dot{P}_A - \dot{P}_I = \frac{(\delta-\sigma)}{(\varepsilon+\eta)}$$

For simplicity, the general price index, P, is assumed to be a geometric mean of the two prices :

$$P = P_A^{\alpha}\cdot P_I^{(1-\alpha)}$$

$$\pi = \alpha\cdot\dot{P}_A + (1-\alpha)\cdot\dot{P}_I$$

(2.6) $$\pi = \alpha(\dot{P}_A - \dot{P}_I) + \dot{P}_I$$

Finally the inflation rate, π, is defined by substituting equation 2.5 into 2.6 as:

(2.7) $$\pi = \alpha\left(\frac{\delta-\sigma}{\varepsilon+\eta}\right) + \dot{P}_I$$

Equation 2.7 implies that even with constant prices of industrial outputs ($\dot{P}_I = 0$), inflation will occur because $\delta > \sigma$, hence the first term on the right hand side is positive: this is due to relative price changes resulting from structural bottlenecks.

As a response to inflation, social groups try to maintain their real purchasing power , wage-earning groups by readjusting their wages, salaries and benefits, profit-earning groups through price increases, and the government via an increase in the nominal budget by money creation (Sunkel, 1960:111). These measures act as propagation elements[9] and fuel a new rise in relative prices , and the process continues. The important point is that monetary authorities have to increase the money supply to meet money market equilibrium during the process in order to sustain the growth rate of the economy and development progress. In fact, as Ghatak (1995a:100) emphasizes, structuralists accept that a requirement for an inflationary process is an expansionary monetary policy. However, they argue that if the money supply is not expanded, the economy will experience either output reduction and higher unemployment via increasing wages (and lower investment due to contractionary credit policy) or social and political problems because of rigid nominal wages. In fact, structuralists argue that inflation can be influenced by money supply reduction. However, this remedy not only does not completely cure inflation, it may well postpone the elimination of structural impediments which initiate and perpetuate inflation. Thus, although they accept the importance of the money supply in the inflationary process, they consider the structural features of DCs as requiring an increasing money supply during development progress.

2.3.2 Budgetary Constraints

For DC governments, it is difficult to maintain a balanced budget while public sector involvement in economic activities increases during the development process. This is because if the government does not increase its investment (or at least holds it constant in real terms) there will not be enough infrastructural elements to fuel the development engine. Furthermore, imperfect markets provoke governments to intervene more in the economy, inducing

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[9] A propagation element is a mechanism which does not bring about inflation by itself, however, it causes inflation to continue and even intensifies it (Sunkel, 1958). "Perpetuation" seems more appropriate to describe this situation.

more expenditure. However, even with a balanced budget, when inflation begins a budget deficit nearly always occurs. Although it is often said that budget deficit causes inflation, the budget deficit may be high due to inflation, as Dornbusch and Simonsen (1992:101) argue. They state that lags in tax collection cause the *real* revenue of the government to decrease in the inflationary period, a phenomenon often called the Olivera-Tanzi effect. The amount of erosion of the government real revenue depends upon the tax structure[10]. In DCs with an insufficient tax base, inefficient (even corrupt) tax administration and the impossibility of a high tax burden due to political difficulties, the lags in tax collection and the inflation rate will be higher, as well the erosion of government real revenue (Tanzi, 1978:417, 444). Present value formulation can be used to illustrate the impact of various lag lengths and inflation rates on tax revenue :

$$TR = \frac{1}{(1+\pi)^n}$$

where TR is a unit of real tax revenue gained today assessed n months ago while prices increase by the monthly rate π. It is clear that with longer lags (greater n), and higher rates of inflation (larger π), real tax revenue will be smaller (Tanzi, 1977:157).

As a result of this structural characteristic and the fact that the government can not easily decrease its expenditures, it faces (increasing) budget deficits. However, open market operation cannot be used to finance the budget deficit because another structural bottleneck is an inefficient and limited capital market, which leads governments to finance deficits by money creation (Ghatak, 1995a:101). Absence of central bank independence makes this possible for governments (a structural characteristic of banking system in DCs). This passive monetary factor may act as a perpetuation element for the initial inflation.

One important feature of the budget structure in DCs, in particular in oil exporting countries, is the role of the export sector in government revenue.

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[10] See also Dornbusch and Fischer (1986: 4). For a detailed discussion about the structure of tax system in DCs, see Ghatak (1995b: 134-144).

Export revenues usually experience fluctuations due to exogenous factors. These fluctuations may worsen budget deficits as well. This matter is studied in section 2.3.4.

2.3.3 External Constraints

Meier (1989:221) states that, based on the " two-gap" approach, development depends on investment which needs domestic saving. However, this requirement is not adequate to guarantee development process. This means some goods and services from abroad are possibly necessary to complement those available at home. In fact, the economic structure of most DCs is so simple, such that if it relies exclusively on internal resources, a limited range of output will be produced. This means domestic saving may well not meet all necessary resource requirements for the investment process. A DC may not have the capability to produce the cement, steel or machinery required for different projects, though it may make adequate financial savings by contracting consumption. Development progress can only be made if the saving can partly be used to buy overseas equipment. In consequence, in the development process, foreign exchange requirements may make for balance of payment difficulties.

In dual-gap modeling, that characteristic has been taken into account. The algebric form of the two-gap analysis, as Ghatak (1995b:154) suggests, is :

$$C + I + X \equiv Y + M$$

$$C + S \equiv Y$$

$$S + FR \equiv I$$

$$M \equiv X + FR$$

where C, I, S, Y, X, M, and FR are respectively consumption, investment, saving, income, export, import and net foreign resource inflow. This model implies that the domestic saving is investible if there is a complementary foreign inflow, which represents external deficit as well[11].

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[11] An assumption of this model is balanced budget. If we, more realistically, take existing budget deficits in DCs into account, the national income account again reflects the external

Actually, high rates of population growth and industrialization in a situation characterized by structural imbalances, technological restrictions and imperfect mobility in factor markets, increase the demand for imports during developent process (Kirkpatrick and Nixon, 1987: 176). However, due to relatively low income elasticity of demand for imports of primary products (the export of most DCs) in developed countries (Todaro, 1994: 417), it is probable that foreign exchange receipts grow insufficiently. External deficits appear and lead to devaluation and consequent inflationary pressure. The outcomes will be worse when the price elasticity of demand for imports in DCs is low (Kirkpatrick and Nixon, 1987: 177).

Balance of payment difficulties are not the only external structural constraint contributing to domestic inflation. As Parkin (1992: 397) states, international trade and capital market international transactions sizably influence its inflation and also a fixed or flexible foreign exchange regime importantly affects inflation performance. There are several factors, more and less associated with structure of the economy in DCs, which may influence domestic inflationary process :

1. A rise in prices of some goods with high weight in total import, for instance fuel and capital goods. Analogously, a rise in general level of imported goods.
2. An increase in costs of invisible imports such as the interest rate on international borrowing (Griffith-Jones, 1985: 10).
3. An increase in the prices of export creating a windfall. These may magnify domestic spending , and push up the prices of the domestically produced outputs. Foreign aid or easy foreign financing usually has the same effects (Griffith-Jones and Harvey, 1985: 336). It influences the general price level because it increases foreign reserves if not compensated by extra imports (or other kinds of capital outflow) (Kirkpatrick and Nixon, 1987: 186).

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constraints : $I + G + X \equiv S + T + M$ or $(G - T) \equiv (S - I) + (M - X)$. This implies fiscal deficits can be offset by trade deficits if there is not a saving gap. An insufficient saving worsens the external constraints and the economy faces three gaps. For a three-gap model discussion see Bacha (1990).

However, this development depends on the policy choice of a DC's government. How they use the new receipts, and when, determine the effects of the windfall (see points 1 and 2 in p. 32-33 and also footnote 21).

4. Restoration of a declining real exchange rate either via devaluation which increases import prices, or import control (licensing, exchange control, quota system ...). Both decrease aggregate supply, which in the absence of monetary contraction, leads to inflationary pressure.
5. A sharp decline in exports via, for example, stagnation in trade partners' economies or drastic fall in exports prices. This in turn decreases government revenue from the external sector. Since the persistent commitment of the government can not be easily cut, budget deficits increase. Likewise, the fall of export receipts decreases import capacity which contracts aggregate supply (Griffith-Jones and Harvey, 1985: 336).
6. Fluctuations in export receipts with downward rigidity of (some) prices, which in the long-run, tend to cause upward movement in the general level of prices (Natalegawa, 1988: 18).
7. Import substitution or export promotion policies, raising average costs in associated sectors, affects the inflationary process indirectly (Kirkpatrick and Nixon, 1987: 186)

Although some of the above points seem to be contradictory, they may lead to inflationary pressure in different circumstances. Griffith-Jones and Harvey (1985: 337) argue that an inflationary process initiated or stimulated by external factors becomes so institutionalized that it becomes very difficult to reverse.

2.3.4 The Case of Oil Exporting DCs

Since oil exporting DCs seem not to have balance of payment problems, at least as severe as other DCs, it is worthwhile to consider some of their characteristics separately. Hagen (1973: 76) portrays a typical oil economy[12] with five parts as : the Fount, the Farm, the Market, the Bank and

[12] By oil economy he means the oil exporting countries or an economy supported by long-term foreign aid.

the Rest of the World. The first part, the Fount, produces very productively, a commodity for the Rest of the World. Productivity in the second and third parts is very low. The Fount transacts its foreign exchange receipts at the Bank (state-owned or private) to obtain domestic currency. These local earnings are spent in the Market via government expenditure or directly. The Market spends a part of its income on foreign exchange at the Bank in order to import goods and services from the Rest of the World. So long as the Fount increases its expenditure, nominal income rises, accompanied by inflation[13], without a significant improvement in technology.

The Hagen description is not the end of the story. Oil receipts usually affect the inflationary process, both when an oil exporting developing country obtains a windfall created by a positive shock , or when it faces a sharp cut in export proceeds after a negative shock. Moreover, the fluctuation in export earnings is another problem. The structural characteristics of DCs play an important role in this context.

Regarding a windfall, its effects depend on where it occurs. They vary between economies with well linked sectors and an 'enclave' economy. A windfall created by a resource discovery or export price jump in a developed economy affects resource allocation via two channels: in the labour market, the booming sectors attract more factors to build up its production, influencing other sectors (resource-movement effect) (Cuddington, 1989); and in commodity markets, via relative prices (spending effect). These effects lead to resource reallocation to restore efficiency at a new equilibrium point. The result of the two effects on resource allocation depends on the economy's structure (Neary & Wijnberger, 1986)[14] .

With respect to economies with an enclave sector, like most oil exporting ones in DCs, there is little competition between the booming sector and the others for productive factors. In fact, such a sector needs skilled workers and sophisticated technology which could hardly be met by other

[13] Owing to the existence of some rigidities and bottlenecks.

[14] See Weymen, J. & Thomas, G. (1986) for North Sea oil discovery and its effect on the UK economy as an example.

sectors. That means it has its own markets for labour. capital and technology. In this case, the outcomes occur only via "spending the windfall".

The relative price of tradable and non-tradable goods (known as real exchange rate) is the main variable to be affected by windfalls. Dividing domestic products into tradable (excluding oil) and non-tradable goods (included services and construction), relative price is defined as :

$$p = e.P_T / P_N$$

where : e = nominal exchange rate

P_T = price of tradable goods

P_N = price of non-tradable goods

In this equation three important points are reflected by p : Firstly , the national income increase builds up the demand for the two kinds of goods. Tradable goods are available at a constant world prices (the country is small). However, excess demand of non-tradable goods causes their prices to rise. Market clearing and full-employment are fulfilled[15] . As a consequence, the price of non-tradable goods rises relative to that of tradables, and intersectoral reallocation in the non-oil part of the economy will occur. That means more non-tradable goods are produced at the expense of the lower-valued tradable production[16] .

Second, p, also called real exchange rate (RER), reflects the changes in external trade. A fall in real exchange rate encourages people to increase consumption of imported goods instead of domestic output. In fact the proportion of import and internal production in total spending is determined by the real exchange rate. Thus the current account balance might be explained by changes in the RER (Dornbusch 1980 : 58). Finally, the relative price defines the price of domestic goods in terms of foreign output. Therefore, it reflects competitiveness in the world market .

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[15] A more realistic assumption for developing countries is that their production could not adjust quickly to excess demand because of institutional constraints.

[16] Dutch Disease, deindustrialization and deagriculturization are different names for this.

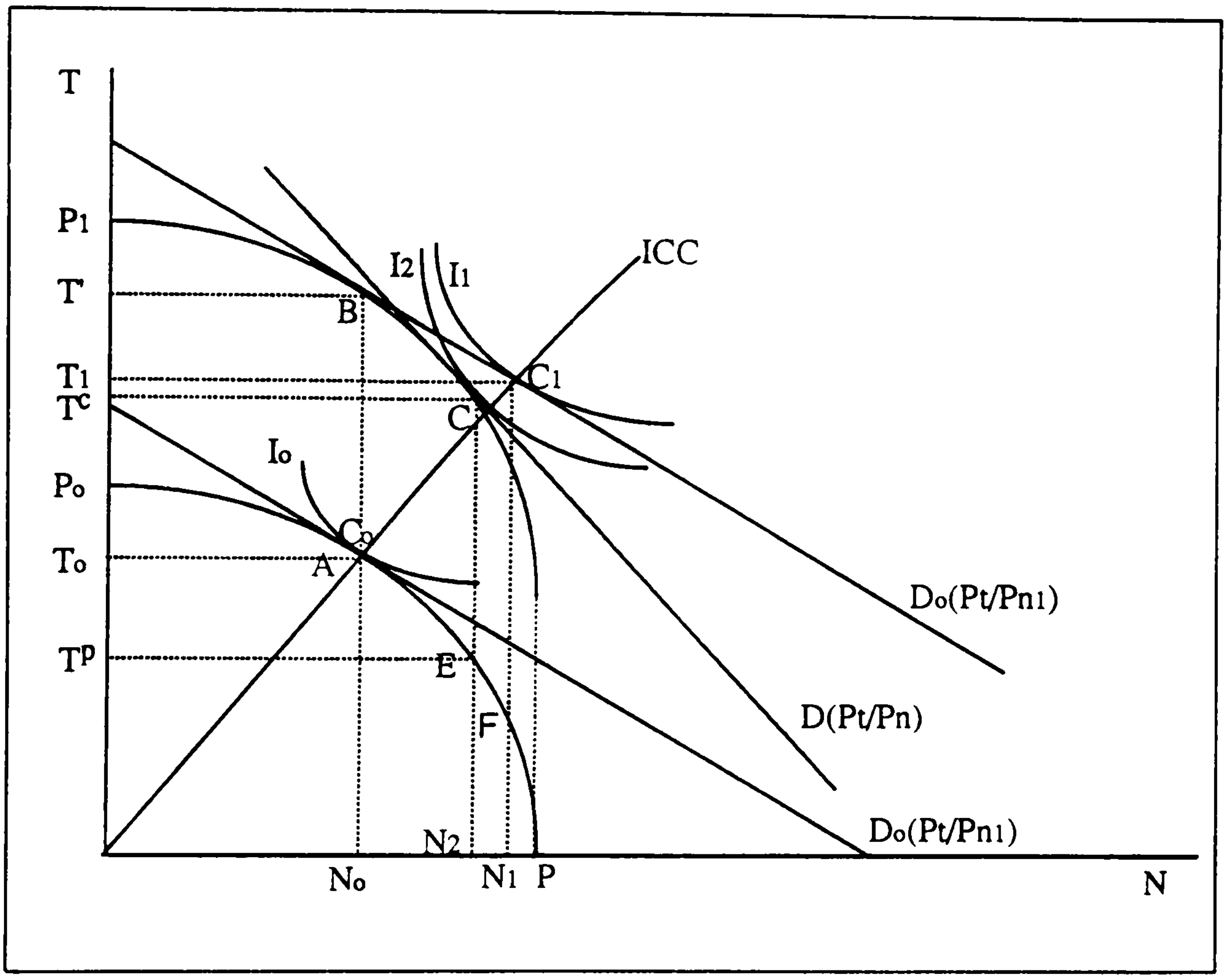
Using a diagram similar to Salter's (1959), the spending effect can be explained clearly. In Figure 3 the horizontal axis represents nontraded goods and the vertical axis traded goods. P_0P is the production possibility curve. The line D_0 represents the relative price of traded to nontraded goods. Before the windfall, D_0 also represents the expenditure line of the community (based on the assumption of full employment). Hence, the initial equilibrium point of production and consumption is at A, where the slopes of the production possibility curve and social indifference curve are equal to that of the relative price line, D_0. At this point the community produces and consumes N_0 and T_0 of nontraded and traded goods.

Before price adjustment, the windfall, as an exogenous transfer, does not change nontraded output, but increases consumption possibilities in traded goods. Therefore the P_0P curve shifts to P_1P, which represents the new budget constraint (Nontraded output is dependent on relative prices, which remain unchanged, but consumption depends also on the real income increased by the windfall). At point B production and consumption of nontraded goods remain on N_0 and the shortage of tradable goods (T_0 T')will be offset by imports.

However, even with unchanged prices, desired consumption is at C_1, the point of intersection of the relative price line D_0 and the income consumption curve (ICC). At this point excess demand for nontraded goods (N_0 N_1) makes them dearer and their production will be more profitable than that of tradable goods. In consequence, the production point moves from A to F. More output of nontraded goods and less demand due to high prices may cause the adjustment to continue until point C, where the new relative price (real exchange rate) line, D, becomes the common tangent of P_1 P and the highest attainable social indifference curve I_2.

Now the consumption of tradable and nontradable goods become respectively Tc and N_2. The corresponding production point is E, where the output of the two kinds of goods become T_p and N_2. The N_0N_2 increase in nontraded goods is secured at the expense of T_0T_p decrease in home production of tradable goods. The windfall is used to import the quantity of T_pT_c of tradable goods. It can be seen that the spending effect and the subsequent relative price change (real exchange rate appreciation) change the domestic

Figure 3 : Spending Effects of a Windfall



output structure and increase the dependence on imports.

Although it seems that the welfare at the new equilibrium point is higher, this is not the end of the process. Dutch Disease has some costs which are usually caused by the temporary nature of the windfall in a commodity boom and also the cost of the movement of the production point from A to E and consumption point from C_0 to C and their reverse movement after the end of the windfall. So far it has been assumed that the windfall is obtained by households exogenously, but if a government receives the windfall directly or most of it from taxation, the economy faces new difficulties:

1. The duration of the windfall affects spending effects. Households usually treat the windfall as a temporary income and their consumption behaviour does not change much or very quickly. Thus the gap between the two output points (A and E) and their associated costs will be smaller. However,

governments often augment their expenditure quickly so the cost of production adjustment is higher.

2. The consumption behaviour of governments and households is dissimilar. Governments usually accept new commitments after the windfall in order to provide more goods and services, which necessitates public sector expansion. Thus the demand gap for nontraded goods, N_0N_1, will be wider and in consequence the cost of movement from point A to E increases.
3. Adjustment to the end of the windfall may create a range of difficulties. It is quite likely that households will adjust to new circumstances due to their prediction of the temporary nature of a windfall. However, governments cannot always adjust their increased expenditure in order to avoid the undesirable social and political effects of expenditure reduction. As an improvement of the inefficient tax system is often neglected during the boom, when the windfall reduction occurs, the established commitments are financed by money creation via internal or external borrowing or both, that in turn result in more pressure on inflation.
4. The windfall brings about more government intervention in economic activities. Therefore, a sizable amount of resources are allocated by official decisions which is not as efficient as market allocation. This issue makes the government a rent distributor that in turn attracts many output factors to seek higher rent, rather than real production. After the windfall cut, there are two reasons why the production point cannot come back to point A (see Figure 3) and occurs probably at a point below the production possibility curve P_0 P : firstly, the behaviour of factors who used to be rentiers, and secondly, deficit financing by money creation.

In fact, the equation 2.3 :

$$M^S = m (eR + D)$$

implies that money supply increases in both eras : when the country acquires a windfall, via increasing foreign reserve, R, and after an adverse shock, via the increasing budget deficit, D. Modifying the Canavese structural model by substituting the price of non-tradable (P_N) and tradable goods (P_T) respectively with agricultural and industrial goods[17], gives :

(2.8) $$\pi = \alpha(\frac{\delta - \sigma}{\varepsilon + \mu}) + \dot{P}_T$$

Equation 2.8 implies that even with zero world inflation ($\dot{P}_T = 0$), an increase in prices of non-traded goods relative to those of traded goods in an oil economy with structural bottlenecks entails inflation. Moreover, as described above, the high windfall leads to undesirable structural changes which may well diminish aggregate supply growth, σ, and the supply elasticity, ε, while the rate of autonomous demand for goods and services, δ, increases due to a rising money supply induced mainly by structural impediments. The situation will become worse when the economy experiences an adverse shock. In addition, the fluctuation of export proceeds have themselves a considerable effect on aggregate supply because the resulting uncertainty constrains investment and also directs it toward projects in which the fruition lags are small but the projects are not necessarily the most efficient.

2.4 Monetarism VS Structuralism : Reconciliation

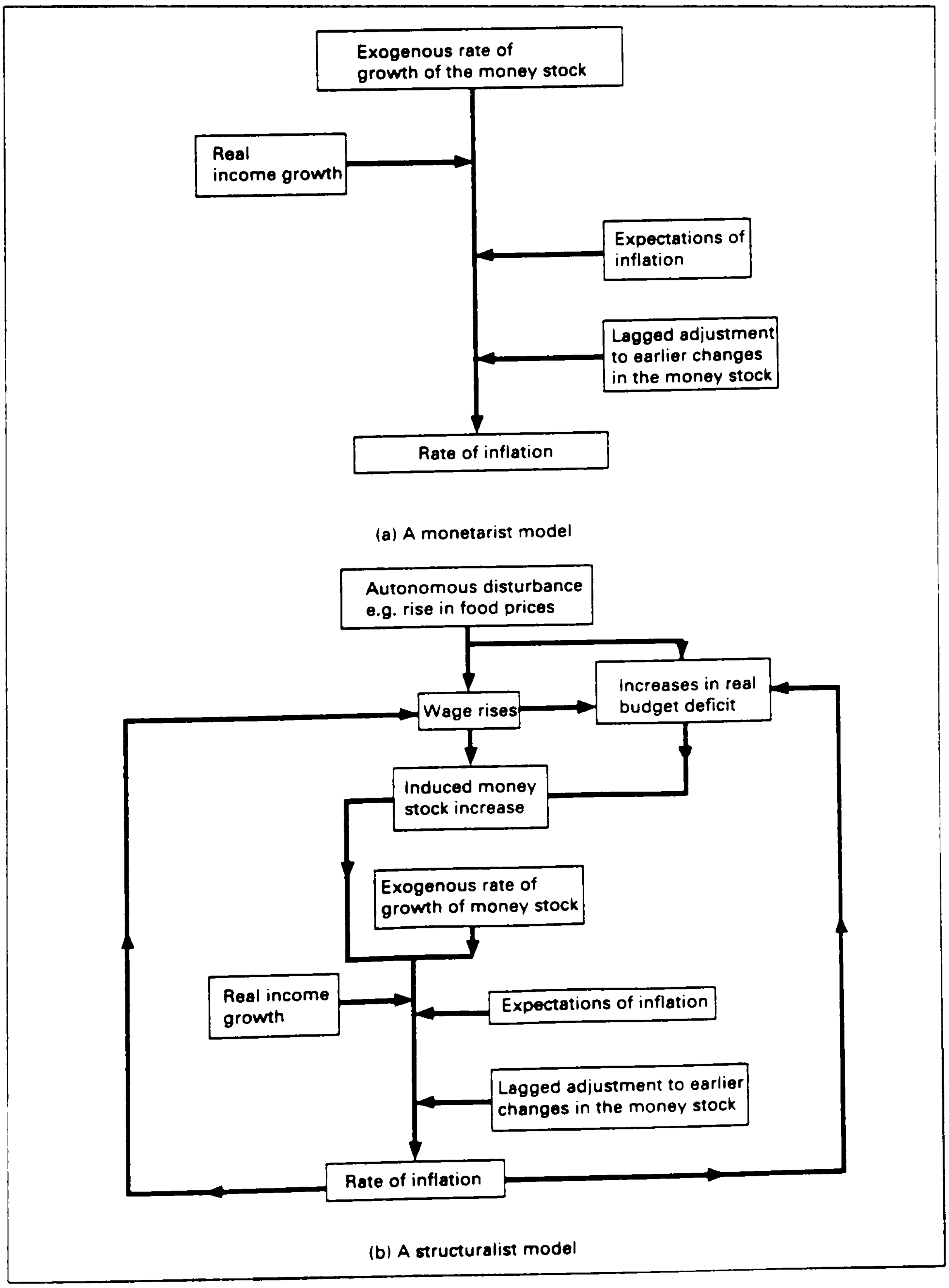
Monetarism, in the extreme form, assigns inflation to an excessive growth rate of the money supply relative to real income growth, whilst structuralism attributes the inflationary process to the operation of structural constraints during the development process. Using a chart provided in Ghatak (1995a: 102), the similarities and differences between these two alternative perspectives can be pointed out.

In part (a) a standard monetarist model is displayed, where money supply is the exogenous variable and inflation is caused by real income growth, expected inflation and adjustments to lagged values of money stock. In part (b) a possible structuralist framework is illustrated. Analogous to part (a), this model considers money stock, real income, expected inflation and lagged

[17] For similarity, here, the relative price is defined as $P_R = P_N / P_T$.

adjustment as causes of inflation. However, the starting point in the process is attributed to a structural event like an increase in relative price. There are also two important feedback effects : first, the inflation-induced budget deficit which affects money growth; second, the inflation-induced wage increase which affects money growth directly and via budget deficit. These feedback effects mean that the money supply is no longer exogenous. The latter is an important difference.

Figure 4 : Flowchart of Monetarist and Structuralist Perspectives



Source : Ghatak (1995a: 102)

Curing inflation, as Natalegawa (1988:10) states, starts with finding the cause of the initiation mechanism. Pure monetarism-based prescriptions emphasize money supply reduction as a core treatment of the problem, which usually implies some costs in terms of output and employment. It is also argued that structural conditions cause a solely monetary prescription to reduce output generally. On the other hand, structuralist remedies, arguing that inflation is initially a structural phenomenon, shift policy towards a long-run framework, which does not naturally generate short-term results.

2.4.1 A Critique of Structuralism

The most important criticism against Structuralism is the absence of a model to test its arguments. Kirkpatrick and Nixon (1987:180) after a favourable comprehensive survey about structuralism state that testing the arguments is very difficult. It is not easy to provide a correct specification and indicators which include the essential constraints. They conclude that :

> "*... the relevance of the structuralist model of inflation to individual LDCs is not always obvious, and the attempt to generalize this model is not always successful.*" (p. 194)[18]

In addition to the weakness mentioned above, Johnson (1984:641) argues that the structuralist view also suffers from theoretical problems. He suggests a model which shows that even within a structuralist framework, inflation, in addition to structural factors, can be explained by excess demand pressure and cost-push factors (p. 638-39).

Monetarists accept the existence of the constraints and bottlenecks in DCs and most of them admit the social priority of development, however, they have two arguments here. Firstly, they claim that these constraints are not, in essence, structural or autonomous, rather they emerge from the distortions of the mechanism of commodity and foreign exchange markets caused by the structuralist-based policies of the government. For instance, food supply inelasticity is a result of the government control on food prices in favour of

[18] Also see Ghatak (1995a:102).

urban residents and prevention of wages increases. This in turn, disturbs market performance. In other words, high relative food prices are necessary to stimulate supply, and if the money supply is controlled, these high prices are compensated by some reduction in the prices of other goods. Hence, the general level of prices will be stable and the economy does not experience an inflation. Secondly, monetarists also argue that inflation is inconsistent with the development process and the constraints which inhibit growth will be removed only by inflation being first brought under control. It is also said that the pressure on prices is not an inherent phenomenon of growth because some countries in Latin America had high rates of growth without (high) inflation (Campos, 1964).

Regarding balance of payment difficulties, mismanagement of macroeconomic policies is again alleged to be responsible for the problem. For example, a long-lasting overvalued exchange rate usually reduces the power of competitiveness of the country in world markets, imposing pressure on the export sector and consequently decreasing financial import capacity.

One may explain the instability of food supply as follows : firstly, price control policy is enforced after a supply side failure in spite of rising prices. Secondly, imperfect resource mobility does not allow the agriculture sector to increase output easily. Finally, downward rigidity of (some) prices provokes the general level of prices to increase as a result of food price increases even if money supply remains constant . In consequence, a government which wishes to avoid heavy social and economic costs of inflation cannot rely wholly on the market mechanism. Of course, some recent structuralists, as Meier (1989:212) reports, recognize the disadvantages of interventionist policies in price controls and financial markets, and import substitution policy. They argue that these kinds of policies have not only been unable to cure structural deficiencies, but have aggravated them, though they do not recommend a solely monetary prescription.

2.4.2 A Critique of Monetarism

The core of the monetarists' argument is that there exists a stable relationship between money and nominal income or the total expenditure on goods and services. Recalling the quantity theory of money, that means in :

$$M\,V = P\,Y$$

or $$\dot{M} + \dot{V} = \dot{P} + \dot{Y}$$

the velocity of circulation, V, remains almost constant ($\dot{V} \approx 0$), thus it is the change of money stock that determines the level of total expenditure. But in long-run, output is determined only by real factors and the money stock change is translated into changes in the price level.

However, as Kaldor and Trevithick (1992: 164-65) point out even if such a relationship exists-"*which is by no means universally accepted by econometricians*"- it is not alone adequate to establish the major notion of the monetarists. At least three additional requirements are necessary to establish the monetary argument about inflation. Monetarists need :

1. to illustrate that the money stock is exogenous, and wages and prices are endogenous, not vice versa.
2. to prove that a change in money supply changes nominal income proportionately.
3. to show that changes in nominal income or total expenditure on goods and services mainly influence prices rather than real output : put differently, the output level is generally assumed to be determined by real factors and independent of the level of money demand.

The correlation between money and inflation emphasized by monetarists (see for example, : Harberger, 1978 and Romer, 1996:392), does not prove any causality. According to Jackman *et al* (1981:127), an obvious correlation between the inflation rate and the money growth rate can be explained in two ways : either it confirms the monetarist approach, (the growth of money causes inflation) ; or it is evidence that the authorities permit the money supply to increase passively, which in turn means that inflation causes money to grow. The distinction is important because if the latter is true, it cannot be proved that a stable relation will continue after altering the monetary regime.

Some famous monetarists accept a two-way causality. Friedman and Schwartz (1963a:693) argue that money affects income and prices, but they also emphasize causality in the opposite direction :

> *"....Mutual interaction, but with money rather clearly the senior partner in long-run movements and in major cyclical movements, and more nearly an equal partner with money income and prices in short-run and milder movements- this is the generalization suggested by our evidence."*

Friedman (1992:259) also stresses the reflex impact of inflation on the quantity of money.

The impact of money changes on nominal income and the division of the impact between real output and prices is a more controversial issue in the monetarist and monetarist-structuralist debate. Monetarists distinguish between the short-run and long-run effects of money reduction. In the monetary approach a change in money stock changes nominal income. This affects prices gradually in the short-run, though prices respond fully in the long-term (Gordon, 1982:1088). However, the way the total impact is divided between prices and real output is not a settled issue. It depends considerably on space and time and there is no theory that determines the factors which affect the division (Friedman, 1992: 261; Friedman and Schwartz, 1982: 60; Gordon, 1982:1113). Friedman (1992: 260) accepts that in the short-run (which may be as long as 3 to 10 years) monetary changes primarily reflect output but through decades money growth primarily influences prices. In the long-run output is determined by real factors like firms, human capital, management (especially monetary management), structure of government and industry and the international trade environment. However, in the short-run

" the changed rate of growth of nominal income typically shows up first in output and hardly at all in prices. If the rate of monetary growth increases or decreases, the rate of growth of nominal income and also of physical output tends to increase or decrease about six to nine months later, but the rate of price rise is affected very little. The effect on prices, like that on income and output, is distributed over time, but comes some 12 to 18 months later, so that the total delay between a change in monetary growth and a change in the rate of inflation averages something like two years. That is why it is a long road to hope to stop an inflation that has been allowed to start. It cannot be stopped overnight."

When money reduction in a period even as long as 10 years primarily decreases output, and the effect of money reduction on inflation appears after up to twice the time of that on output, it may be difficult for DCs to accept a monetarism-based prescription. It is particularly difficult, when the division of the money reduction effects between output and prices is not clear and it varies *" widely over space and time and there exists no satisfactory theory that isolates the factors responsible for the variability"*[19].

This may lead to an abandonment of the development process which means a continuing the lack of infrastructure, sectoral mismatch, and other structural impediments, factors which may well make economic growth impossible. Furthermore, in DCs there are nearly always some political circumstances in which a sharp money reduction as a cure for inflation induces intolerable social difficulties. In fact, using a monetary shock, as Meier (1989:215) states, increases the burden on those segments of community already seriously depressed by inflation.

2.4.3 Concluding Remark : Reconciliation

Is there an alternative view which combines the advantages of these two competing views? This section tries to provide a possible suggestion.

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[19] Friedman (1992: 260). Yates and Chapple (1996) using a cross-section of 43 countries, found that at lower rates of inflation, the inflation-output trade-off is higher.

We begin by comparing briefly once again the features of both theories:

1. The coexistence of inflationary processes with money supply growth is accepted by the two schools of inflation theory. However, in considering the causation of inflation, as Addison *et al* (1980:147-49) discuss, monetarists treat money expansion as a *proximate* cause for inflation and ignore the *fundamental* causes of inflation which themselves lead to money supply increases. On the other hand, structuralists are concerned with *fundamental* causes[20] . Although some of them admit the proximateness of money, they treat the increase in the quantity of money as a passive phenomenon which results from fundamental factors associated with structural impediments. In addition to Addison *et al*'s description, structuralists argue the inevitability of money supply growth in the development process. Lahiri (1991:752) says that monetarists have been sometimes called *structuralists in a hurry* because their description of monetary accommodation to inflation rarely passes beyond the proximate or mechanical causes of money growth (which are the authorities' decisions) to point out the fundamental structural factors causing the process.
2. Monetarists ignore structural bottlenecks and focus only on the monetary variables determining inflation . As a consequence, for many DCs the monetarist-base prescription cannot generate the desired results. This may be due to the costs of money reduction as a necessary and sufficient condition of treatment (in their view). In other words, monetary treatment in the short-run (in an economic sense) depresses output and extends unemployment, and will be completely effective over a period which is too long to tolerate in a socio-political sense. Although monetarists argue that the alleged

[20] Addison *et al* (1980) call the competitive camp for monetarism as socio-political analysis for inflation but the features refered to are almost the same as those of structuralism.

bottlenecks are policy-induced[21] , are mutable and can be eliminated or, at least, relieved by appropriate policies, they usually pay little attention to actual socio-political situations which limit policy options. This limitation results from structural characteristics. " *The concept of structural constraint cannot be divorced from the specific social, political and historical framework within which it is operative* " (Kirkpatrick and Nixon. 1987:195). It seems that the main defect of the monetarists' treatment lies in a fact emphasized by themselves : the lack of a theory which can be used to divide the impact of money reduction between output and unemployment, and prices. Similarly to Friedman, Parkin (1992:399) stresses that :

> " *Uncertainty surrounds both the issue of the impulse (or impulses) that generate inflation and other fluctuations and on the propagation mechanisms that translate those impulses into movement in output and the price level.* "

In a DC with the economic characteristics discussed above, a prescription with such uncertainty tends to induce socio-political and even economic problems which will be probably more difficult to confront by the government than inflation.

3. On the other hand, structuralists concentrate on sustained growth as a necessary condition for elimination of structural impediments, which inherently takes a long time. During the necessary process of profound economic changes , they implicitly accept inflation to continue as a consequence of growth. The painful repercussions of the neglect of inflation cause new distortions and deepen some of the present bottlenecks via for example further intervention of the government and its subsequent inefficiency in the economy.

[21] At least policies can lead to the deepening of some structural impediments in some circumstances. For instance, Devarjan and deMelo (1987) show how a different set of policies in spending a windfall in three African countries with close similarities led to different results and structural changes.

Moreover, Ghatak (1995a: 98) points out another weakness of the structuralist approach. They, contrary to monetarists, introduce no single model to explain and estimate the role of different components of causes of inflation, rather they use a variety of methods to develop the idea that certain structural features may be treated as an initial cause of inflation, or to propose a propagating mechanism by which inflation initiated by some autonomous factors is built into the economy.

A summary comparison of the two schools of inflation theory is presented in Bevan *et al* (1990:1). They state that monetarists[22] tend to neglect different economic structures in studying DCs, while in structuralist studies great attention has been paid to the particular characteristics of the economies studied. However, structuralists have not tried to illustrate rigorously how these characteristics influence the appropriateness of *orthodox* theories. Ignorance of institutional features in the neoclassical procedure and the lack of feasible micro-foundations for the other theories have a tendency to make the exchanges between them possible..." *because both ...(seem) right: theory must be tailored to structure to be applicable, but an atheoretic approach is inadequate.*"

The case studies demonstrate that it is often not easy to provide a monetarist or structuralist view of the world. This is because of complexity of underlying reasons for instability, which cannot easily be separated. It seems that there is an interrelation between excess demand, a budget deficit, an imbalanced current account and monetary growth (Ghatak, 1995a:120). Perhaps the key to reconciliation lies in combination of short-run and long-run interests. Although the monetary approach may bring inflation under control earlier than postulated in a structuralist approach, it tends to preclude the necessary long-run structural changes. But neglecting the role of money results in some new problems in the short-run, introducing more obstacles to the path of the necessary structural changes in long-run. Moreover, monetarists expect full results in the long-run, thus, the undesirable short-run effects of

[22] "*Modern neoclassical macroeconomists*" is their expression.

monetarists' or structuralists' approaches must not be ignored. In fact, as Dell and Lawrence (1980) emphasize:

> *"A period of adjustment should be nothing more than an episode in a long-run process, and it is therefore indispensable that the categorical imperatives of the short-run should not be allowed to dominate and perhaps even overwhelm the requirements of the long-run."*

In the absence of a robust and general theoretical model for explaining inflation in DCs, reconciliation may be possible by a wider macro-analytical model which pays enough attention to bottlenecks as well as to monetary factors. Such a reconciliation as Kirkpatrick and Nixon (1987:196) conclude, must combine short-run fiscal and monetary policies and long-run efforts to achieve fundamental structural reforms.

2.5 Empirical Evidence

Inflation has been the focus of numerous empirical investigations through the decades, in search of evidence for competing schools of thought. In this section, first some efforts to seek support for monetary approach are reported, then attempts to find evidence in favour of the structuralist view are considered and finally the results of some analytical models which tend to combine both views are provided.

A famous monetary model used by many economists for DCs in a different way, is the model provided by Harberger (1963) explaining Chilean inflation. This model chose inflation rate as the dependent variable and the current and previous rate of money supply, real income and a proxy for expectations (the previous changes in inflation rate), as explanatory variables. The OLS estimation of this model confirms the monetarists' view on Chilean inflation in the period under study. Vogel (1974), extending Harberger's model to sixteen Latin American countries, finds that a pure monetarist model can almost successfully explain inflation behaviour in these countries, despite their diversity with respect to the variation of inflation and other parameters.

Nevertheless, he reports contradictory outcomes of different researchers' empirical work about the same countries[23].

Regarding structuralism, Edel (1969) provides a comprehensive empirical investigation on structuralist hypotheses using data from eight Latin American countries. He considers the role of scarce foodstuffs as a major component of inflation and also examines the causes of agricultural production deficiencies in the countries under consideration, five of which experienced increasing relative food prices. The conclusion of the Edel's study generally confirms the structuralists views while evidence " *fails to uncover much support for the monetarist positions* " (p. 138). Moreover, he demonstrates that there are no systematic relationships between agricultural sector performance and price control policies. This is unfavourable to the monetarist contention that government intervention to control food prices is responsible for inadequate agriculture sector production (ch. 2).

Leaving aside some occasional studies, there are not many papers that, applying a pure model from either monetarist or structuralist camp, provide a successful description of inflation in DCs. An example of a structural tradition which failed to explain inflation in DCs is the study of Argy (1970) on 22 DCs. He defines indices for four structural hypotheses, namely : 1) a demand shift; 2) agricultural bottlenecks; 3) export instability; and 4) foreign exchange shortages. After calculation of these indices for the all countries studied, during 1958-1963, Argy uses regression analysis to examine whether these factors account for changes of inflation. The results show that structuralist variables are poor in describing inflation. Only the proxy of excess demand in agriculture is nearly significant, suggesting that in the countries with increasing relative prices of food to living costs , there is a tendency for higher rates of inflation. However, adding monetary variables in the regressions improves the results considerably. Although Argy himself acknowledges a few defects, like the period studied being too short to capture pronounced structural effects, the investigation does not generally support structuralist views.

[23] Nugent and Glezakos (1979:433) consider the shortcomings of Vogel's study.

On the other hand, Saini's (1982) investigation demonstrates the opposite result. He applies a Harberger-style monetarist model for six Asian DCs with low and moderate inflation and finds that monetarist approach does not explain inflation in the countries under consideration. However, including imported inflation as an explanatory variable into the monetarist model increases the explanatory power of the model.

2.5.1 An Analytical Model

Since a pure monetarist theoretical model or a perfect structuralist econometric model has seldom explained price movements successfully, there is a tendency among researchers concerned with DCs to set up analytical models to examine the role of different structural or monetary variables to account for inflation. Likewise, there are some attempts to consider different aspects of the two views separately. For instance, Bhalla (1981) studies the role of monetary and non-monetary variables on domestic inflation in 12 Latin American, 11 Asian and 7 African countries which consist of primary producers, oil exporters and semi-industrialized cases. The period of study is 1972-1975, when worldwide inflation appeared. This study tries to separate the direct effect of imported inflation from its effect via money expansion as well as the impact of food shortages. The outcomes highlight that money growth systematically affects the price level. At the same time, structural variables, food shortages and in particular import prices, are significant. There is also evidence for two further important points: firstly, imported inflation accounts for almost half domestic price level increase and secondly, an important channel for transformation of the external effect on domestic inflation is a large increase in foreign reserves either via an improvement in the trade balance or more importantly, by way of capital inflow. These increases in foreign reserves tend to lead to unusual rises in money supply inducing inflationary pressure. Arize (1987) uses a traditional monetary model augmented by the domestic costs of imports, reflecting both the foreign prices of imports and the exchange rate. This mixed model is applied to 11 African countries. The period is 12-14 years starting in 1960. Empirical findings show that both the money supply and imported inflation have significant effects on local inflation.

Another example of an analytical model is Montiel's (1989) work to investigate high-inflation episodes in Argentina (1982/3-1985/1), Brazil (1983/1-1985/4), and Israel (1983/2-1985/3) decomposing the role of fiscal constraints and balance of payment difficulties. The results of this study show that nominal exchange rate devaluation mainly trigger an acceleration of inflation. Regarding oil exporting DCs. Noorbakhsh (1990) considers inflation in 12 oil exporting countries, using an analytic framework consisting of monetarist and structuralist variables. Both kinds of factors are significant. Oil-induced money supply (treated as a monetary variable) is the most important explanatory variable, while imported inflation (a structuralist variable), helps to explain price changes. He also introduces a proxy for another structuralist factor, the absorptive capacity of the economy[24] to capture some bottlenecks in the economies. This factor, though significant, has a small effect on inflation. The researcher concludes that a combination of the two paradigm variables can explain inflation in the oil exporting DCs. It is noteworthy that although the researcher treated the oil-induced money supply as a monetary variable, it is not completely exogenous. Rather, it is related to structural imbalances of these economies. In other words, from a structuralist point of view, money supply growth in such circumstances cannot be isolated from the structure of the economy. Expressed differently, money supply is to some extent an inevitable outcome of such a heterogeneous and specialized economy, though it increases as a result of policy choice [25]. Concerning these studies, the short span of the period considered is a matter of importance. It has already been noted that the short-run effects of monetary factors as well as structural elements differ from

[24] "*Absorptive capacity relates to the ability to use capital productively...total investment must not only cover its cost but must also yield a reasonable increase in income.. while the capacity to absorb capital is a limiting factor, it can, within a few years, be stepped up...there are, however, narrow limits to the pace and extent at which a country's absorptive capacity can be expended.*" Rosenstein-Rodan (1961:108)

[25] For a brief discussion of Prebisch analysis of dualism in developing countries, see Palma (1987b).

the long-run impacts. Furthermore, the traditional econometrics used does not distinguish between the two kinds of effect.

Along this line, many recent investigations on individual DCs apply newer econometric methods. The analytical model used is frequently derived by an analysis characterizing the specific circumstances and features of an individual country. Alkhatib (1994) using a VAR model, in a non-monetarist context, considers interrelationships among prices, output, nominal exchange rate and money supply for the Jordanian economy in the period 1975-1991 with quarterly data. His results confirm a significant role for the nominal exchange rate as a proxy for external shocks in determining domestic price changes. Ryan and Milne (1994) apply an analytical model to the impact of different monetary and institutional variables on inflation for various earning groups in Kenya during 1976-1990. The results highlight a significant role for both money growth and structural factors. Using an error correction model and cointegration techniques, Moser (1995) examines the determinants of inflation in Nigeria in the period 1963-1993. The analytical model used consists of monetary variables, the exchange rate and climatic variables. All variables have a significant effect. The study shows that concurrent monetary and fiscal policies have a sizable influence on the effect of exchange rate depreciation on inflation. In Metin's (1995) work on the Turkish economy during 1950-1988 in a cointegration context, pure monetary variables are included as well as variables related to labour market and external sector. Her study points out that money growth is the main factor in explaining inflation, though other factors are significant. Likewise, the effects of the two kinds of variables of inflation and output in Mexico in 1980s are considered in Rogers and Wang (1995). Here, estimation of a VAR model leads to the conclusion that inflation is determined by both groups of the factors, with most changes being due to fiscal and money growth.

2.5.2 Causality Between Money and Inflation

There are also numerous studies concerned with a particular part of the structuralist or monetarist view. One important issue which has attracted much attention is the causality between money and inflation. The econometric method used is a Granger, or Granger-Sims style causality test, or recently developed cointegration tests.

Jones and Uri (1987) use three econometric methods to consider the causality between money and inflation in the USA during 1953-1984. They failed to find a clear causal direction. Their mixed results show that the general money supply does not determine consumer prices, though a causal relationship between prices and narrowly defined money is suggested. Anderson *et al* (1988) reexamine Cagan's model for two hyperinflation cases, Greece and Hungary following the second world war. They find evidence in favour of one-way causality from inflation to money growth. Chinese hyperinflation during 1946-1949 is the field of Quddus *et al's* (1989) study. They find that in mainland China there was a two-way causality. However, for Taiwan and Manchuria causal direction was from inflation to money. Makinen and Woodward (1989) consider hyperinflation and the stabilization program of Taiwan in the period 1945-1952, using Granger-Sims style causation tests. The empirical findings show that while the causality from money growth to inflation is rejected, causation in the opposite direction cannot be rejected.

Lahiri's (1991) investigation on inflation in Yugoslavia suggests a two-way causality between money and inflation. A similar paper on Algeria for the period 1970-1988 is Beltas and Jones's (1993). In this case an unidirectional relationship from money to inflation is reported. The authors also state that the results of different studies on this matter in developing countries, as well as developed countries, are contradictory. Kamas (1995) tests the impact of money on inflation in a developing country with a crawling pegged exchange rate. Using a VAR model, she shows that money has little role in accounting for inflation. Cointegration techniques are used by Ahumada (1995) to reexamine a monetary model on monthly data of Argentina over the period 1978-1991. The results suggest a long-run relationship between money and inflation: however, in order to support the monetarist contention that money determines inflation, weak exogeneity tests are conducted. According to the outcomes of exogeneity tests there is no evidence for the monetary argument. This in turn means money appears to grow passively. In general, empirical findings of different studies tend to suggest that endogeneity of money supply can not be rejected, implying that governments often allow the money supply to act as an endogenous variable.

The impact of contractionary monetary policy is another issue studied. For instance, Blejer and Khan (1984) studying 24 DCs, conclude that tight monetary policies lead to a decline in economic growth via an adverse impact on the level of investment by the private sector[26]. Khan and Knight (1985) show that contractionary monetary performance has a significant effect on output, in particular in the short-run, such that each 10 percent reduction in growth of money supply in DCs reduced by 1 percent the rate of output growth over 1 year. Blejer and Khan's (1984) investigation also highlights that a long-run domestic credit reduction lowers the growth rate of the economy through reduction in investment. Corbo and de Melo (1985), among others, point out that in the Latin American countries where monetary stabilization programs have been implemented, their economies faced a significant reduction in real production and employment.

The empirical studies suggest that an analytical model established in the light of the features of every individual country, consolidating appropriate factors of the two schools of interest, is the best way to explain inflation. Also, estimation of such a model in a multiple cointegration context for a relatively long period, may lead to distinctive results for short and long-run effects.

[26] See also Buffie (1984:306)

3 *The Outlook of the Iranian Economy*

3.1 Introduction

3.2 The Government Budget

3.3 Banking System Performance

3.4 Foreign Trade and Exchange Rate

3.5 Production Structure

3.6 Concluding Remarks

3.1 Introduction

It is the purpose of the present chapter to propose an overall view of the Iranian economy focusing on inflation. In doing so, inflation, government revenue and expenditure, and such relevant characteristics as banking performance, trade and production will be considered.

For years before the period being studied. inflation had not been a problem in the Iranian economy, however, after the oil price jump in 1973, a period with an accelerating inflation has commenced. During the 1960s the economy experienced a very low annual inflation rate averaging 1.5 percent per year. In the last years of the fourth development plan, between 1970-1972 the inflation rate increased to an annual average rate of 3.5%. These average rates characterize the Iranian economy as a low-inflation economy. However, this figure increases considerably when the oil prices rise in 1973, such that the average rate jumps to 8.9% as a result of expansionary monetary and budgetary policies during 1973-1975.

Although the government commenced a price control programme in 1975, prices continued to increase more sharply, at an average rate of 16.3% during 1976-1979. This rate also reflects the increasing world inflation induced by the oil price shock in addition to domestic factors.

The post revolution era began with a reduction in the inflation rate but then, owing to the start of the Iraq-Iran war in 1980 and the revolutionary environment, the rate of inflation commenced to increase dramatically. These circumstances provoked the government to enforce severe price control coupled with rationing of essential commodities. Although these policies retarded the upward price movement until 1985, the time of oil price collapse, the economy experienced accelerating inflation during the rest of the period such that its rate even reached 22.3% at the end of the period. Table 1 and Figure 1 show the path of consumer price (CPI) and wholesale price indices (WPI). Although the Iranian economy faced a high inflation rate, compared with some DCs, its inflation can be regarded as moderate. See Table 2.

The most important development which had a great impact on the whole economy, was the oil price increase in 1973. This event coupled with a 35% increase in the volume of crude oil exports between 1971 and 1974, increased oil export earnings 6.5-fold. This increase in foreign exchange revenue augmented the share of oil exports in total export earnings from 91 percent to 97 percent[27] and the share of oil induced revenues of the government in its total general revenues from 60 to 86.4 percent[28].

In Iran, analogous to most oil producing DCs, the government directly acquires oil export earnings. These revenues are sold automatically to the Bank Markazy (the central bank) and the government's account is credited accordingly, resulting in a foreign reserves increase and subsequently a high-powered money increase. The windfall allowed the pre-revolution government to increase its expenditure dramatically. The spending effect of the government expenditures led to higher rates of output and inflation. However, after a few years, when the impact of the structural imbalances of the supply side of the economy appeared, the spending effect translated mostly into price increases. This process happened because the government had spent inconsistently with the absorptive capacity of the economy[29] which created persistent commitments to the government.

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[27] IMF, *IFS*, yearbook, 1989.

[28] Organization of Planning and Budget (OPB) (1994), "Data Collected: time series of national income, manetary and fiscal data", Tehran

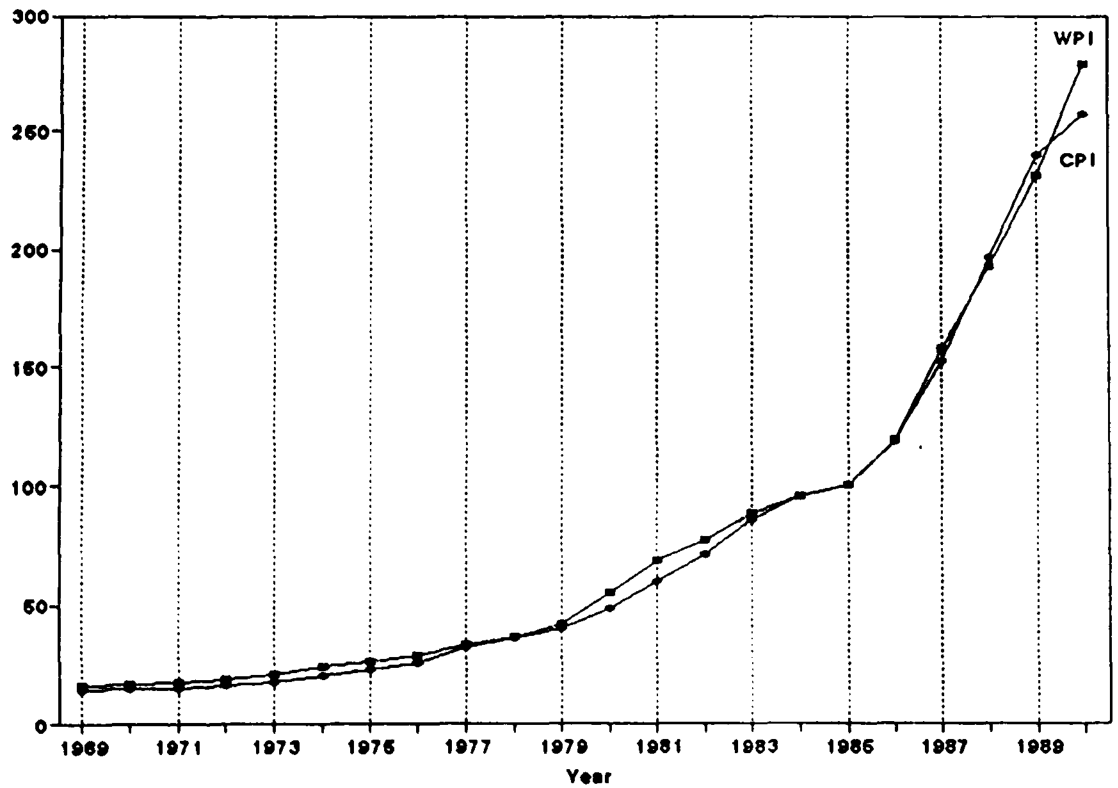
[29] " *The evidence for Iran during the post-1972 period suggests a tendency of trying to do too much in too short a time* " Loony (1985b:330).

Table 1 : Inflation Rate 1969-1990

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
WPI	16.2	16.6	17.7	18.7	20.8	24.3	26.2	28.6	33.5	36.9	42.1	55.2	68.2	76.9	88.2	95	100	119	157	192	232	279
CPI	14.3	14.6	15.2	16.2	17.7	20.3	22.9	25.4	32.4	36.2	40	48.2	59.9	71.1	85.1	95.8	100	118	152	196	240	258
Inflation Rate (CPI%)		2	4.1	6.5	9.2	14.7	12.8	10.9	27.6	11.7	10.5	20.5	24.3	18.7	19.7	10.9	4.4	18.4	28.6	28.6	22.4	7.6

Source : IMF, IFS, Yearbook 1989. Inflation rates are calculated by the author.

Figure 1:
a) Price Indices 1969-1990



b) Inflation Rate 1970-1990

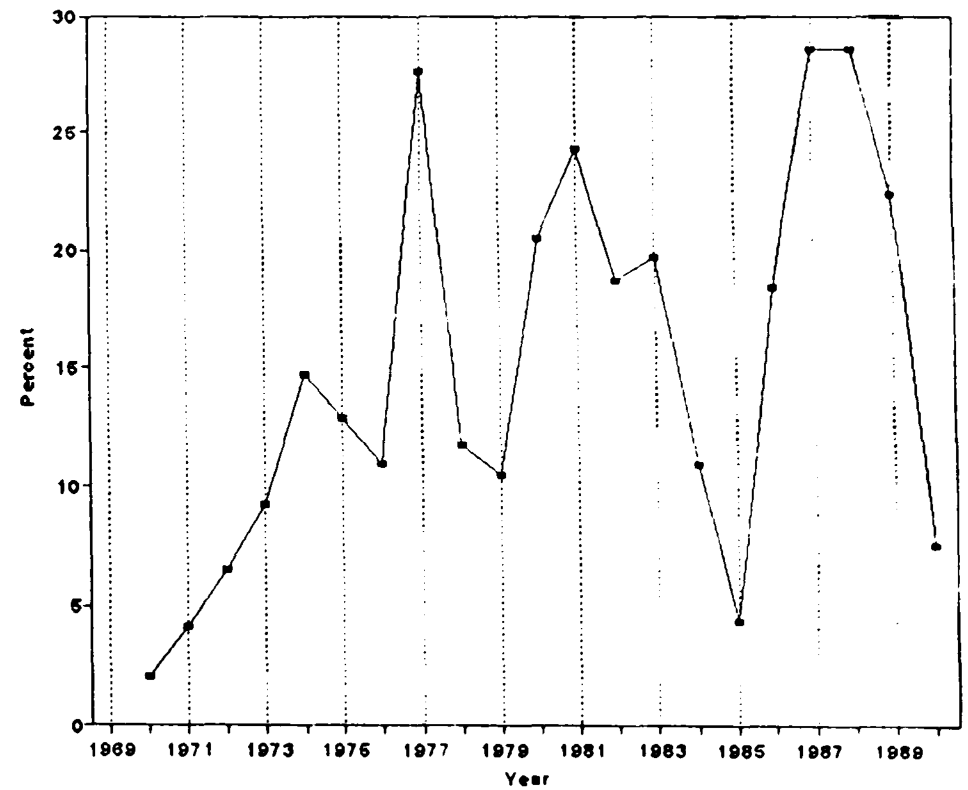


Table 2: Inflation Rates in Some Developing Countries

	1960-69	1970-72	1973-75	1976-79	1980-82	1983-89	1988-89
Argentina	22.9	35.6	313.4	238.7	123.3	755.3	3079.8
Brazila	45.9	19.7	28.2	44.3	95.4	415.7	1287
Cameron	2	6	17.2	10.9	14.9	7.4	4.3
Chile	25.1	42.4	413.7	94.3	27.4	21.3	15.9
Colombia	11.2	9.8	22.7	23.9	26.2	22.3	27
Costa Rica	2	4.1	20.9	5.7	53.3	17.9	18.7
Cote d'Ivoire	3.4	2.7	17.4	17.3	10.3	4	4.1
India	6	4.9	22.8	2.4	12.2	8.4	7.8
Indonisia	100.6	7.7	35.8	13.8	17.1	8.1	2.7
Iran, Islamic Rep.	**1.5**	**3.5**	**8.9**	**16.3**	**13.8**	**15.9**	**22.3**
Kenya	1.8	3.9	18.5	12.8	15.4	8.9	9.1
Korea Rep.	12	13.7	24.8	14.6	25	3.8	6.4
Mexico	2.7	5.2	17	20.1	80.3	82.5	20
Morocco	2.5	3.1	17.6	9.8	10.8	6.2	2.8
Nigeria	3.5	11.1	29.1	17.9	20.8	27.5	52.5
Pakestan	3.7	5.1	23.5	7.9	11.9	6.2	8.3
Serilanka	2.2	5	11	9.4	22.1	10.5	12.8
Thailand	2.2	1.7	19.9	7.4	16.2	2.9	4.6
Turkey	3.5	11.5	16.8	37.1	110.2	48.1	69.3

Source : Little et al (1993), figures for Iran are calculated from Table 1

After the revolution in 1980, though oil prices increased again, owing to reduction in volume of oil export (arbitrary or induced by the war), the government oil-induced revenues decreased, subsequently a period with increasing budget deficit began with money supply continuing to increase, while production suffered from inefficiencies induced mainly by the intervention policies and performance of the goverment. The supply side of the economy experienced more difficulties during the war, in particular, when oil prices decreased sharply in 1985. As a result of disequlibria in money and commodity markets, the economy faced an accelerating inflation rate during the period.

This chapter is organized as follows: section 3.2 discusses budget and budgetary policies of the government. The banking system is analyzed in section 3.3. The next section is devoted to describing the external trade and the exchange rate. Production, investment and employment are discussed in section 3.5. Finally, the conclusion is provided in part 3.6.

3.2 Budget and Budgetary Policies

Just like most oil exporting DCs, the Iranian government possesses the entire oil revenues and uses these foreign exchange receipts as the main vehicle to finance her expenditures. As Table 3 indicates the share of oil-induced revenues in the total revenues (of general budget) sharply increased after the windfall (by 86.4 percent in 1974). It then accounted for about two-third of the total, though this share reduced to one-third after the adverse oil shock in 1985 when oil export earnings dramatically decreased (Figure 3). The share of the government budget in GNP illustrated in that table reflects the importance of the government fiscal performance in the whole economy. This ratio was about 30 percent during the five-year period preceding the 1973 oil shock while it accounted for almost half of the GNP for the remaining five years before the new political regime came to power in 1979. This share has since been declining in the post-revolution era (Figure 2). However, if we take into account the total government budget including state-owned enterprises,

Table 3 :Shares of Oil-induced Revenue in Total Revenue and Total Expenditure in GNP

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Oil-induced revenue/Total revenue	45.4	46.9	60.1	59	66.9	86.4	78.8	76.2	74.8	59.6	68.1	65.9	58.3	67.1	63.7	50.4	44.2	23.4	34.7	31.8	24.2	19.8
Government budget/GNP	28.7	30	33.9	33.7	30.7	50.1	52.8	42.2	46.9	43.4	33.1	33.8	33.7	30	27.5	22.7	21.3	19.5	18.3	19	15.7	16.6

Source: OPB(1995)

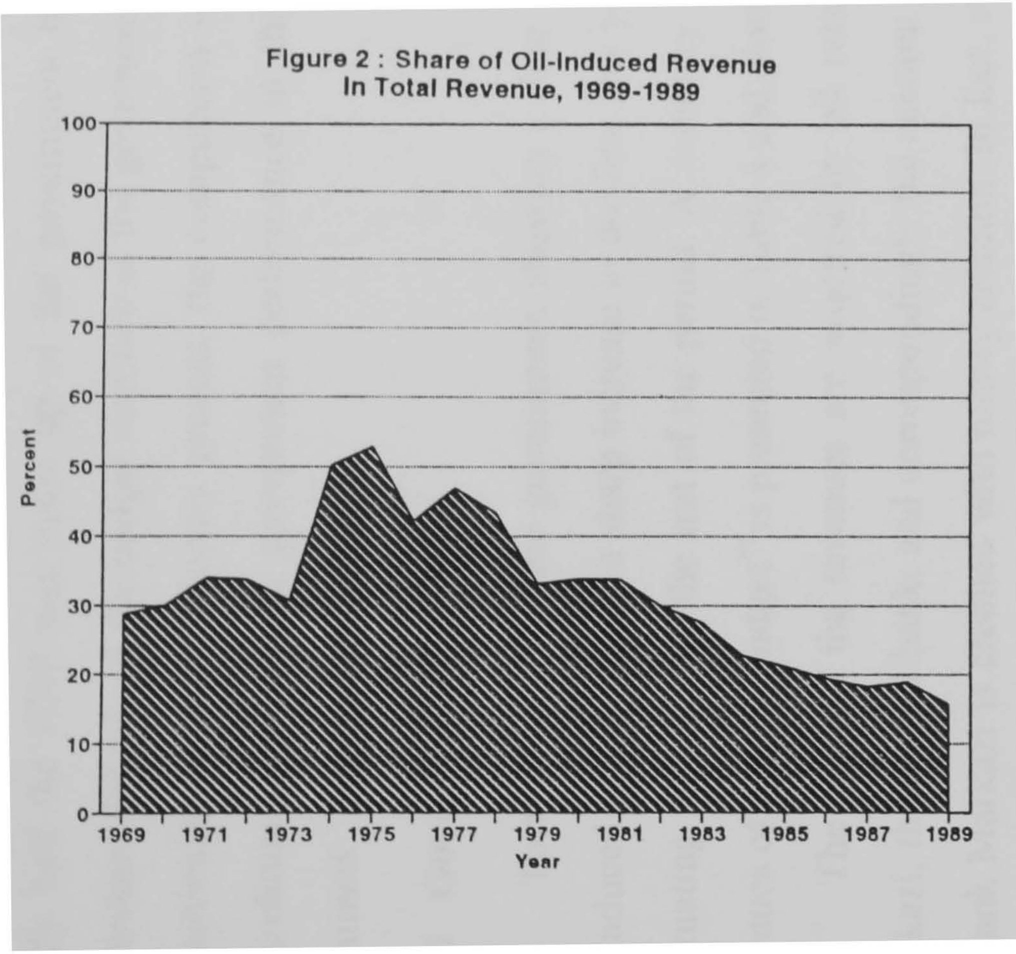


Figure 2 : Share of Oil-Induced Revenue In Total Revenue, 1969-1989

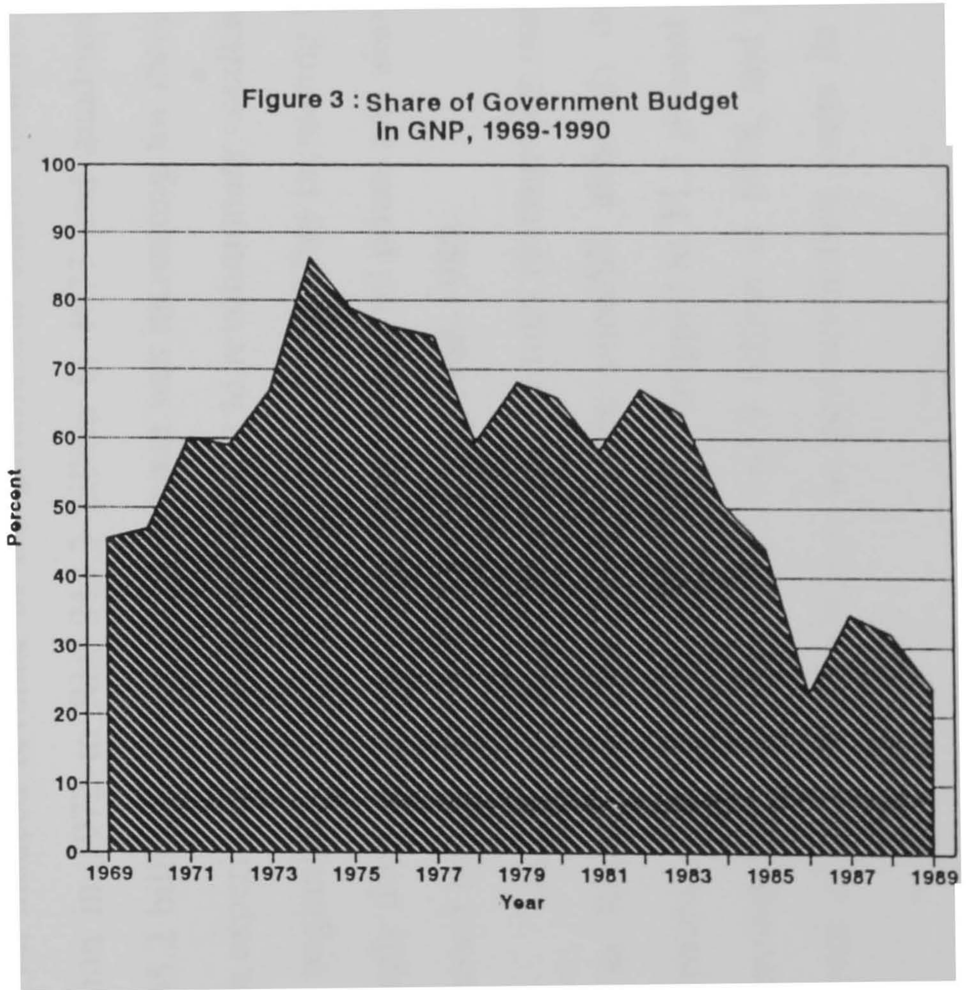


Figure 3 : Share of Government Budget In GNP, 1969-1990

nearly half the GNP was made up of the government budget. In order to understand the role of the budget structure of the government in the economy, in particular in its inflationary process, the components of the revenue and expenditure and also the government performance in these fields must be examined.

3.2.1 Government Revenues

Total revenues of the government, showing a clear co-movement with oil-induced revenue, after a sharp increase in the first few years, experienced a fluctuating path during the rest of the period. A summary of the government revenues of general budget[30] is presented in Table 4 and plotted in Figure 4.

The bulk of the revenues are acquired by oil receipts sold to Bank Markazi, the central bank, and correspondingly the account of the government at Bank Markazi is credited with money creation. In fact, even in the absence of a budget deficit, when an important portion of government revenue is obtained via foreign exchange, budgetary performance plays an expansionary monetary role. It can be seen in Table 4 that when oil prices increased in 1973, the oil-induced revenue of the government almost doubled from Rls. 178.2 billion in 1972 to Rls. 311.3 billion in 1973 and quadrupled again to Rls. 1205.2 billion in 1974. This revenue was increasing for three following years, then experienced some reduction due to revolutionary condition of 1978 and at the beginning of the Iraq-Iran war in 1980. After increasing for a few years it sharply decreased owing to dramatic fall in oil prices and also export limitation imposed by the war conditions during 1986-1989.

Tax revenues contributed to the total revenues by one-third until 1973 up to Rls. 131.3 billion. After the windfall although its absolute value increased, its share in total revenues dropped to 11.3 percent in 1974. Its peak in pre-revolution era was Rls. 465.9 billion in 1978, and accounted for 13 percent of the total revenues. In post-revolution years its nominal amount

[30] The budget of government's enterprises accounted for between one-third to half of total government budget during the period, however it is excluded because they are subject to different legal processes and based on different accounting systems.

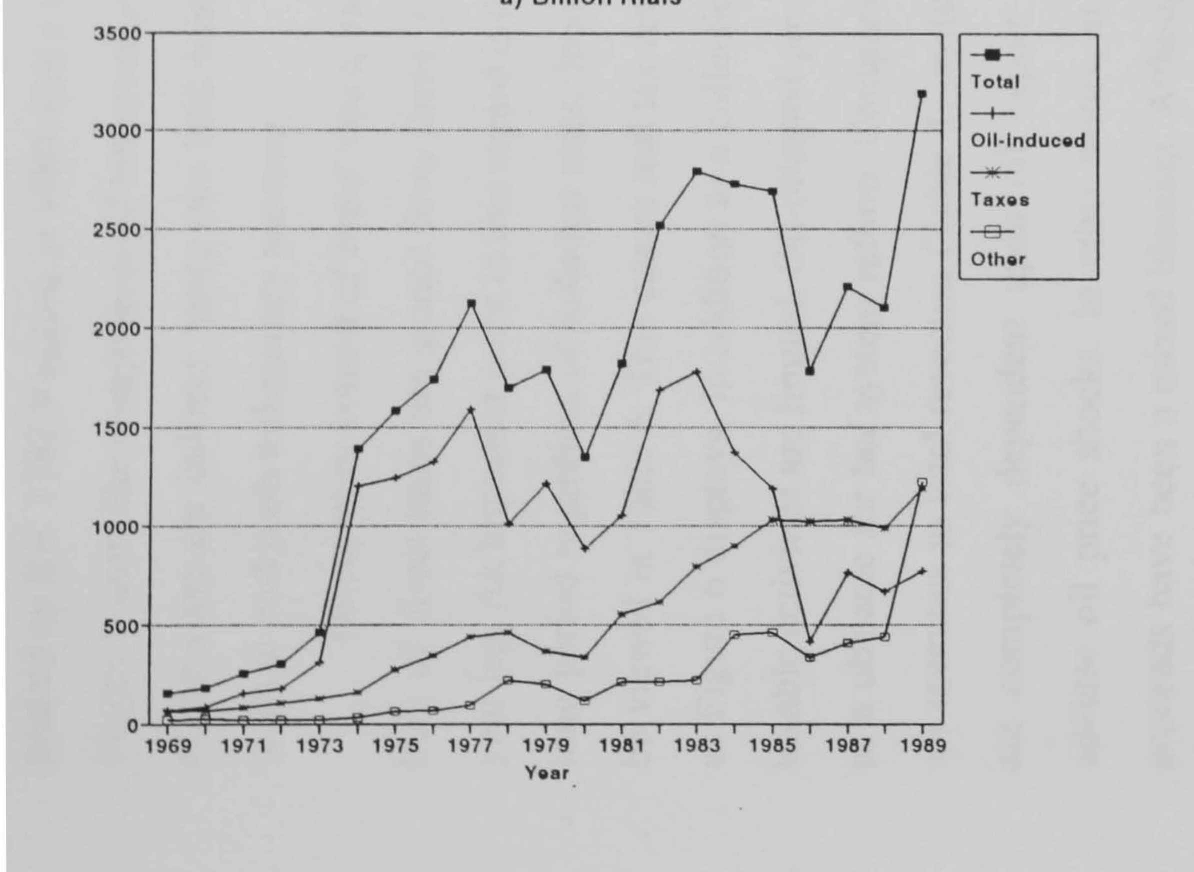
Table 4 : Government Revenues, 1969-1989 (Billion Rials)

year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Total Revenue	155	182	258	302	465	1395	1582	1744	2127	1699	1792	1349	1821	2518	2794	2727	2691	1782	2211	2099	3181
Oil-induced	70.1	85.6	155	178	311	1205	1247	1329	1590	1013	1220	889	1056	1690	1779	1373	1189	417	766	668	771
Taxes	60.6	70.6	82.2	103	131	158	271	343	444	466	368	340	554	614	797	899	1034	1025	1030	987	1188
Others	23.8	26.2	20.8	21.3	22.5	31.9	64.5	72	92.8	220	204	120	211	214	218	455	469	341	414	445	1223
Oil/Total(%)	45.4	46.9	60.1	59.0	66.9	86.4	78.8	76.2	74.8	59.6	68.1	65.9	58.0	67.1	63.7	50.4	44.2	23.4	34.7	31.8	24.2
Tax/Total(%)	39.2	38.7	31.8	34.0	28.2	11.3	17.1	19.7	20.9	27.4	20.6	25.2	30.4	24.4	28.5	33.0	38.4	57.5	46.6	47.0	37.3
Others/Total(%	15.4	14.4	8.1	7.1	4.8	2.3	4.1	4.1	4.4	13.0	11.4	8.9	11.6	8.5	7.8	16.7	17.4	19.1	18.7	21.2	38.4

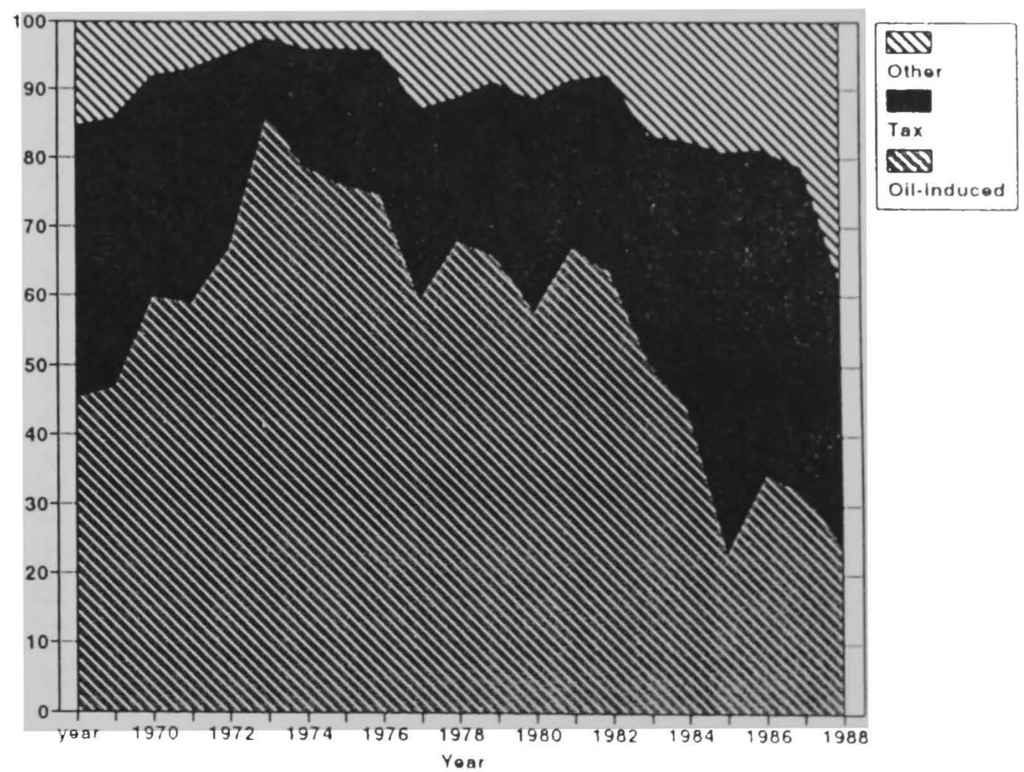
Source : OPB(1994)

Figure 4 :Government Revenues 1969-1990

a) Billion Rials



b) Percent



peaked up Rls. 1187.9 billion in 1989 with a share of 37.3 percent. Table 5 and Figure 5 show the components of tax revenues. It can be seen that almost half of the taxes are indirect taxes (the bulk being import duties) whose increase leads to cost push inflationary pressure.

Direct taxes consist of firms' taxes, income taxes and wealth taxes. The bulk of direct taxes are gained from firms' profits collected after about a one year lag. An important point in this regard is that tax rates remain constant for a long period regardless of inflation rates. Income tax rates, as an example, can be viewed in Table 6. This causes real tax revenue to erode sharply from 1976 as Figure 6 displays. In addition to a collection lag and inflexible rates, actual taxable activities are limited. Oil-oriented government revenue can be regarded as a obstacle for tax system reform. Comparing the share of tax revenues and oil revenues in total revenues (Table 4) confirms that the role of tax revenues are completely dependent upon oil export earnings caused by desired or adverse oil price shocks. In other words, as Shahroodi (1978:87) states, oil proceeds have been a mixed blessing. Although these revenues can contribute to the economic development of the country, they have deteriorated the tax effort (the ratio of actual tax revenues to GNP). An investigation about tax effort of fifty DCs shows that while Iran has fourth highest taxable capacity, its tax effort was ranked 28th. This inefficient tax system makes individuals and agencies increase effective demand in goods and services markets.

Other sources of government revenues like affiliated institutions and royalties met the third part of the total revenues. The share of other revenues decreased during 1970-1977 but began to increase from 1978, and this share has been rising considerably from 1984 when the government faced sizable reduction in oil export earnings and set a preferential exchange rate to fight foreign exchange shortages and to offset the reduction in its oil-induced revenues, resulting in cost push pressures. The contribution of this exchange tax to total revenues reached 38.4 percent in 1989, greater than oil-induced revenues (24.2%) or tax revenues (37.3%)[31].

3.2.2 Government Expenditure

Government expenditure has played a significant role in the economy influencing national income and price changes.The major portion of the total expenditure has been current expenditure. This share increased considerably after the revolution owing to problems arising from revolution and in particular the war.

The amounts of current and investment expenditures and their share in total expenditure are presented in Table 7 and Figure 7. As these charts show 1974 is the turning point in both the current and investment expenditures. A few months before oil price jump in October and December 1973, the Fifth Development Plan (1973-1977) commenced. The pre-revolutionary regime revised the Fifth Plan and doubled current and investment expenditures. Total expenditure including especially spending and investments abroad tripled in 1974. In fact, " *the revised version was in essence the original Fifth Plan plus most of the projects rejected for the original plan as being uneconomical*"(Loony,1985a:65). This development followed by increasing expenditure later on, established an inflationary budget.

An increase in current expenditure of more than 120 percent in 1974 followed by an average annual rate of 13.7 percent during 1975-1978 created persistent commitments for the government. Although after the revolution the new government scrapped some unnecessary expenditure chiefly related to the security and military systems of the previous regime, a sharp increase in salaries and wages in the first year after the revolution[32], more government intervention in economic activities and the war requirements made current expenditure increase at an average rate of 8.4 percent in nominal terms for the

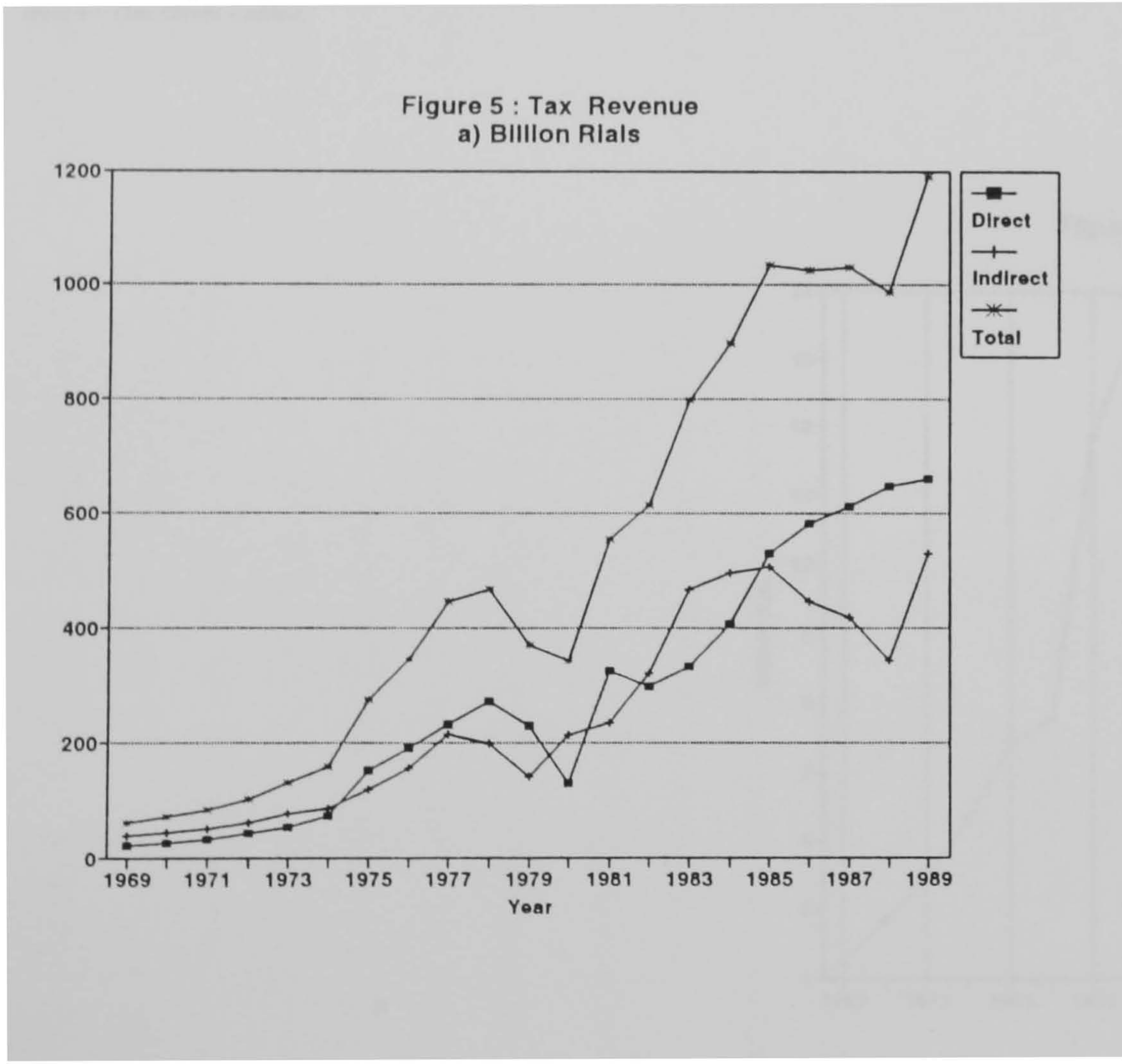
[31] The earnings from exchange taxes (induced by the preferential exchange rate) accounted for 3.9, 6.2 and 23.4 percent of the total revenues respectively in 1987, 1988 and 1989 (Rafati et al, 1993:75).

[32] Minimum wages for government employees which was Rls. 12000 monthly in 1977, increased to Rls. 25000in 1979 two months after the new regime took over.

Table 5 : Tax Revenue Components (Billion Rials)

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Direct	21.83	26.56	32.22	41.81	52.93	72.19	151.9	187.8	230.3	269.5	228.1	129.2	321.9	295.5	332	404.7	529.6	579.8	612.4	645.9	659.7
Indirect	38.75	44.06	50.4	60.8	78.3	85.1	119	155.1	213.3	196.4	140.2	211.3	232.2	318.5	464.5	494	504.1	444.8	417.9	340.6	528.1
Total	60.58	70.62	82.62	102.6	131.2	157.3	270.8	342.9	443.6	466	368.3	340.4	554.1	613.9	796.5	898.7	1034	1025	1030	986.5	1188

Source : OPB (1994)



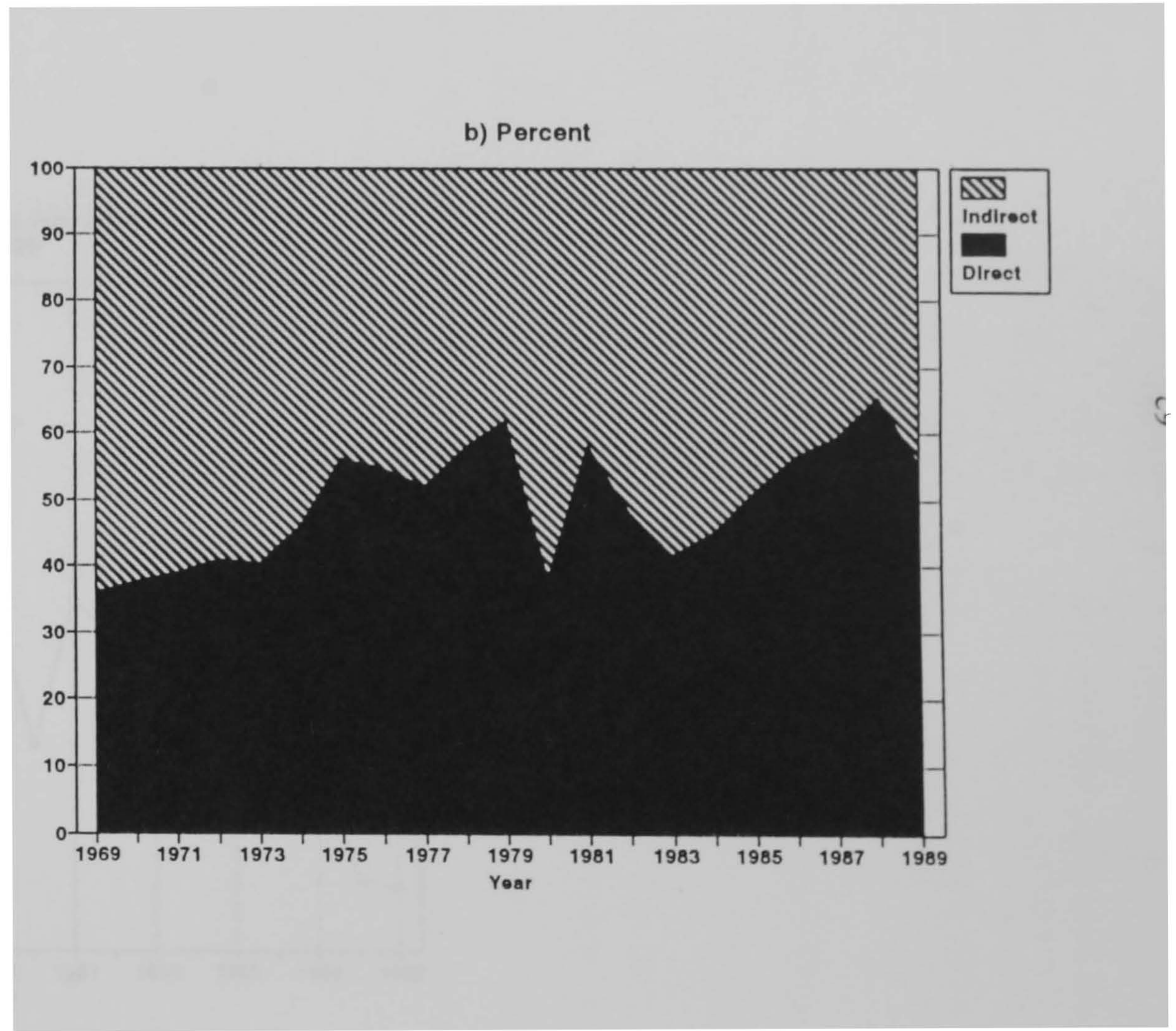
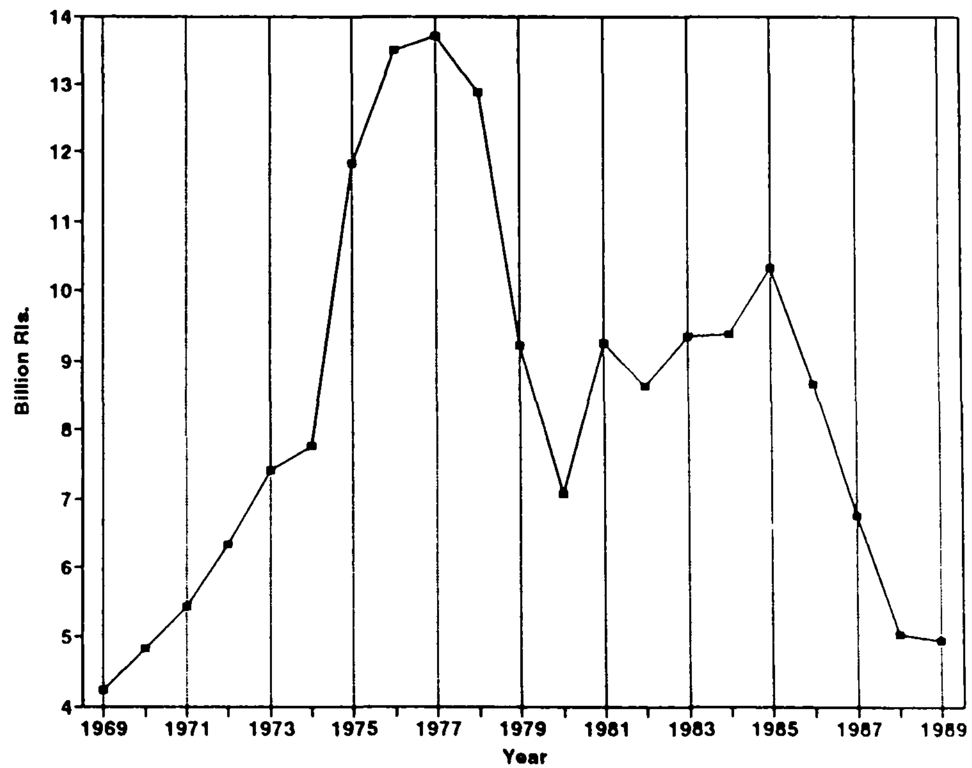


Table 6 : Real Tax Revenues and Income Tax Rate

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Income Tax Rate (%)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	110	10	12	12
CPI	14 3	14.6	15.2	16.2	17.7	20.3	22.9	25.4	32.4	36.2	40.0	48.2	59.9	71.1	85.1	95.8	100 0	118.4	152.3	195.9	239.7
Tax Revenue(Billion Rls.)	60 6	70.6	82.6	102.6	131.2	157.3	270.8	342.9	443.6	466	368.3	340.4	554.1	613.9	796.5	898.7	1034	1025	1030	986.5	1188
Real Tax Revenues	4.24	4.84	5.43	6.33	7.41	7.75	11.83	13.50	13.69	12.87	9.21	7.06	9.25	8.63	9.36	9.38	10.34	8.66	6.76	5 04	4.96

Soure : The Other Tables.

Figure 6 : Real Tax Revenues
1969-1989



post-revolution years of the period. The number of public sector employees indicates the growing extent of the government activities. This figure increased from 849,000 persons in 1972 to 1,673,000 in 1976, then reached 3,454,000 persons in 1986[33]. Since real expenditures have been decreasing after 1977 (Figure10) while the intervention of the government and the number of employees were increasing, current expenditure has quantitatively and qualitatively an inflationary effect.

Investment Expenditure

In Iran, analogous any other oil exporting economy, where the bulk of the national income is directly allocated to the government in the form of oil proceeds, planning has a more significant role compared with non-oil exporting economies. The government has to dispose of its oil receipts and requires to spend them according to a planned framework[34]. In such circumstances, the plans of expenditure crucially direct the whole economy and route private investments[35] (Karshenas and Pessaran, 1995). Despite this important issue, planning process which was weakly carried out during the first four five-year plans, was abandoned in the revision of the Fifth Plan approved in August 1974. Loony (1985a: 66) states: " *In effect, the revised Fifth Plan eliminated the planning process in Iran ... . Targets and allocations were now increased without much thought and the current budget became far more important than the development budget. Planning authorities were reduced to macroeconomics model-makers with no input into government policy. In their place, budgetary authorities began to control the expenditure process through yearly allocations with little or no account taken of the longer-run ramifications of the stepped-up level of expenditure.* "

Table 7 shows an increase in investment expenditure by 116 percent from Rls. 161.0 billion in 1971 to Rls. 348.7 billion in 1974. It then grew at an average annual rate of 38.5 percent for the following three years and peaked at

[33] Statistics Center of Iran, *Statiatical Year-book*, various years.
[34] If it does not save the receipts in foreign assets.
[35] Of course, oil proceeds can be saved in foreign currency form or used to repay foreign debts. These cases may be included in the plan.

Rls. 926.8 billion in 1977, the year before the revolution began. After a reduction due to the revolutionary condition and the war starting year, it improved at an average yearly rate of 26.4 percent until 1983 when it reached its post-revolution peak Rls. 1148.6 billion. Then, with a declining trend of the oil-induced revenue of the government (negative average rate of 38.4 percent during 1983-1986) the capital expenditure fell continuously with 10.7 percent average rate until 1987 when it reached the lowest level of Rls. 729.2 billion in the recent years of the period. An improvement can be seen in this measure during the last two years in response to oil-induced revenue increases. Figure 8 displays how oil-induced revenue and investment expenditure show co-movement while current expenditure moves almost independently. Inspection of the shares of the two kinds of expenditure (plotted in Table 7 and Figure 7b) also suggests that point. Capital expenditure which accounted for about 30 percent of total expenditure in pre-revolution episode, during recent ten years of the period (1979-1989) ranked from 31.3 percent in 1983 (best year) to 19.4 percent in 1988 (worse year).

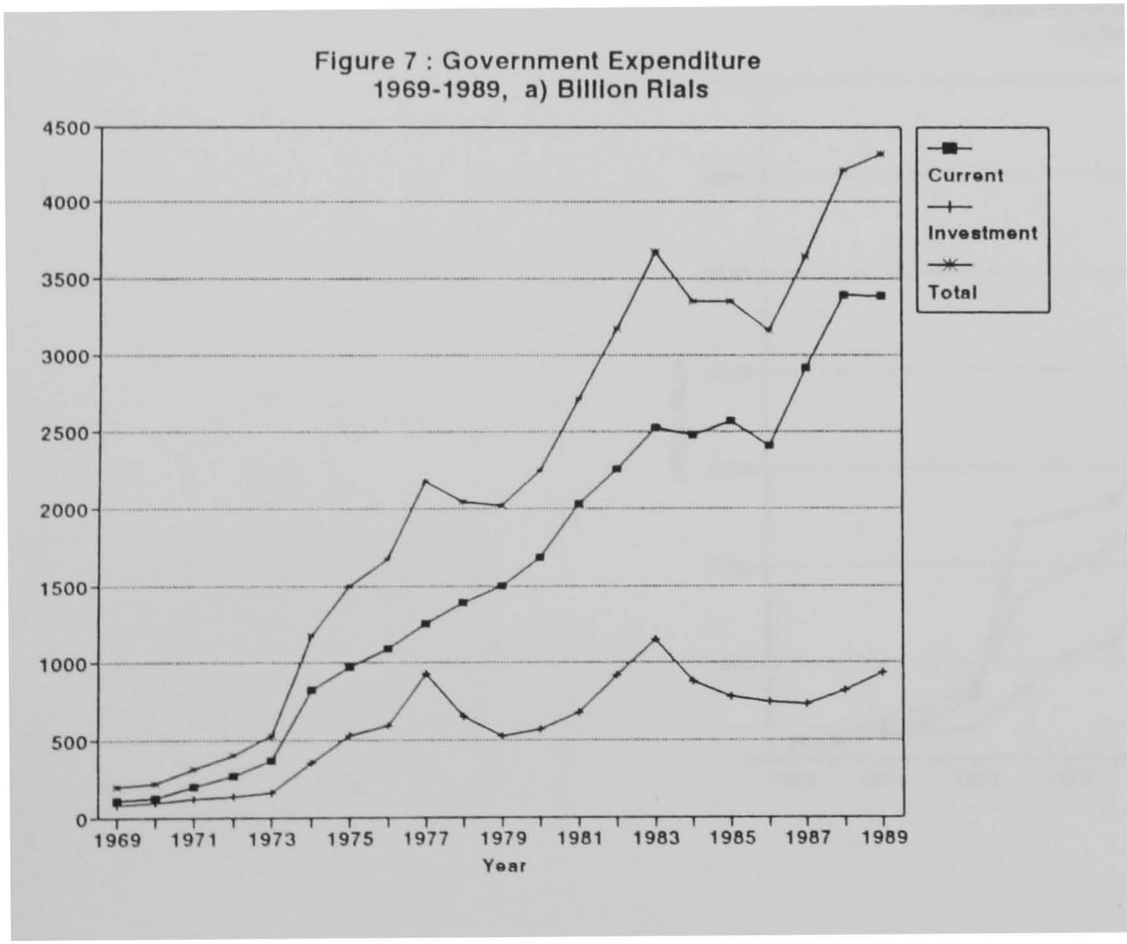
Apart from the magnitude and distribution of expenditure for current and development purposes which themselves have tended to generate price increases, it is important to examine the circumstances and methods of carrying out the investment spendings. Government investment as a part of expenditure increases aggregate demand (income effect) and after a period it increases supply side capacity (capacity effect). A sharp increase of the government investment generates a high income effect and usually leads to some delay in the completion of projects. Therefore, in these circumstances investment would be likely to increase the inflation rate without corresponding disinflationary capacity effect. In fact, as Looney (1985b: 330) emphasizes " *The evidence for Iran during the post-1972 period suggests a tendency of trying to do too much in too short a time.* "

As Tavakkoli (1993) points out a considerable portion of government investment has been directed toward uneconomic large scale and long gestation projects in the period. For instance the Organization of Plan and Budget (1983) reports that planned period of time to complete hospital projects have been

Table 7 : Expenditure Components

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Total Expenditure	194	221.1	315.4	401.5	531.4	1174.4	1496.2	1675.4	2174.9	2044.2	2018.2	2249.3	2707.1	3166.3	3671.7	3353.6	3350.7	3156.8	3640.6	4210.6	4316.7
Current	111	124.5	199.4	269.7	370.2	825.7	969.4	1083.8	1248.1	1387.1	1494.9	1681.2	2032.4	2251.5	2523.1	2475.6	2571.9	2410.3	2911.4	3394.2	3385.2
Investment	83	96.6	116	131.8	161.2	348.7	526.8	591.6	926.8	657.1	523.3	568.1	674.7	914.8	1148.6	878	778.8	746.5	729.2	816.4	931.5
Current/Total(%)	57.2	56.3	63.2	67.2	69.7	70.3	64.8	64.7	57.4	67.9	74.1	74.7	75.1	71.1	68.7	73.8	76.8	76.4	80.0	80.6	78.4
Investment/Total(%	42.8	43.7	36.8	32.8	30.3	29.7	35.2	35.3	42.6	32.1	25.9	25.3	24.9	28.9	31.3	26.2	23.2	23.6	20.0	19.4	21.6

Source : OPB (1994)



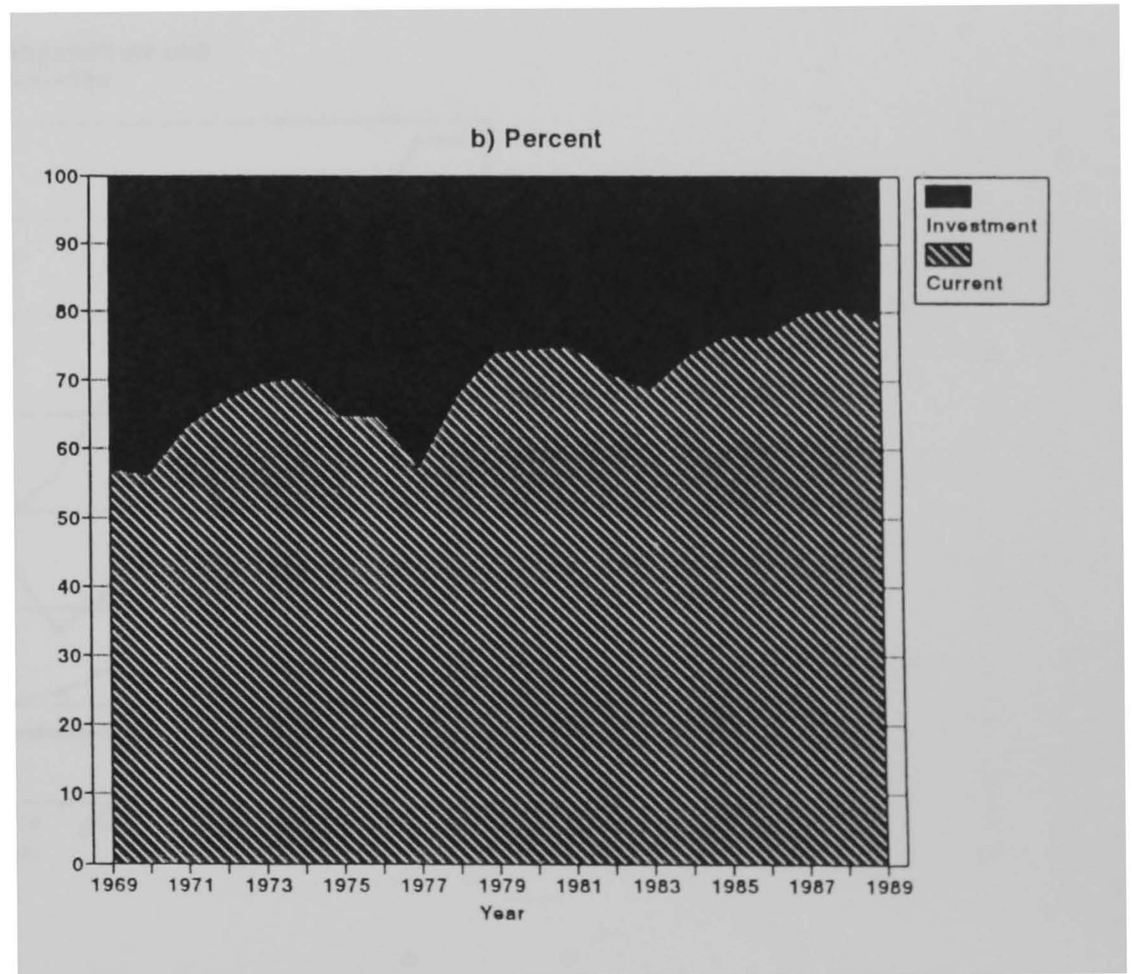
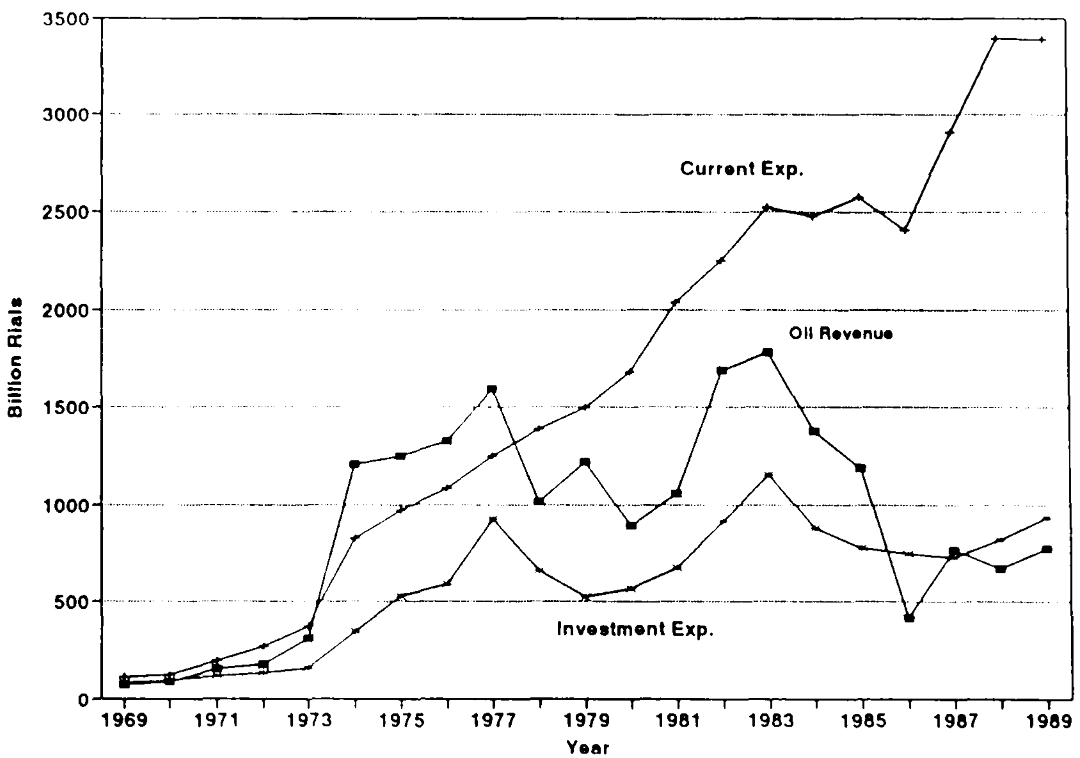


Table 8 : Oil-induced Revenue, Current and Investment Expenditure 1969-1989 (Billion Rls.)

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Oil-Induced Rev.	70.1	85.6	155	178	311	1205	1247	1329	1590	1013	1220	889	1056	1690	1779	1373	1189	417	766	668	771
Current Exp.	111	124.5	199.4	269.7	370.2	825.7	969.4	1083.8	1248.1	1387.1	1494.9	1681.2	2032.4	2251.5	2523.1	2475.6	2571.9	2410.3	2911.4	3394.2	3385.2
Investment Exp.	83	96.6	116	131.8	161.2	348.7	526.8	591.6	926.8	657.1	523.3	568.1	674.7	914.8	1148.6	878	778.8	746.5	729.2	816.4	931.5

Source : OPB (1994)

Figure 8 : Government Expenditure and Oil Revenue, 1969-1989



prolonged to 11 years as against the standard period of 4 years. Official reports show that management difficulties and shortages of capital goods were more important factors in making projects costly and inefficient. According to Shahshahani and Kadhim (1979: 69), this problem resulted from wasteful capital spending of the government without paying attention to absorptive capacity of the economy. Absorptive capacity is importantly a function of time because some necessary factors for efficient utilization of capital cannot be obtained quickly owing to their interdependence and complexity. For example, skilled manpower requirement necessitates the education system to change while even with enough financial resources it cannot be achieved in short-run. " *Thus, the abandoning of a spending policy in favour of immediate spending of oil revenues as they accrue appears to have been a major mistake. Excessive spending produced a high rate of inflation* . " (p. 70)

Budget Deficit

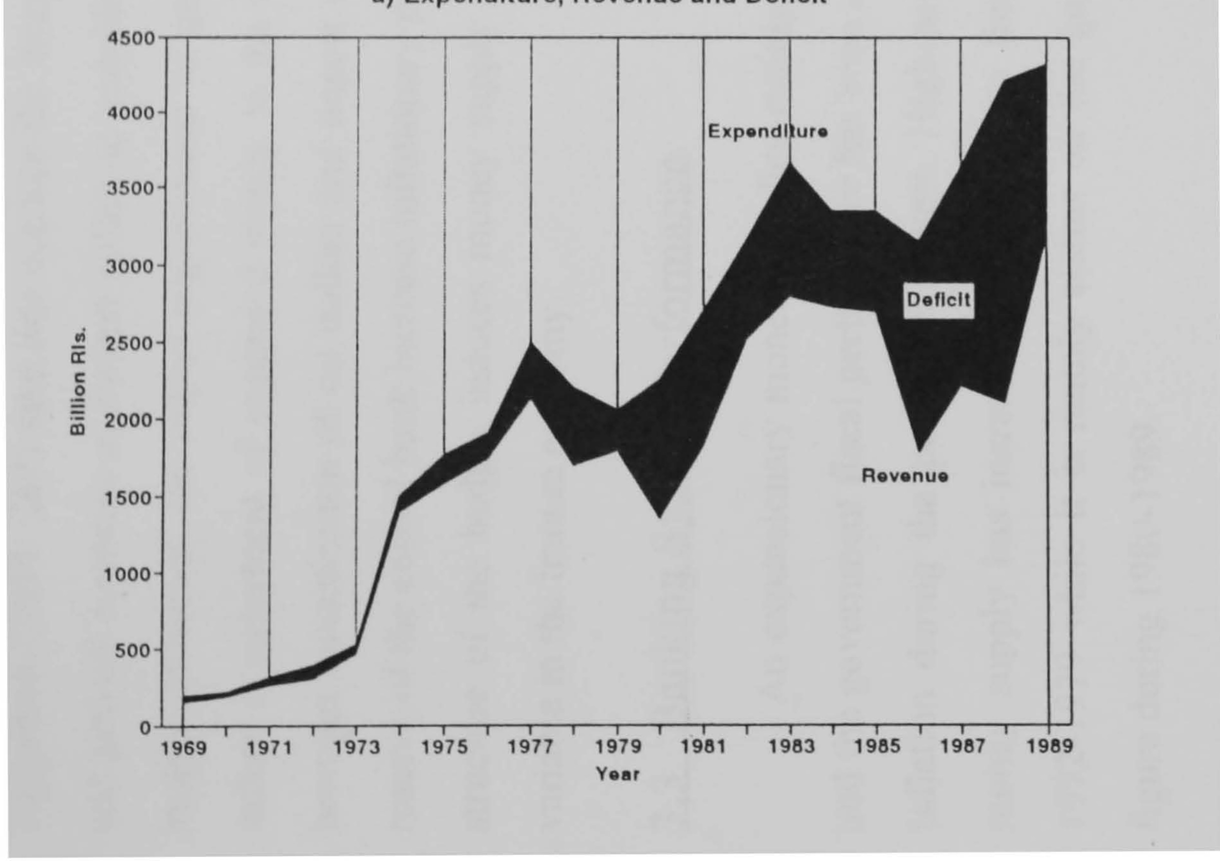
In spite of large magnitudes of oil revenues in the first years of the period which were repeated again during 1981-1984, failure to restrain government expenditures in the face of the declining government revenues led to a significant widening of the fiscal deficit and thus creation of further money for the whole period. The budget deficit, which fluctuated almost entirely with oil earning shocks, peaked at Rls. 2111.7 billion, more than 50 percent of the total budget and near 10 percent of GDP in 1988. Table 9 presents expenditure, revenue and deficit of the government and Figure 9a plots their paths. As Table 9 and Figure 9b show an increasing portion of these deficits have been financed by central bank credit or equivalently by money creation. It is commonly accepted that a main part of the inflationary process of the Iranian economy has been due to this persistent deficit and the subsequent money supply increase. Moreover, as discussed above the oil-oriented budget of the government has essentially an expansionary structure. In fact, oil-induced revenues unlike tax revenues do not reduce disposable income: rather, their spending domestically is equivalent to further creation of money. In consequence, some researchers like Aghevli and Sassanpour (1991: 88) and

Table 9 : Government Budget, 1969-1989 (Billion Rls.)

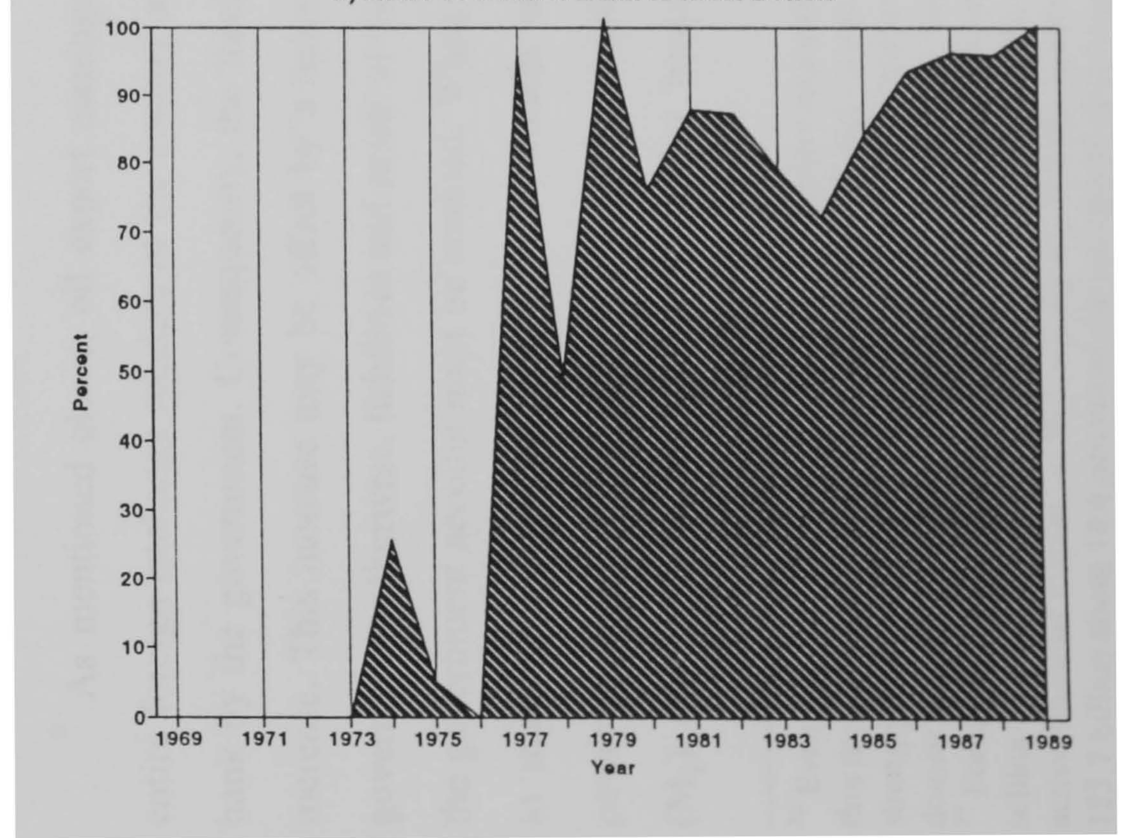
Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Revenue	154.5	182.4	258.3	302.1	465	1395	1582	1744	2127	1699	1792	1349	1821	2518	2794	2727	2691	1782	2211	2099	3181
Expenditure	194	221.1	315.4	401.5	531.4	1511	1776	1914	2492	2208	2061	2252	2707	3167	3672	3354	3351	3157	3641	4211	4317
Deficit(1)	39.5	38.7	57.1	99.4	66.4	116.3	193.8	169.9	365.5	508.5	269.3	903.1	885.7	649.7	878	627	659.3	1375	1430	2112	1135
Borrowing from Central Bank(2)						30	10	0	350	250	350	688.6	779.1	567.2	695.3	454	554.7	1284	1375	2025	1138
2/1 (%)						25.8	5.2	0.0	95.8	49.2	130	76.2	88.0	87.3	79.2	72.4	84.1	93.4	96.1	95.9	100

Source : OPB (1994)

Figure 9: Government Budget, 1969-1989
a) Expenditure, Revenue and Deficit



b)Share of Central Bank to meet Deficit



Tayyebnia (1994: 262) take into account the discrepancy between expenditure and non-oil revenues as budget deficit to consider the monetary effect of the budget. However, the import requirements of government and private sector induce a repayment of expanded money to the central bank, though the lag between monetization of oil dollars and import demand and also net foreign reserve of the central bank increase inflationary pressure[36]. In consequence, the structure of the budget induces money supply being partly an endogenous variable in the Iranian economy.

3.3 Banking System Performance

An expansionary monetary policy mainly induced by budget structure and the government fiscal performance has been a notable cause for increasing inflation during the period of interest. High-powered money as a base for money supply has increased chiefly due to foreign assets increases during 1972-1979 while it is mainly claims on the government that increases this figure during 1980-1989.

3.3.1 Foreign Assets

As mentioned above, oil export earnings which make for nearly the entire foreign exchange receipts of the country are directly sold to the central bank by the government. Consequently, the foreign assets of the central bank increase. This increase may be offset by a reduction of central claims on the government, otherwise, liabilities and assets of the central bank being the same, the government account must be credited. When the government uses deposits to make payments, the central bank creates new money, increasing high-powered money[37]. Such increases in high-powered money raise money supply (M_1) allowing commercial and specialist banks to offer new credit which

[36] Even if we accept this definition of the monetary expansionary effect of the budget, it seems that the arguement of Khan and Aghevli (1978) and Ghatak (1995a: 101) about DCs, is not strongly justified in Iran case that the expenditure in real terms decreases almost similar to real domestic revenues in inflationary process as Figure 10b illustrates.

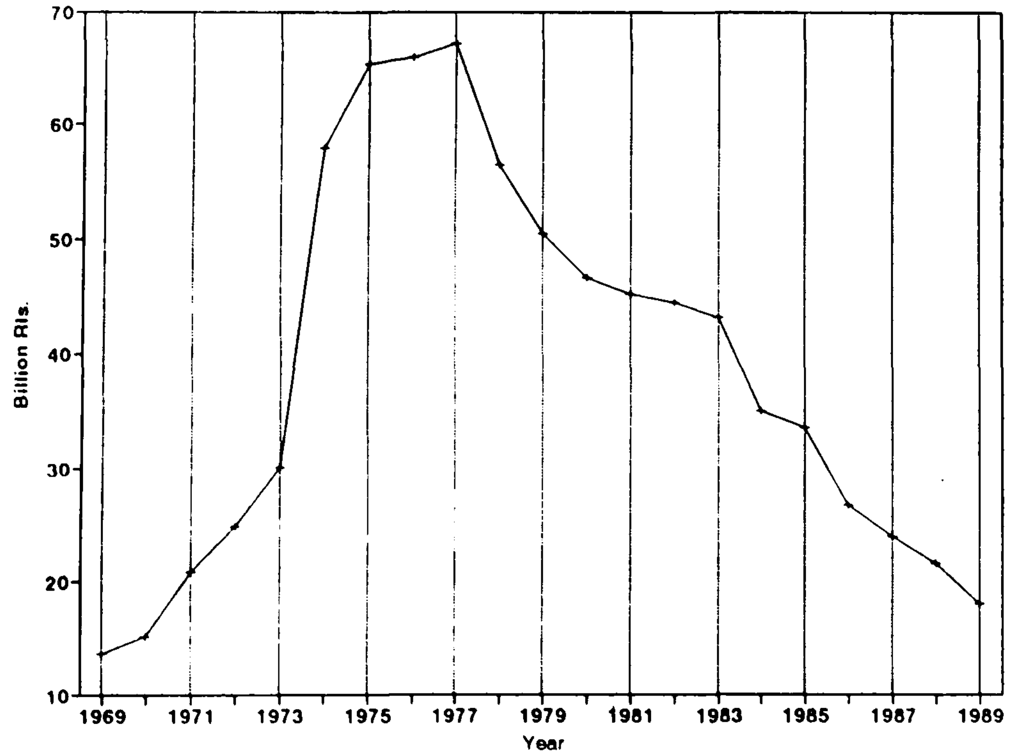
[37] Foreign assets increase can be neutralized by sterilization operation of the central banks like selling bonds to the public (Sachs and Larrain, 1993: 264). However, in Iran there has been no active financial market, so that net government bonds transaction during 1973-1978 was Rls. 123.7 billion about 18.6 percent of the increase in net foreign assets during the same period.

Table 10 : Real Tax Revenue and Real Expenditure 1969-1989

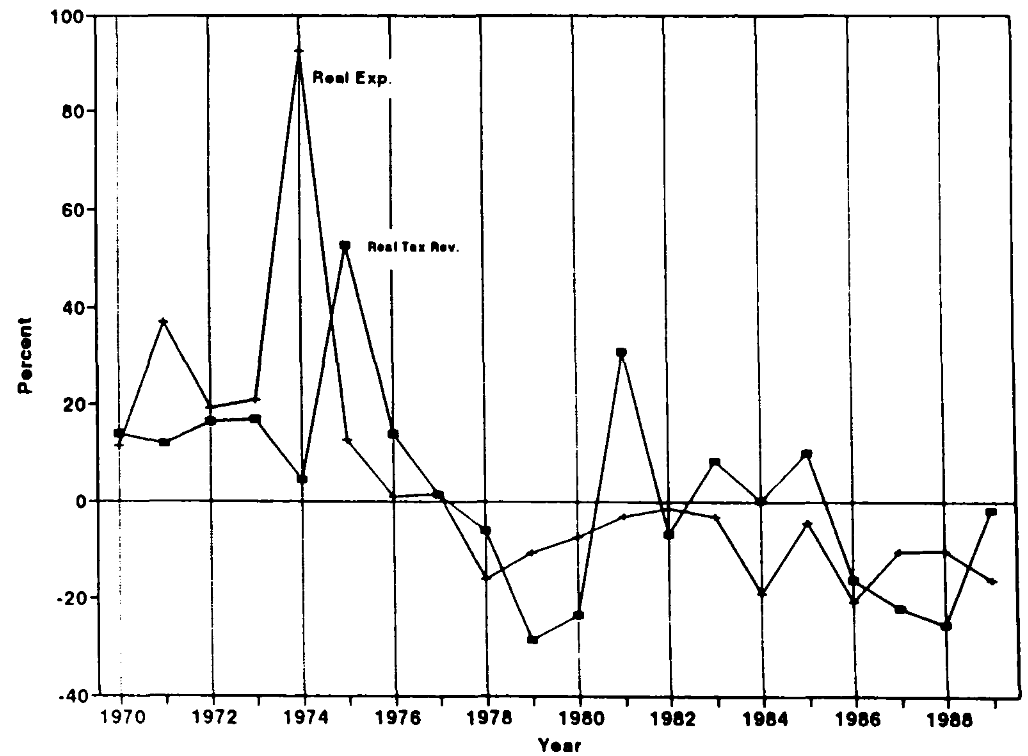
Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Naminal Exp.(Billion Rls.)	194	221.1	315.4	401.5	531.4	1174.4	1496.2	1675.4	2174.9	2044.2	2018.2	2249.3	2707.1	3166.3	3671.7	3353.6	3350.7	3156.8	3640.6	4210.6	4316.7
CPI	14 3	14.6	15.2	16.2	17.7	20.3	22.9	25.4	32.4	36.2	40.0	48.2	59.9	71.1	85.1	95.8	100.0	118.4	152.3	195 9	239 7
Real Expenditure	13 57	15.14	20.75	24.78	30.02	57.85	65.34	65.96	67.13	56.47	50.46	46.67	45.19	44.53	43.15	35.01	33.51	26.66	23.90	21 49	18.01
Real Tax Rev.	4 24	4.84	5.43	6.33	7.41	7.75	11.83	13.5	13.69	12.87	9.21	7.06	9.25	8.63	9.36	9.38	10.34	8.66	6.76	5.04	4.96
RTR(%)		14.15	12.19	16.57	17.06	4.59	52.65	14.12	1.41	-5.99	-28.44	-23.34	31.02	-6.70	8.46	0.21	10.23	-16.25	-21 94	-25.44	-1.59
RE(%)		11.63	37.02	19.44	21.14	92.70	12.94	0.96	1.77	-15.88	-10.65	-7.51	-3.16	-1.46	-3.12	-18.87	-4.28	-20.43	-10.34	-10.08	-16.21

Source : OPB(1994) and OPB,Statiatic Center of Iran, Statistical Almanac, various years.

Figure 10 : a) Real Expenditures 1969-1989



b)Change in Real Tax Rev. and Real Exp.



increases broad money (M_2). As Table 11 indicates, net foreign assets of the central bank sharply increased after oil price jumps in 1973 and 1974, so that it rose about 17-fold during 1971-1974 from Rls. 29.6 billion to Rls. 508.0 billion. Whilst net domestic credits of the central bank (claims on the government and banks) decreased from Rls. 108.4 billion to 86.3 billion.

Foreign assets of the central bank which increase up to Rls. 1047.7 billion in 1979[38] then show some fluctuation and stay around Rls. 700 billion during the last seven years of the period[39].

3.3.2 Claims on Government

Although during 1971-1978, before the revolution, the government acquired high oil revenues annually, it experienced an increasing fiscal deficit (Table 9, Figure 9) mainly financed by money creation. Table 9 also shows the share of the central bank in meeting budget deficits. As Table 11 shows, claims of the central bank on the government after a downward trend for a few years reaches Rls. 620.2 billion in 1978, about 7 times the first year of the period. The bulk of this liability of the pre-revolutionary government is due to budgetary performance in the last year of the previous regime when it increased salaries and wages with the aim of quietening the revolutionary movement while the revenues were decreasing considerably. This development increased the change in claim of banking system on public sector from Rls. 21.1 billion at the end of summer 1978 to Rls. 295 billion two quarters later and made the net central bank's claims on the government almost 5 times those of the previous year. This figure continued to increase at a relatively smaller rate averaged annually 24.6 percent for the rest of the period and peaked up to Rls. 10985.9 billion in 1989. This increasing path of the claim of the central bank on the government has been the essential cause for monetary base expansion during post-revolution period.

[38] The sizeable increase of foreign assets in 1979 is due to a considerable decrease in imports while foreign exchange reciepts are as usual.

[39] Massoudnia (1983) examines the effect of the growth of foreign reserve of the central bank on domestic inflation and finds a direct relationship between them through money supply. Also see Rahbar (1990).

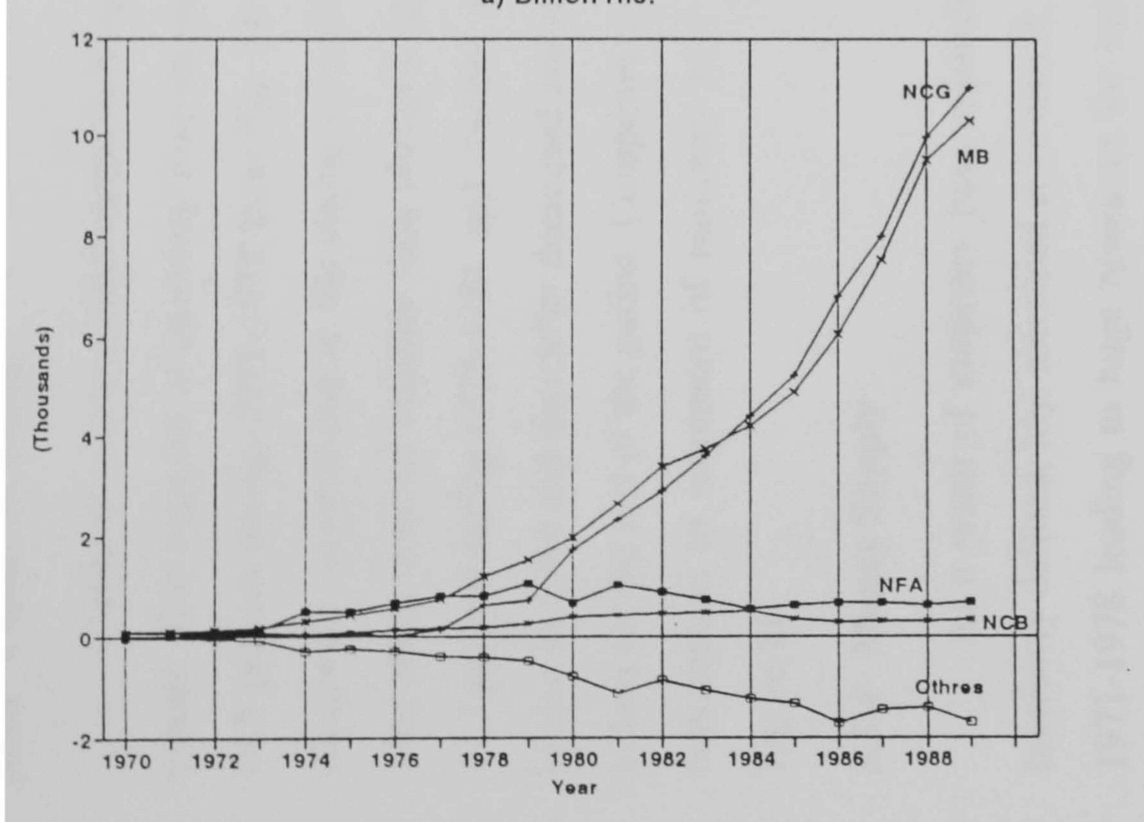
Table 11 : Monetary Base Components, 1970-1989 (Billion Rls.)

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Net Foreign Assets(1)	-8.8	29.6	70.3	142.7	508	506.5	677.7	828.5	806.2	1048	667.3	1026	884.7	734.4	545.9	633.3	674	679	619.2	699.1
Net Claims on Government(2)	106.8	93.9	96.5	82.6	49.1	59.2	27.7	135.8	620.2	713.6	1727	2338	2924	3630	4413	5247	6807	8007	9979	10986
Net CLaims on Bancks(3)	15.3	14.5	20.2	44.6	37.2	98.7	149.1	174.9	194.2	256.9	393.9	421.6	465.4	468.1	506.1	355.9	295	315	319.9	322.6
Net Other Assets(4)	-21.7	-29.3	-45.7	-81.6	-283	-245	-288	-401	-411	-484	-799	-1130	-868	-1067	-1228	-1336	-1713	-1459	-1399	-1697
Monetary Base(5)	91.6	108.7	141.3	188.3	310.9	419.6	566.9	738.6	1210	1534	1989	2655	3406	3765	4237	4900	6063	7542	9520	10311
1/5(%)	-9.6	27.2	49.8	75.8	163.4	120.7	119.5	112.2	66.6	68.3	33.6	38.6	26.0	19.5	12.9	12.9	11.1	9.0	6.5	6.8
2/5(%)	116.6	86.4	68.3	43.9	15.8	14.1	4.9	18.4	51.3	46.5	86.8	88.1	85.9	96.4	104.2	107.1	112.3	106.2	104.8	106.5
3/5(%)	16.7	13.3	14.3	23.7	12.0	23.5	26.3	23.7	16.0	16.7	19.8	15.9	13.7	12.4	11.9	7.3	4.9	4.2	3.4	3.1
4/5(%)	-23.7	-27.0	-32.3	-43.3	-91.2	-58.3	-50.7	-54.2	-33.9	-31.6	-40.2	-42.6	-25.5	-28.4	-29.0	-27.3	-28.3	-19.3	-14.7	-16.5

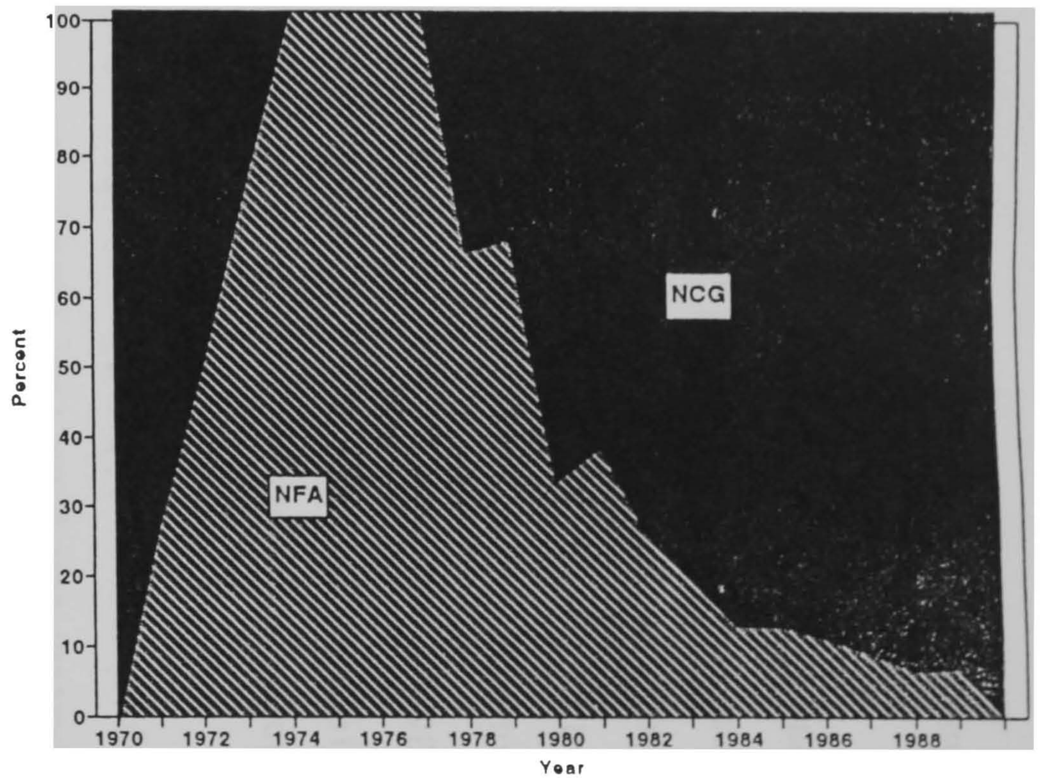
Source : Calculated from OPB (1994)

Figure 11:Monetary Base, 1970-1989

a) Billion Rls.



b)Share of NFA and NCG in Monetary Base



3.3.3 Claims on Banks

Claims of a central bank on the banking system is part of high-powered money. This segment of monetary base increased at an average annual rate of 44.9 percent during 1971-1978 from Rls. 14.5 billion to 194.2 billion. These claims are created due to the easing of credit policy of the banking system. That sharp trend of increase then changed sizeably to a gentle rise averaging 17.3 percent during 1978-1984 and reached its highest level of up to Rls. 506 billion in 1984 and thereafter decreased and continued to stay around Rls. 300 billion for the rest of the period. Components of high-powered money and their contribution to increment of monetary base are illustrated in Table 11 and Figure 11.

3.3.4 Money Supply

As a result of monetary base expansion until 1978, supply of money (narrowly defined, M_1) increased at an annual average rate of 40 percent during 1971-1978 leading to huge resources for banking system, which encouraged the banks to offer easy credit to private sector's demand, so that the net claims of the banking system on the private sector increased at an average rate of 39 percent during the Fifth Plan, 1972-1977. The trend of money supply (M_1), quasi-money and broad money (M_2) can be viewed in Table 12 and Figure 12a.

As discussed above, in this sub-period, the most important cause of increasing monetary base is the foreign assets increase via the windfall of 1970s and its budgetary consequences (See Figure 11b). In Dadkhah's (1985: 365) words, *this fatal mistake* occurred because the government neglected to differentiate its revenues and its expenditures in dollars from those of in rials after the windfall and also because of the failure of the central bank in conducting its responsibilities in banking system control. "*Thus, the revolutionary government inherited an explosive situation in terms of both money supply and inflation*" (pp. 378).

The post-revolution government tried to decrease monetary expansion using selective credit policies and imposing credit ceilings. Of course, the

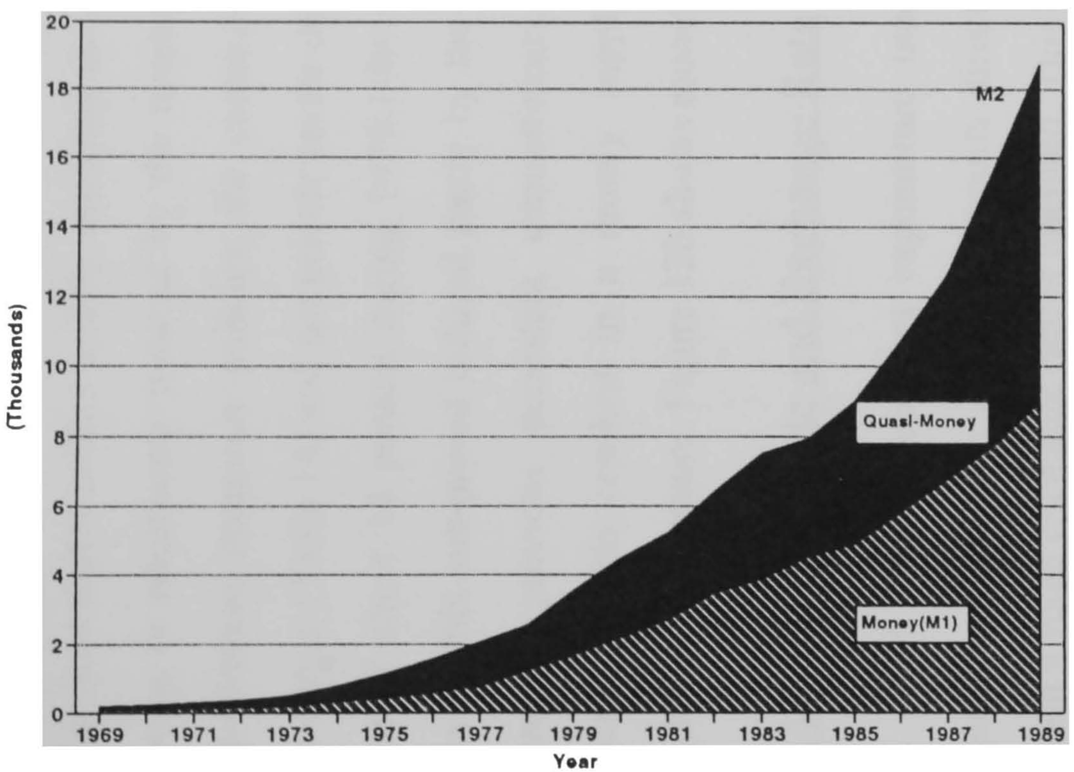
Table 12 : Money Supply (Billion Rls.)

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Money(M1)	90.5	97.4	117	159	203	327	447	611	791	1237	1666	2203	2708	3484	3870	4558	4924	5811.1	6776.7	7758.1	8987.2
Quasi-Money	115	138	179	241	313	483	699	982	1307	1342	1884	2305	2529	2947	3645	3409	4079	4911.6	5891.4	7929.5	9766.1
Broad Money (M2)	206	236	296	399	516	810	1146	1594	2097	2579	3550	4508	5236	6431	7514	7967	9002	10723	12668	15688	18753
Inflation		2	4.1	6.5	9.2	14.7	12.8	10.9	27.6	11.7	10.5	20.5	24.3	18.7	19.7	10.9	4.4	18.4	28.6	28.6	22.4
Change in M1(%)		7.6	20.1	35.6	27.7	61.4	36.5	36.9	29.3	56.4	34.7	32.3	22.9	28.7	11.1	17.8	8.0	18.0	16.6	14.5	15.8
Change in M2(%)		14.5	25.7	34.8	29.1	57.1	41.4	39.1	31.6	23.0	37.7	27.0	16.1	22.8	16.9	6.0	13.0	19.1	18.1	23.8	19.5

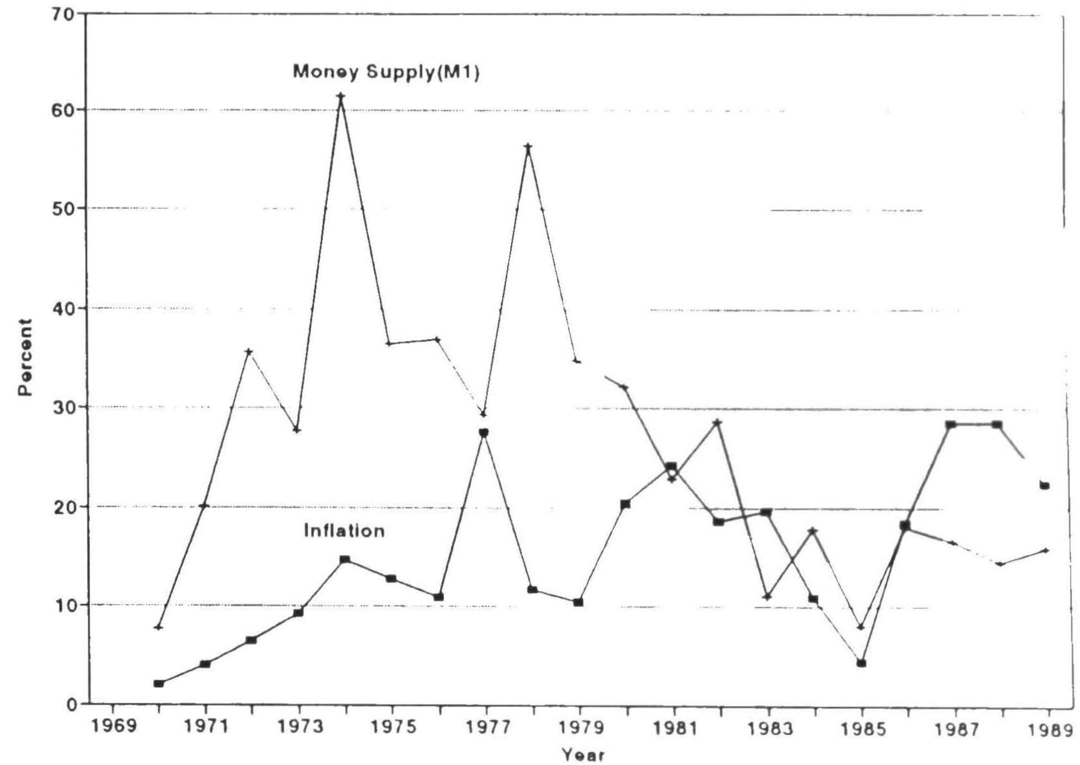
Source : OPB (1994)

Figure 12: Money Supply

a) Billion Rls.



b) Rate of Money Supply and Inflation



central bank failed to keep pace with the approved limitations, hence, changes in private sector credits usually exceeded the ceilings (Table 13). Nevertheless, owing to uncertainty induced by the revolution, the war and interventional government economic policies, the commercial banks usually faced excess resources (Table 14) and net private sector debt increased at an average annual rate of about 14 percent during 1979-1989. However, a high budget deficit during this sub-period induced partly by the aforesaid reasons, in addition to meeting previous persistent commitments, caused the monetary base to increase. This resulted in a money supply increase, and its consequent inflationary pressure. Figure 12b shows money (M_1) changes and inflation[40] .

3.4 Foreign Trade and Exchange Rate

A vast government expenditure made possible by oil revenues or domestic borrowing increases imports directly or via relative price changes when a fixed exchange rate is operated. This erodes non-oil exports leading to more dependence on oil revenue. Consequently, when an adverse oil shock occurs the government is compelled to devalue the exchange rate in some way, resulting in higher imports prices which contribute to domestic inflation, in addition to any contribution by world inflation.

3.4.1 Exchange Rate

Iran had experienced a fixed exchange system with quantitative controls before 1973. However, during 1973-1979 lax exchange policy resulted from the huge foreign exchange revenue from oil exports. In practice, there was no control and the capital market at an official going rate became active. Excess demand for exchange was met, in addition to non-oil export proceeds, mainly by Bank Markazy pouring up to 7 billion dollars into the free market during that period (Bahrami, 1990:41). This exchange performance decreased the exchange rate in the free market (the value of dollar in terms of domestic currency) for the first years of the period. After the revolution, in order to cope with the balance of payment problem, severe quantitative exchange and import

[40] For a comperihensive study on money supply in the Iranian economy see Nazarian (1990).

controls were implemented. In the recent years of the period, preferential rates have prevailed, though the official exchange rate, pegged to the SDR, remains almost intact (Table 15).

An important issue in this regard is the free (black) market which has coexisted in parallel with the official market as in most DCs with similar exchange and import policies. The exchange rates in this market have been increasing since the revolution, so that it changed by about 500 percent by the mid-1980s and increased at a sharp rate of over 2000 % by the end of the period, 1989[41] (see Table 15).

This path of the black market exchange rate reflects a high overvaluation of the official exchange rate stemming from the oil price collapse and the subsequent sizable reduction in oil export proceeds while the exchange needs of the war economy were increasing. One important effect of this overvalued exchange rate is a higher rate of expectation of inflation resulting in higher inflationary pressures[42].

3.4.2 Foreign Trade

The Iranian economy has been closely tied to oil export during recent decades. Because of the negligible share of non-oil exports in total goods exports, oil is virtually the single source of foreign exchange. It has accounted for about 95% of total exports. Thus, it clearly determines changes in current account balance. The amount of additional proceeds of the 1970s oil boom was very large. The average growth rate of merchandise export revenue (oil and non-oil) for three pre-boom years was 12.2 percent. Assuming that this rate had been constant for 1973-1977, the difference between actual revenue and the postulated proceeds would have been more than 65 billions of dollars[43]. These huge incomes, in five years, for an economy which had been operated at an

[41] Karshenas and Pesaran (1995: 10)

[42] Tayyebnia (1993: 266) using the ratio of black market to official rates of exchange in Harberger's model for Iran, shows that each 10 percent change in this variable changes inflation positively by 5.5 percent. In that estimation the coefficient of expected rate of inflation is not significant. This implies that the ratio used also reflects expectation of inflation because of the multicolinearity between the expected rate of inflation and the exchange rate.

[43] Estimated by facts provided in: IMF, *IFS*, variou years.

Table 13 : Credit C ling Change 1981-1989(%)

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989
Approved	20	*	*	10	10	9.7	7	8.8	18
Actual	5.3	8.2	22	5.7	12.9	9.8	13.8	17.8	29.7

Source : Bank Markazy, Economic Report and Balance Sheet, Various Years

** Data is not available.*

Table 14: Surplus Sources of Commer ial Banks 1979-1989

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Free Source	508.7	2349	2588	3110	3123	3198	3611	4584	5829	7563	9525
Surplus	226.5	257.2	322.3	718.1	34.2	44.8	371.2	790.9	1197	1966	1993

Source : Bank Markazy of I.R.I., Economic Report and Balance Sheet, Various Years.

Table 15 : Exchange Rate (Rials, period average), 1969-1989

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
SDR	75.8	76	76	82.2	82.1	81.3	82.1	81.1	82.4	88.2	91	92	92.3	92.3	92	92	92	92.3	92.3	92.3	92.3
Dollar (official)	75.4	76	76.4	76.4	69.1	67.6	67.6	70.2	70.6	70.5	70	71	78.3	83.6	86	90	91	78.8	71.5	68.7	72
Dollar (free market)	78.5	79	78.7	76.5	69.9	67.9	86.7	73.4	73.7	84.6	127	138	150	250	350	550	614	742	991	1019	1212

Source : IMF, IFS, 1989 and March, 1993. Free market rate from the data center of Shaheed Beheshti University, Tehran, Iran.

average 3.5 billion dollars a year during the five years prior to the first oil-boom, was very significant[44].

The spending effect of this windfall increased imports directly and also as a result of relative price changes. A part of government expenditure is directed towards foreign goods and services. Income back to the private sector through government expenditure on home produced goods and services, creates some new demand for foreign goods and services. Moreover, expenditures (public and private) on nontraded goods lead to higher prices while tradable goods are available at almost constant world prices. Table 16 shows the changes of the indices of the prices of goods domestically produced and consumed (P_n), imported goods (P_t), and exported goods (P_x). P_n and P_t are used as proxies for respectively nontraded and traded goods. P_t reflects imported inflation and increasing costs of imports. A reduction in relative price of traded to nontraded goods (the real exchange rate), with a fixed nominal exchange rate, encouraged more imports. The relative price path is illustrated in Figure 13[45].

Given the budget structure and budgetary performance of the government, an increase in imports seemed inevitable. So import promotion policies were conducted for some years after oil boom in order to meet excess demand in the market of goods and services. Another purpose was to reduce money market disequilibrium by selling foreign exchange as sterilization operations which meant that it decreased money supply. This development sharply reduced the current account surpluses from 8.5 billions dollars in 1974 to almost zero in 1978(a 31 million dollars deficit), and doubled payments for imports of goods and services from 12.4 to 23.2 billions dollars in those two years. Table 17 and Figure 14 show the current account balance. A decreasing real exchange rate in these years, making imported goods cheaper for

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[44] Total imports (goods and services) during 1968-1972 were 17.5 billions of dollars (*IFS*, November 1975).

[45] Ebrahimi (1993) using WPI and CPI of USA as indicators for tradable goods prices (P_t) and CPI of Iran as that of nontradable (P_n), considers the behaviour of real exchange rate (RER = E P_t /P_n) and points out that bilateral real exchange rate has deteriorated after the 1973 windfall. The multilateral real exchange (using weighted average of WPI or CPI of various trade partners) shows the same path.

Table 16 : Wholesale price indices and Real Exchange Rate, 1971-1989*

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
P (WPI)	21.9	23	26	30.5	32.1	36.4	41.7	45.7	54.7	71.4	85.1	100	108	116	125	156	202	247	292
Pn	20.8	21.4	24	28.4	30.1	35	40.4	44.2	53.6	71.5	83.3	100	108	118	126	154	196	239	286
Pt	30.5	33.2	37.9	42.6	44.3	47.2	52.9	58.4	67.2	81.8	93.3	100	105	109	117	152	202	251	285
Px	17.9	20.6	28.5	30.8	31.9	38.6	43.3	45	56.3	75.1	85.8	100	99.2	115	162	485	1008	1072	1120
RER (Pt/Pn)	1.47	1.55	1.58	1.50	1.47	1.35	1.31	1.32	1.25	1.14	1.12	1.00	0.96	0.92	0.93	0.99	1.03	1.05	0.99

Source : Bank Markazy Of I.R.I., Economic Report and Balance Sheet, Various Years.

** Pn, Pt, and Px refer respectively to the price index of domestically produced and consumed goods, imported goods and exported goods.*

Figure 13: Real Exchange Rate
1971-1989

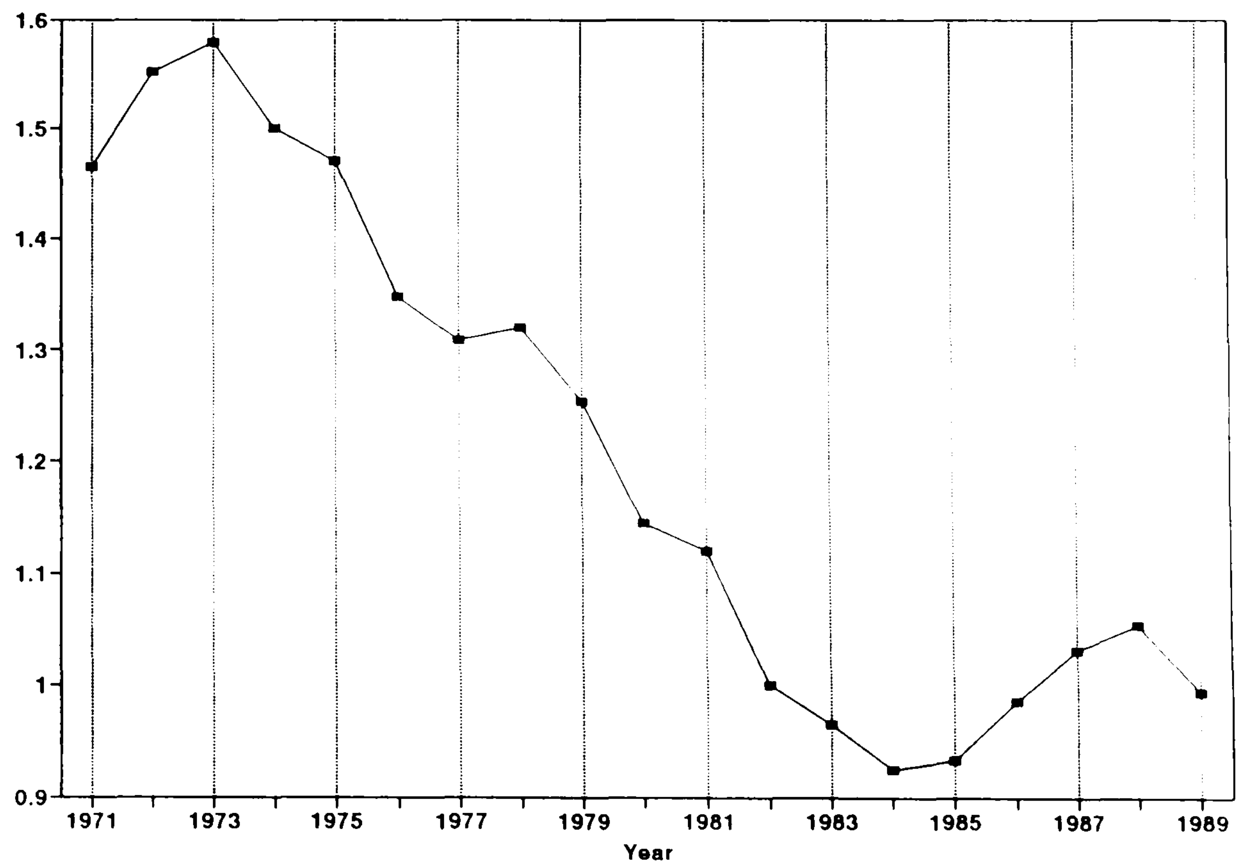


Table 17 : Current Account Balance (Million Dollars), 1970-1989

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Reciepts	1690	2733	3337	6232	20922	21972	24618	25590	22737.6	22658.4	14214	14320.3	21456	22082	17947.7	15022.7	7145.4	10292	8810	13380
Payments	2365	3015	3502	5887	12439	19058	21087	24496	21238.6	16548.7	18813.4	17057.2	14904	24198	18650.5	13444.3	11342.5	11744	10159	11680
Balance	-675	-282	-165	345	8483	2914	3531	1094	1499	6109.7	-4599.4	-2736.9	6552	-2116	-702.8	1578.4	-4197.1	-1452	1349	1700

Source : Bank Markazy of I.R.I, Economic Report and Balance Sheet, Various Years.

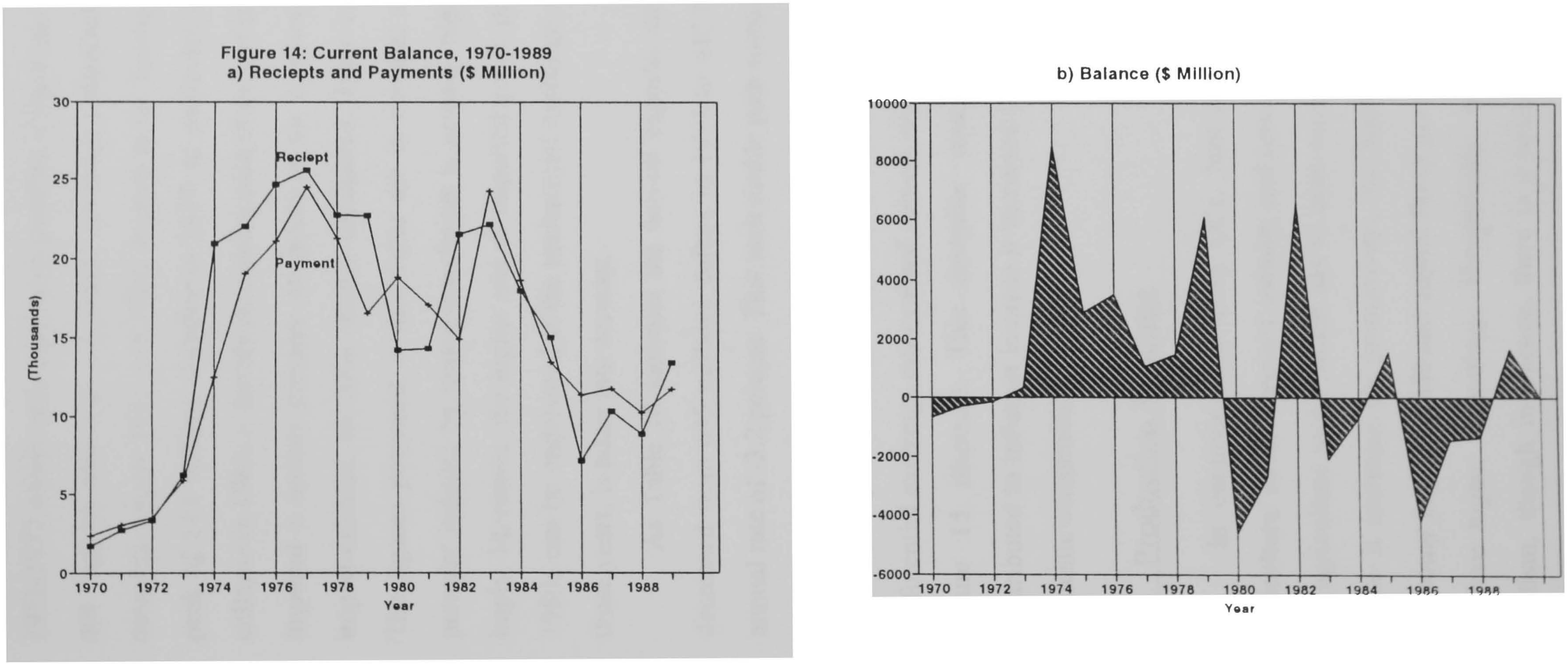


Figure 14: Current Balance, 1970-1989
a) Reciepts and Payments ($ Million)

consumers, encouraged more imports. Continuing of the low import prices of 1971-1977 would only have been possible if the trade sector's bottlenecks did not appear and high oil export revenues continued. However, from 1978 onwards, except 1983 and 1984, imports never reached the pre-revolutionary peak of 14.1 billions of dollar in 1977. In particular, at the time of oil price collapse in 1985, a sharply decreasing path of import started. This development imposed a serious pressure on prices in an economy which was becoming import-oriented, an issue shortly considered. Table 18 records foreign trade. The figures presented in this Table are in nominal terms, thus, inflationary pressure induced by import constraints is actually higher than these measures imply. Moreover, the higher rate of imported goods prices in the latter half of 1980s can be understood if the preferential exchange rate system enforced for those years, is taken into account.

As Table 18 indicates the non-oil exports, after a period of increase, decreased from 635 millions dollars in 1973 to 542.8 in 1978 at an average annual rate of -3.2 percent. This undesirable path worsened after the revolution, such that it reached the lowest level of 284 millions dollars, about 1.4 percent of total exports. Later, when the oil revenues decrease started in 1985 preferential exchange rates caused non-oil exports to increase, as Table 18 and Figure 15 illustrate. This desirable structural development, of course, contributed to inflation because it increased the price of exportable goods for domestic consumers.

3.5 Production Structure

In common with other DCs, Iran had suffered from a traditional agriculture/ modern sector (industry and services) dualism. In DCs it is usually the agriculture sector which has to meet resources for industrial development while it increases its productivity. As Ranis's (1988) model of open dual economy implies, trade and capital flows generate new economic capacities to achieve higher technology. Theoretically, this can lead to the solving of dualism, though in practice, there is a tendency to disregard the agriculture sector in the development process. This will be worsened if there is a natural resource revenue to fuel the development engine. In such cases, neglecting the scale of the country's economy, a costlier industrial growth can then be followed.

In fact, the Iranian economy, with an important oil sector, has been characterized by an oil/non-oil dualistic feature as well as an agriculture/industry dualism. Oil domination in production and foreign trade is portrayed in Table 19 and Figure 16. Before the 1973-1974 oil boom, the oil sector's contribution to GDP was nearly 50 percent. For the rest of the years until the revolution, this share shows a declining path, as Shahshahani and Kadhim (1979: 62) state. However this resulted essentially from exogenous factors and cannot be regarded as a consequence of national attempts to reduce reliance on the oil sector. Indeed the share of domestic-oriented agriculture sector during the same period was declining like that of the oil sector in favour of oil revenue-intensive sectors: industry and services, the leading sectors which accounted for about 50-60 percent of GDP, This can be seen in Table 20 and Figure 17[46].

During 1970-1978 nearly 90 percent of oil production was exported (almost entirely in crude form), hence, there was no notable forward linkage impact. The share of this sector in the labour force during these years remained less than 1 percent. This, coupled with high technology used in this sector, also implies a weak backward linkage. Ertefaee (1974), using time series analysis and input-output analysis, points out that the spill-over effects from oil sector, a dynamic growing enclave sector, on the rest of the Iranian economy have been of negligible significance. While forward linkages of oil sector on manufacturing as well as backward ones, are very weak, the latter have been deteriorating.

Kalantarifard (1980) indicates that the oil revenues during 1952-1976 had been spent in a way that led to an undiversified economy, so that the economy which could survive almost without oil revenue in 1952, after 25

[46] In order to highlight the importance of the economic performance in the first years of the period, the issues are considered during two subperiods pre and post revolution in many cases.

years, was entirely dependent on oil proceeds and could only last for about forty days if oil revenues were ruled out. His argument can be supported if the changes of the share of intermediate imported goods in GDP, as a dependency index, is considered. As Table 21 points out, this index increases annually at 7.3 percent during 1972-1977 (duration of the Fifth Development Plan). Unlike a developed economy with well-matched intersectoral relationships, in Iran, the booming sector, which made the windfall, has no notable complementary link with other sectors[47]. Moreover, and probably more importantly, the production of OPEC's members is determined by a set of factors, excluding oil prices, which often does not change in the short-run. Thus, even with a well-linked economic structure, Iran as a member of this organization might not have been allowed to increase its oil production after the oil price increase. Hence, the windfall had no resource movement effect. Table 22 shows that in spite of the boom, oil production has not increased; rather there have been a slight reduction. In consequence, the windfall affected the economy via a spending effect accomplished by government expenditure.

Since the government has obtained all the oil revenues, and these revenues have been distributed among the private sector via government expenditure, the government has had a large role in forming the spending effect of the windfall and the following resource reallocation. Thus, the most significant question is, what the best time, means and measure of windfall expenses were. Another important question is about the appropriate trade and monetary policies. According to Devarjan & de Melo (1987) the effects of the 1970s commodity boom on Cameroon, Cote d'Iviore, and Senegal, three members of a Monetary Union, which have a similar economic structure, show how various budgetary and commercial policies result in significantly different outcomes. In Iran's case the government's responsibility is heavier because of its monopolistic role. Broadly speaking, the windfall injection into the economy during a short period almost quadrupled nominal gross national income (GNI), reflecting purchasing power of the people, from Rls. 930.7

[47] See section 2.3.4 for theoretical discussion.

Table 18 : Foreign Trade (Merchandise, $ Million), 1970-1989

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Non-Oil Export	283	334	440	635	581.5	592	540	625.2	542.8	818.8	645.2	339.5	283.7	356.6	361.1	465	915.5	1160.8	1035.8	1043.9
Oil Export	1268	2114	2460	4945	18654	19074	20671	20904.7	18115.6	19829.1	19315.7	14320	20050	20457	16663.2	13967.7	5982.3	9189	7599	11993
Import	1677	2061	2570	3737	6614	11696	12766	14626	10372	9695	10844	13515	11845	18103	14494	11408	9355	9369	8177	12807

source : Bank Markazy of IRI, Economic Report and Balance Sheet, various years.

Figure 15: Foreign Trade, 1970-1989
Million Dollars

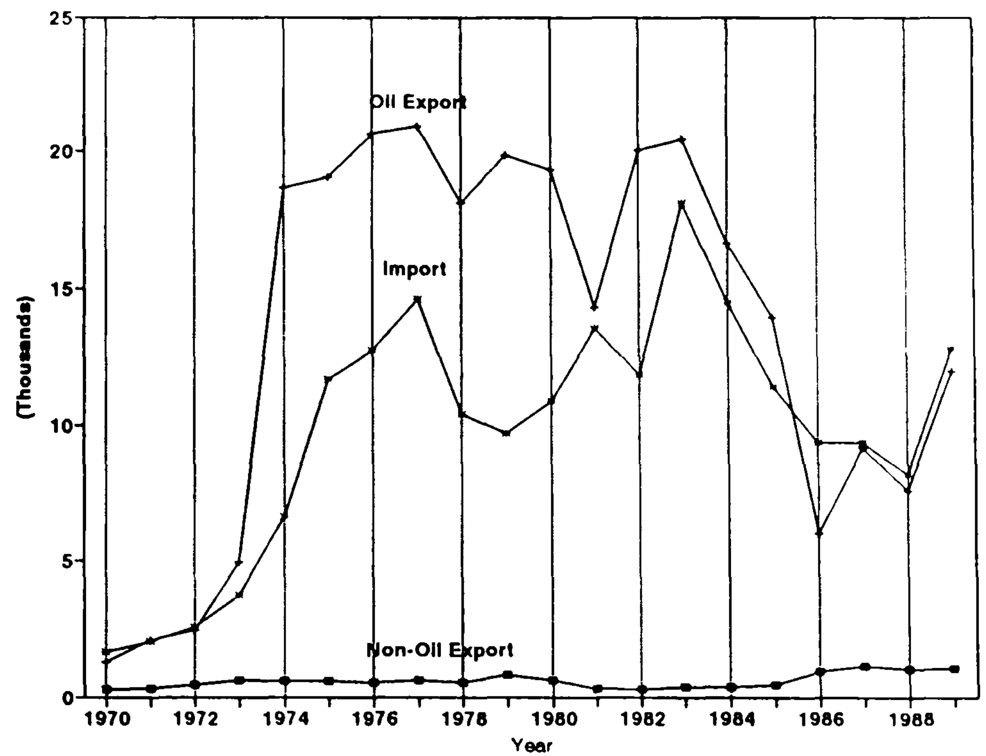
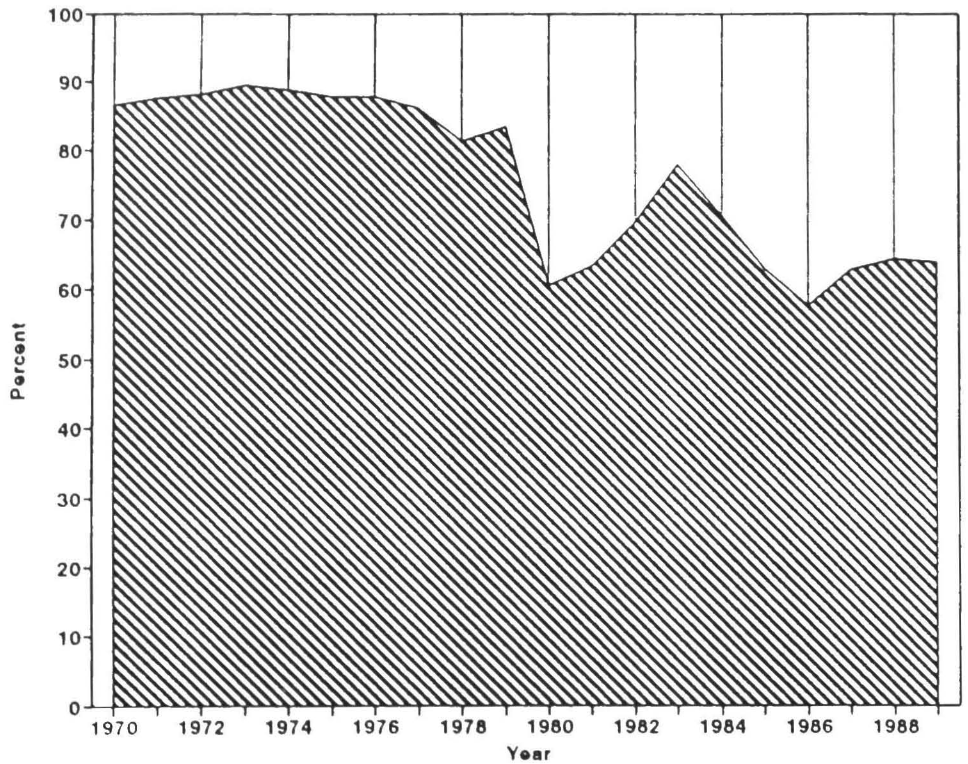


Table 19: Oil Share in Oil Production and Total Export, 1970-1989(%)

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Oil Export/Oil productio	86.5	87.6	88	89.5	88.8	87.8	87.7	86.2	81.3	83.5	60.6	63.3	69.6	77.9	70.6	62.9	57.7	62.8	64.4	63.9
Oil Export/Total Export	82.3	78.6	77.8	82	97.4	97.3	98.1	97.8	97.5	96.2	82.1	96.2	98.6	98.5	98.3	97.7	96.4	98.4	91.1	95.3

Source : Bank Markazy of I.R.I, "National Income Account 1338-1353, and 1353-1366" and "Economic Report and Balance Sheet", various years.

Figure 16: Oil Sector Role 1970-1989
a) Oil Export/Oil Production



b) Oil Export/Total Export

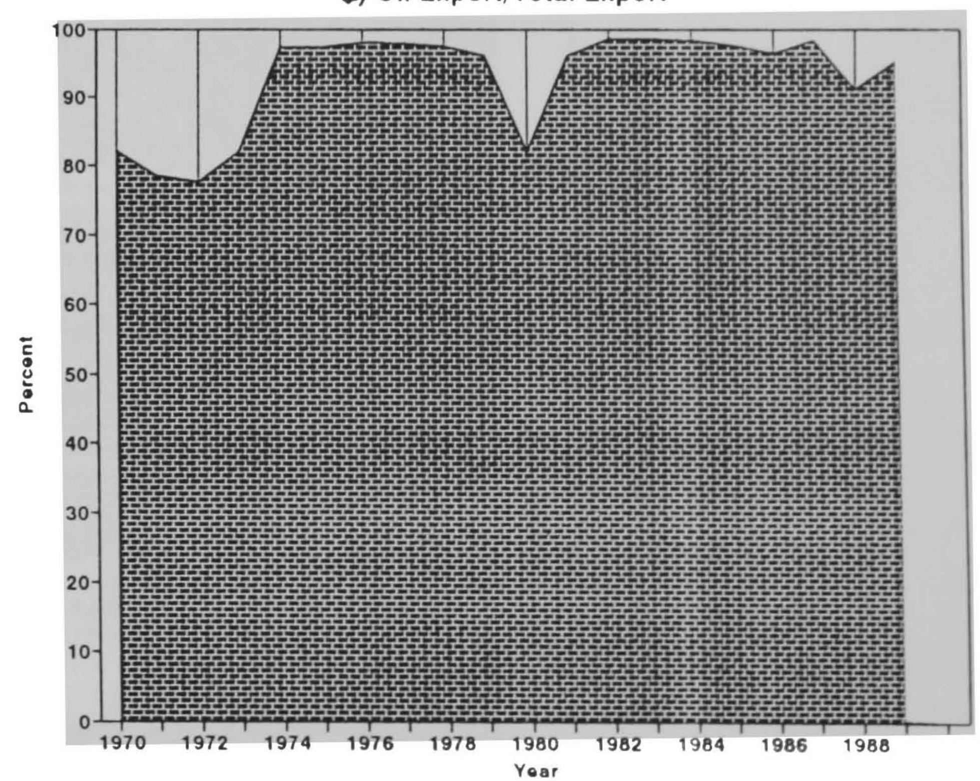
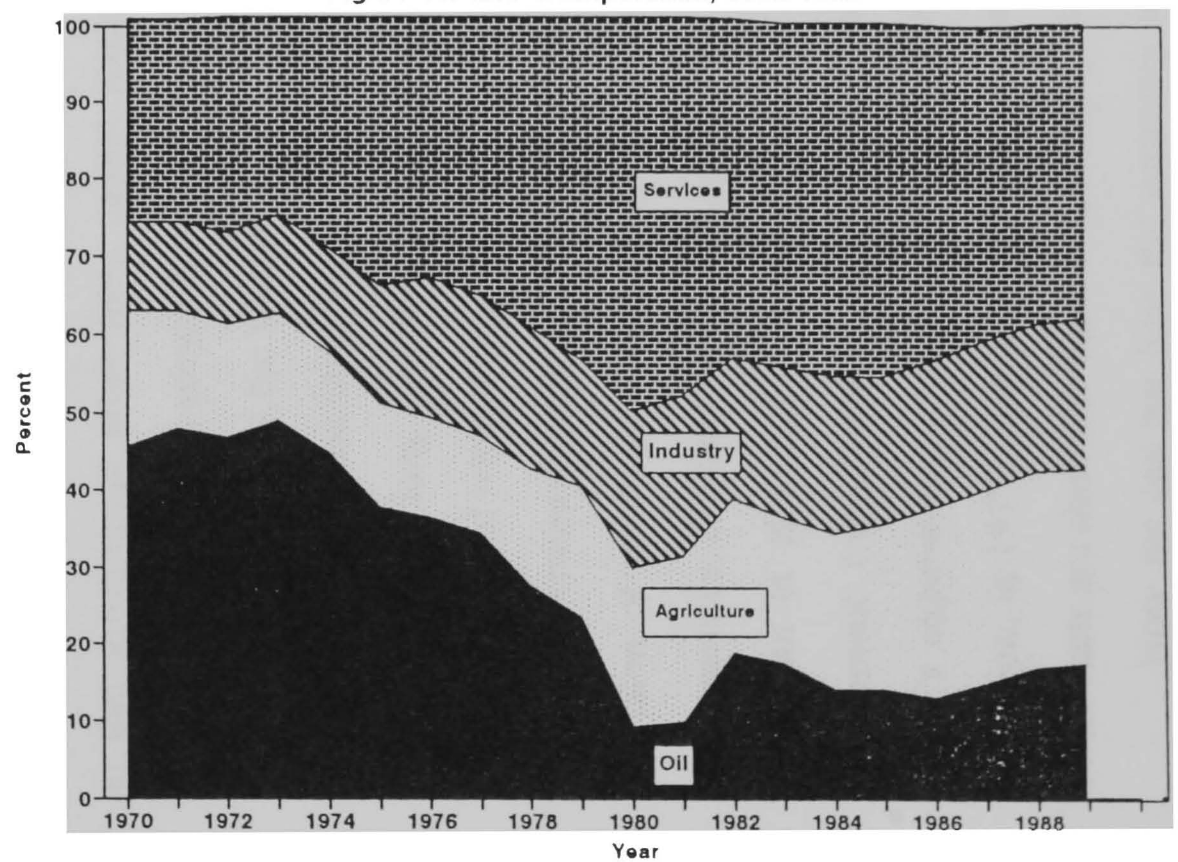


Table 20 : GDP Components 1970-1989(%)

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Oil	45.7	48	46.8	48.9	44.9	37.8	36.4	34.3	27.5	23.4	9.4	9.8	18.8	17.4	14.1	14	13.1	14.9	16.9	17.5
Agricuture	17.5	15.2	14.7	13.9	13	13.6	13	12.8	15.3	17.1	20.7	21.6	20.2	19	20.4	21.6	24.8	25.3	25.6	25.4
Industry	11.5	11.5	11.7	12.7	13.3	15.1	17.9	18.1	18.4	16.4	20.3	20.8	18.2	19.6	20.5	19	19	19.4	19.1	19.5
Services	26.6	26.5	28.3	26.2	31.4	36.5	35.3	37.5	42.3	45.8	52.6	49.9	44	44.6	45.7	45.8	43.5	40.4	38.9	38

Source : OBP(1994)

Figure 17: GDP Components, 1970-1989



billion to Rls. 3362.7 billion during 1971-1974 while the impact of monetary expansion, induced by the windfall, on real output (real GDP) was only a 53.6 percent increase during that time. This gap highlights the subsequent inflationary process[48] .

Regarding the government budget, consumption expenditure accumulated rapidly, so that the rate of change in real consumption reached 65% in the year immediately following the boom. The indices of real consumption indicate that during 1973-1977 this item increased 2.4 fold and the share of government and private sector altered in favour of the former. This led to both expansion of commitments and a rise in wages[49]. Real capital formation was much more significant. Its annual growth increased constantly so that government gross fixed capital formation at the end of the period extended seven-fold in comparison with the pre-boom year.

With regards to the means of the government's expenditure, the largest portion of government investment concentrated on capital intensive, high cost, low benefit and long gestation projects. This has in turn caused an income effect on demand without a consistent output capacity effect on supply.

Government spending is transferred to the private sector in three ways : provision of productive services, alteration in demand and its relative price consequences, and through the labour market and other transfers, as refered to by Bevan et al (1992). Income going back to the private sector through government expenditure, induced almost the same development for this sector's expenditure : namely a substantial rise in consumption and capital formation, in 1977, relative to 1972, an increase of 2 and 5 folds respectively. These facts are shown in Table 23 and Figure 18 .

Now we can see how the necessary adjustment of the goods market influenced by high domestic absorption appreciated the real exchange rate. New excess demand coupled with imperfect elasticity of domestic production induced more expensive non-tradable goods relative to tradable merchandises,

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[48] See Cuddington (1989) for a discussion aboat the effect of a windfall on GNI and real GDP.
[49] Cuddington (1989) looking to the booming economy in many developing countries shows that overspending is common.

Table 21: Dependency Index 1972-1977

Year	1972	1973	1974	1975	1976	1977
Intermediat Import (Billion Rls., 1974=100)(1)	166.5	191	288.5	393.8	412.9	442.7
GDP (Billion Rls., 1974=100)(2)	1233.8	1423.8	1630.3	1885.6	2145.3	2304.2
Dependency Index [(1/2)*100]	13.5	13.4	17.7	20.1	19.3	19.2

Source : IMF, IFS, 1989

Table 22: Indices of Oil Sector 1969-1978 (1985=100)

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Oil Price	5.4	5.4	6.7	7.4	9.9	39.3	38.9	41.4	45.6	45.6
Oil Production	155.1	176	208.7	231.6	269.4	276.8	245.9	271.2	260.3	246.4
Oil Export	10.3	11.8	17.7	22.2	31.6	115.5	107.6	133.1	137.7	127.1

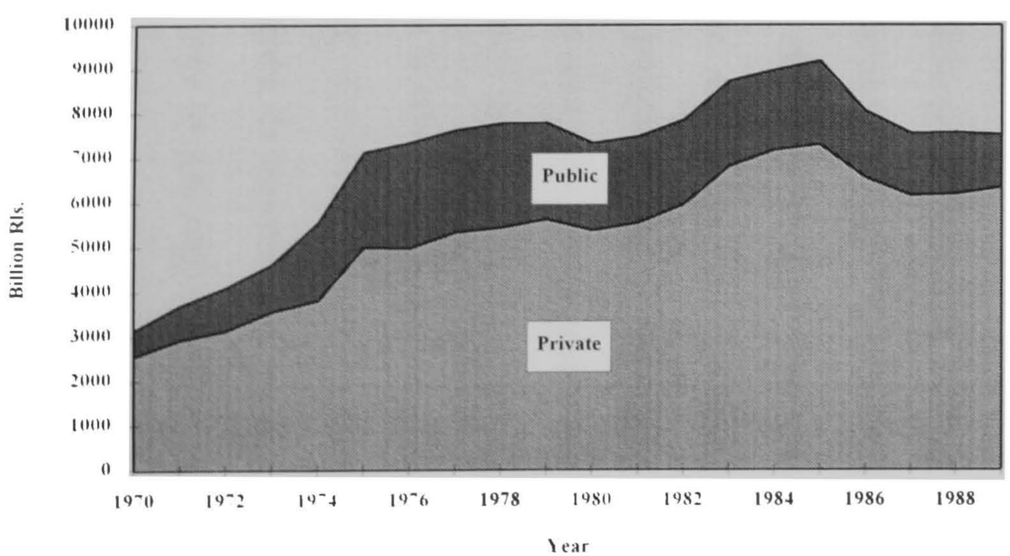
Source : IMF, IFS, 1989.

Table 23 : Public and Private Consumption and Capital Formation, (Billion Rls., 1982=100)

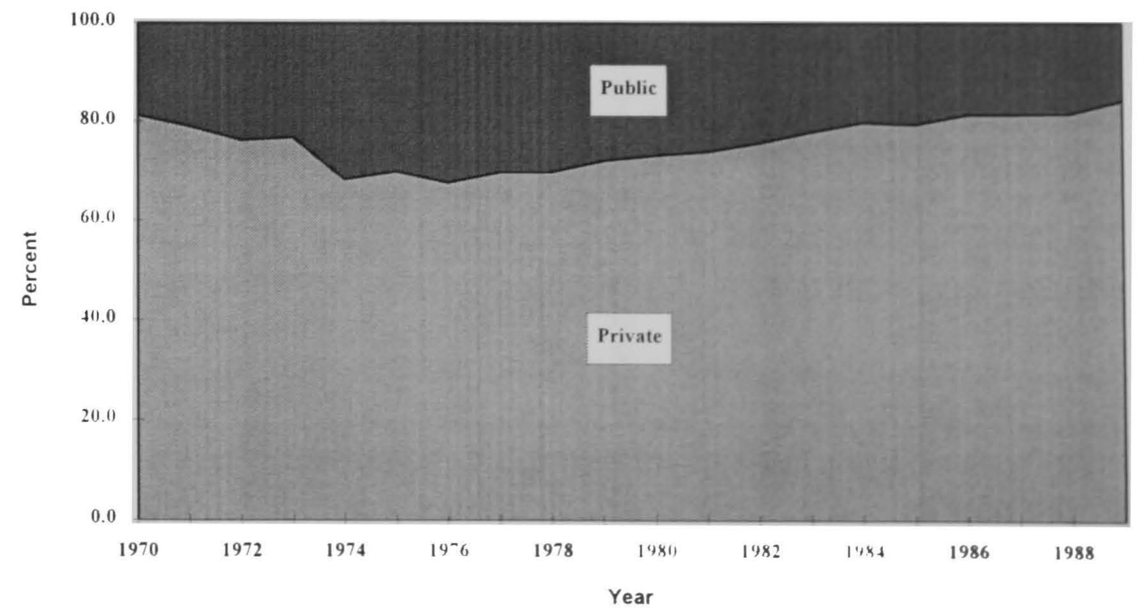
Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Consumption	3139.1	3695.7	4092.6	4613.6	5549.3	7132.6	7349	7629.7	7777.4	7792.4	7328.5	7481.2	7853.4	8733.8	8981.1	9188.7	8051.3	7544.1	7567.9	7516.5
Private	2549	2918.1	3117.4	3544	3792.9	4986.7	4969.6	5322.6	5430.5	5615.1	5360.1	5533.3	5943.3	6803.7	7170.3	7290.6	6543.7	6141.3	6171.8	6327.1
Share(%)	81.2	79.0	76.2	76.8	68.3	69.9	67.6	69.8	69.8	72.1	73.1	74.0	75.7	77.9	79.8	79.3	81.3	81.4	81.6	84.2
Public	590.1	777.6	975.2	1069.6	1756.4	2145.9	2379.4	2307.1	2346.9	2177.3	1968.4	1947.9	1910.1	1930.1	1810.8	1898.1	1507.6	1402.8	1396.1	1189.4
Share(%)	18.8	21.0	23.8	23.2	31.7	30.1	32.4	30.2	30.2	27.9	26.9	26.0	24.3	22.1	20.2	20.7	18.7	18.6	18.4	15.8
Capital Formation	866.9	1013.4	1249.4	1404.9	1633.8	2453	3328.8	3231.9	2623	1815.8	1848.4	1724.2	1841.5	2551.1	2562.2	2153.3	1645.9	1360.6	1143.6	1216.8
Private	412	462.4	644.2	673.8	695.5	1203.9	1424.8	1451	873.1	898.7	987.1	851.2	784.3	1406.8	1484.4	1262.6	885.2	790.9	679.3	748
Share(%)	47.5	45.6	51.6	48.0	42.6	49.1	42.8	44.9	33.3	49.5	53.4	49.4	42.6	55.1	57.9	58.6	53.8	58.1	59.4	61.5
Public	454.9	551	605.2	731.1	938.3	1249.1	1904	1780.9	1749.9	917.1	861.3	873	1057.2	1144.3	1077.8	890.7	760.7	569.7	464.3	468.8
Share(%)	52.5	54.4	48.4	52.0	57.4	50.9	57.2	55.1	66.7	50.5	46.6	50.6	57.4	44.9	42.1	41.4	46.2	41.9	40.6	38.5

Source : Bank Markazy of I.R.I., National Accounts of Iran, 1338-1356, 1353-1366 and 1367-1369.

Figure 18: a) Public and Private Consumption 1970-1989



b) Shares of Public and Private Consumption in Total Consumption



since with a fixed nominal exchange rate the tradable prices for domestic were constant[50]. The fall in the relative price or real exchange rate , RER, affected project evaluation, in such a way that the capital opportunity cost was taken into account incorrectly. This causes a negative capital return[51]. In fact, in this circumstance the projects with more foreign exchange needs are more attractive because they cost less compared to the others. The benefit of the projects are evaluated based on these low costs. While if the opportunity cost of the foreign exchange was accounted for, the inefficiency of many projects would be realised. Relative price variation coincided with official appreciation of the nominal exchange rate (cheaper foreign exchange in terms of domestic currency). This subsequently exacerbated RER as discussed in 3.4.2 (See Figure 13). The RER would have taken another path if the government had avoided high consumption and capital formation in implausible projects. An important implication of the RER is for the determination of manufacturing competetiveness. Although domestic manufacturing found it difficult to compete in world markets because of quality issues. the RER appreciation diminished Iran's potential for competetiveness.

As the model provided in 2.3.4 implies, the fall in the relative price of tradable goods to non-tradable ones (RER appreciation) caused by more demand for non-tradable goods, transfers more resources to this sector in order to meet the new excess demand. Thus, construction and services sectors dilate at the expense of a contraction of agriculture and manufacturing. Although the agriculture sector contracted relatively. as the model implies, the manufacturing sector expanded after the windfall. analogous to the experience of the majority of oil exporting developing countries (World Bank, 1984). In fact, since industrial production cannot compete qualitatively in world markets, governments with an import substitute policy had no choice but to impose quotas in order to protect domestic production. Hence, this output might well

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50 . Variations due to world inflation are ignored, here.

51 . See Cuddington (1989) for negative effect of RER appreciation on export diversification.

be treated as semi-nontradeable goods and their prices also go up relative to tradeables[52] .

With this modification the sectoral changes in the Iranian economy might be explained. As government expenditure was channelled towards urban areas rather than rural, industry (including construction and excluding mining) and services sectors expanded at the expense of agriculture. While the average rate of agriculture sector real growth during 1971-1977 was 6.6 percent, industry and services grew respectivly by 18.5 and 16.9 percent annually. The share of the agriculture sector in real GDP decreased from 15.2 percent in 1971 to 12.8 in 1977 while those of the two others increased respectively from 11.5 and 26.5 to 18.1 and 37.5 (Table 20 and Figure 17).

With real exchange rate appreciation, investment moves towards capital-intensive activities due to cheap foreign exchange. This went as far as the gross fixed capital formation in industry sector (including oil and gas) increased faster than that of agriculture. The services sector (as a well-linked sector with industry and with high capital gain) also experienced a rapid growth in capital formation. It seems straightforward that even distribution of government expenditure between rural and urban areas coupled with appropriate RER policy would have constrained the undesired reallocation process.

The revolutionary Islamic government used a bureaucratic arrangement to try to correct resource mis-allocation. Emphasizing agriculture and attempting to reduce the reliance on oil led to a change of the share of the agriculture sector in GDP from 15.3 in 1978 to 25.4 percent in 1989. Likewise, the oil sector showed a downward trend and remained around a mean of 16 percent (Table 20 and Figure 17). However, the share of industry remained almost constant at around 19 percent, though that of services decreased from

[52] Fardmanesh (1990) proposes another reason for this phenomenon. He states that an increase in the world price of manufactured goods relative to agricultural goods after the oil boom, increased the price of manufactured goods in oil exporting countries which are price takers, thus this sector's output increased like nontraded goods at the expense of the agricultural sector.

52.6 percent in 1980 to 38 at the end of the period, such that the sum of foreign-oriented sectors (industry and services) reduced in favour of domestic-oriented production (agriculture). In other words, while agriculture grew at a 4 percent average annual rate during 1979-1989, the industry and services growth rate were respectively 1.7 and -1.8 percent. Despite this structural success, overall production showed a declining path with some boosts in the high oil earning years. There are several reasons explaining the low and costly production in this subperiod.

1. The Islamic government inherited an economy with significant imbalances which started appearing some years before the revolution and imposed themselves on the economic movement of the country, in particular when oil revenues dropped acutely in mid 1980s. The oil-dependency of the economy, aggravated during 1972 -1977, continued in foreign trade such that the share of oil export proceeds in total foreign exchange receipts remained around 97 percent until the end of the period. This characteristic caused serious difficulties when the economy faced a fall in oil revenues due to export difficulties imposed by the war or oil price collapse. This fall translated directly in current non-oil production (excluding agriculture) and also transferred straightforwardly to government investment, with a budget constraint and to private investment, with a foreign exchange constraint. These reductions in investment would lower necessary productive capacity in the future. Those imbalances also generated severe balance of payments problems leading to more intervention by the government and some undesirable consequences (discussed below).
2. The protracted Iraq-Iran war attracted considerable resources from productive activity to defense requirements. Additionally, some part of productive resources were out of work either because of the occupation of a part of the country by the enemy or the war situation itself.
3. Establishment of an official distributive mechanism for resource allocation and of a highly regulated economy led to a more inefficient and costly

production process. Most notable among them was official distribution of foreign exchange sold at a fixed rate.

4. Overvaluation of the exchange rate resulted in a very high premium in the parallel free market. This premium and also other subsidized and cheap inputs and credits distributed by the government brought about considerable rents for their recipients. Such rents made rent seeking activities attractive. Thus a sizable segment of scarce resources were channeled toward inefficient activities with negligible social product.
5. Unclear property rights, war conditions, unexpected and almost arbitrary intervention by the government, acute discrepancy between official and black market exchange rates, and increasing inflation all led to notable uncertainty influencing the amount of private investment (See Table 23 and Figure 18) as well as the investment behaviour of the private sector, so that investment had a tendency toward projects where the gestation lags were small but not necessarily efficient from the national production view point.
6. Government intervention and some other factors mentioned above generated more inelasticity on the supply side of the economy. One indicator of this low elasticity was excess unused capacity in various sectors while there was an increasing inflation rate. For example, the unused capacity in agriculture, industry and electricity sectors were respectively 44, 39 and 36.2 percent in 1982 with boosted oil revenues (OPB, 1986).

In consequence, GDP which depends on government policies and budgetary performance, and oil sector operation, reflects several imbalances of the economy influencing inflation. Therefore, it may be regarded as a proxy for the structural bottlenecks of the economy.

3.6 Concluding Remarks

The Iranian economy has been a double dualistic economy with traditional/modern sector and oil/non-oil segments. The agriculture sector has grown almost independently of modern industrialization while the oil sector has worked with negligible spill-overs to the non-oil sector. The government alone acquires oil export earning so that the largest portion of its revenues comes from the oil sector while this sector is the only earner of foreign exchange and a main contributor to domestic production. In other words, the oil sector has played the determining role in the Iranian economy.

In this situation the government earned a windfall induced by the oil price jump in 1973. There were two choices for the government : either to increase its expenditure as the revenues were acquired, or to adapt its expenditure in line with the absorptive capacity of the economy leading to a smooth and persistent balanced growth. What actually happened was the former, which produced high rates of inflation and worsened structural imbalances which in turn aggravated the inflationary process, in addition to other undesirable economic and social problems. Most important among them was higher dependency on the oil sector[53] .

The post revolution government, in a war and revolutionary environment, tried to overcome this deep-seated characteristic of the economy. However, the economic inheritance coupled with the interventional performance prevented the government from achieving a balanced growth path. When oil earning decreased as a result of war or the oil price reduction of 1980s, the monetary expansionary feature of the budget worsened due to an increasing fiscal deficit. Moreover, the foreign exchange constraint directly affected production and investment, which themselves have been suffered from high costs and inefficiency mainly due to the official resource distribution mechanism. This environment perpetuated the inflation, reflecting the impact of monetary factors in the persence of structural bottlenecks.

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[53] " *The import-subsitution industrialization policies pursued by the Iranian government during the 1963-1979 period had the paradoxical effect of increasing the economy's dependency on the oil sector.* " Karshenas and Pesaran (1995). This well-articulated paper compares the pre and post revolution economic performance of the government in Iran.

4 *Model Description*

4.1 Introduction

According to Nugent and Glezakos (1979), a conventional money demand function of the form:

$$(4.1) \qquad M_d = P\, Y^{(1+a)} C^{-b} e^{u}$$

is usually applied to derive a standard model for analyzing inflation and estimating its determinants in a monetarist context. In this function M, P, Y, and C stand respectively, for money supply, prices, real income, and the opportunity cost of holding money. e is an error term. Taking logarithms, then differentiation with respect to time and rearranging for prices gives:

$$(4.2) \qquad \dot{P} = \dot{M} + \gamma_1 \dot{Y} + \gamma_2 \dot{C} + v$$

where $\gamma_1 = -(1+a)$, $\gamma_2 = b$ and $v = e^{-u}$, and dot refers to the rate of change over time. In the monetary approach the price equation reflects the long-run money demand relationship. In other words, these models neither explain the dynamics of the inflationary process nor the transformation mechanism whereby a rise in money supply increases inflation. In order to solve these weaknesses researchers typically accept some lagged responses, and proxies for non-monetarist factors are often included to achieve better specification. A typical expanded model can be as follows:

$$(4.3) \qquad \dot{P}_t = \gamma_0 + \gamma_1 \dot{M}_t + \gamma_2 \dot{M}_{t-1} + \gamma_3 \dot{Y}_t + \gamma_4 \dot{C}_t + \sum_{i=1}^{n} \delta_i \dot{X}_{it}$$

where $\dot{X}_{it}$ stands for different cost-push and/or structural variables like rate of changes in wages, import prices, and relative prices: and other variables are defined as before. With regard to these attempts, there are several defects of which the two major ones are:

- The money demand function, reflecting long-run relationship, requires a proper measure of income, that is permanent income rather than actual income used in practice. Moreover, the actual measure of income is usually treated as exogenous variable, while various theories, Keynesian, monetarist and others suggest that in short-run income can be affected by money supply, and thus can not be regarded as exogenous.
- The second shortcoming concerns the ad hoc combination in model 4.3 in which feedbacks are ignored when it is estimated as a single equation. Single equation estimation of such models when variables in reality have simultaneous feedback (for instance from prices towards money or wages) leads to specification biases. " *Therefore, a carefully specified simultaneous equation model in which feedbacks both ways are recognized would seem the only way*" (Nugent and Glezakos :433). In other words, as Laidler (1993: Ch. 9) states, the variables on the right hand side of the demand for money function, say, income or opportunity cost, may not be treated as exogenous because they themselves are influenced by money supply in short-run, thus, the problem of simultaneous equation bias arises and a single equation estimated by ordinary least squares is not an appropriate method and some proper procedure to tackle the problem such as two-stage least squares must be used.

During recent years several investigations have been conducted to analyze inflation in the Iranian economy and to estimate its determinants. These studies usually suffer from the above shortcomings. In order to avoid these defects, the model used in this study is Aghevli and Khan's (1978), modified to be more appropriate for Iran's case. Aghevli and Khan's model which has been applied successfully to four developing countries, consists of five behavioural or definitional equations estimated by a two-stage least squares procedure. The main difference between their model and the model used here is that they treat income and government expenditure respectively as exogenous and endogenous while in this research, based on the reasons provided below, national income is treated as endogenous and government expenditure as an exogenous variable. This chapter is organized as follows: section 4.2 reports some previous work about inflation in the Iranian economy. Aghevli and Khan's model is considered in section 4.3. Finally, the model used in this thesis is examined.

4.2 Empirical Record

Inflation has been an important issue in the Iranian economy during recent decades and has attracted many efforts from which the six latest studies are reported here. In assessing these empirical attempts some common features can be noted:

1. All researchers except Makkian (1990) and Tabatabaee-Yazdi (1991) use a single-equation approach. The work of Aghevli and Sassanpour (1991) involves a macro model with 6 behavioural equations (including price) and 3 identities, but as can be seen below the method is again ordinary least squares. Such works, as discussed in the introduction, may well not lead to reliable estimates. The two exceptions are the investigations of Makkian (1990) and Tabatabaee-Yazdi (1991) in which the model of Aghevli and Khan (1978) is estimated for Iran using the three-stage least squares method.

2. The importance of cointegration tests on macro variables undertaken in recent macro-econometric studies. implies another question regarding the studies reported below. Since macro variables for the Iranian economy usually have unit root(s)[54]. ordinary least squares estimates before testing for integration and cointegration may result in the problem of spurious regression. Bahmani-Oskooee's study is the only exception which conducts the associated tests: however, the tests are not accomplished completely, an issue considered shortly.
3. All but one use a monetary-based model which includes some lagged variables and a few structural factors.
4. The data used are annual observations for at most 31 years.

The following are the summary results of the recent studies.

Ikani (1987) analyzes inflation and estimates components in the monetarist and structuralist context, for the period 1960-1977. Firstly, he uses a Harberger-style monetary model in which the consumer price index, CPI is the dependent variable and the explanatory variables are money supply (narrowly defined), M_1, real income (GDP), y, the opportunity cost of holding money (previous rate of inflation) A, and a lagged value of M_1. The estimated equation is:

$$\hat{P}_t = \underset{(2.9)}{5.79} + \underset{(4.09)}{0.29}M_{1t} + \underset{(3.09)}{0.2}M_{1t-1} - \underset{(-4.9)}{0.91}y_t + \underset{(1.93)}{0.46}A_t$$

$$\bar{R}^2 = 0.83 \qquad DW = 1.42$$

where brackets show t-ratios. All coefficients but that of the opportunity cost, A, are significant. The adjusted determination coefficient is quite high and the DW statistic shows that the null of no autocorrelation cannot be rejected[55]. Although econometrically the model seems satisfactory, it is not consistent with the monetary argument that the change in money supply changes prices proportionally because according to the results, *ceteris paribus*, each percent increase in money supply only raises prices by 0.5 percent. Then Ikani

[54] As shown in the chapter 5 and in the work of Bahmani-Oskooee (1995).

[55] The author also estimates the equations, here and in the structural form, with two other definitions of income. The results are almost the same.

develops a structural model in which money, income, relative food prices (F), the nominal wage index for the construction sector (W), and the wholesale price index for imported goods (Q), are explanatory variables. Estimation of the new model results in:

$$\hat{P}_t = \underset{(2.6)}{3.8} + \underset{(1.3)}{0.11} M_{1t} - \underset{(-4.0)}{0.65} y_t + \underset{(1.45)}{0.41} F_t + \underset{(3.5)}{0.27} W_t + \underset{(2.9)}{0.63} Q_t$$

$$\bar{R} = 0.837 \qquad DW = 1.91$$

All variables have theory-consistent signs and are significant, except money and relative food prices. The latter is significant at the 10% level. The determination coefficient and DW statistic seem satisfactory. The researcher concludes that a set of structural imbalances coupled with cost and demand pressure led to an inflationary process in Iran in the period of interest.

Tayyebnia (1993) tests both the monetarist and the structuralist approach to explain inflation during 1960-1991. He initially uses a standard monetary model within which price is determined by the money supply (broadly defined as M_2), real income (y), and the expected rate of inflation as a proxy for opportunity cost (A). In order to derive the rate of expected inflation he constructs a regression in which price is regressed on its past value. The author also uses an adaptive expectation approach to estimate another series that is similar to the first. The findings are as follows:

$$\dot{P}_t = \underset{(3.38)}{9.55} + \underset{(0.13)}{0.22} \dot{M}_{2t} + -\underset{(0.16)}{0.48} \dot{y}_t + \underset{(0.33)}{0.3} \dot{A}_t$$

$$R^2 = 0.39 \quad \bar{R} = 0.31 \quad DW = 1.13$$

where standard errors are in brackets. Niether money nor expected inflation has a significant coefficient, and the explanatory power of the model is very low. There is also positive autocorrelation[56]. Adding a dummy variable for the year that the new Islamic government came to power, improves the estimation:

$$\dot{P}_t = \underset{(2.8)}{3.1} + (\underset{(0.09)}{0.21} + \underset{(0.11)}{0.51} D) \dot{M}_{2t} - \underset{(0.14)}{0.15} \dot{y}_t + \underset{(0.28)}{0.92} \dot{A}_t \tag{4.4}$$

$$R^2 = 0.69 \quad \bar{R} = 0.63 \quad DW = 1.57$$

[56] This model with two lags for money is also estimated but lagged values were not significant and the test for their being redundant is not rejected, so they are omitted.

Now only income's coefficient is insignificant. Comparing the two models. Tayyebnia states that the role of the money supply in explaining inflation clearly increases after the revolution. However, in both cases a monetary approach cannot successfully decribe the inflationary process. Tayyebnia tries to examine a monetary assumption that real output is not influenced by the money supply. To do so, he supposes a role for money in increasing real income and develops an ecoonometric model based on an equilibrum condition for the money market. Then he estimates this equation simultaneously with the price equation (eq. 4.4) using 3-stage least squares. The price equation estimated in this model shows no considerable difference from the single-equation estimation. In consideration of the structuralist view, Tayyebnia includes several non-monetary variables separately in a Harberger-style model along with money and income. According to these estimates, wages (the wage index for the construction sector, W). import prices (the imported goods price index, IMPP), relative food prices (F), the ratio of the budget deficit to GNP (k) as a proxy of public sector imbalances, and the ratio of the free market price of foreign exchange to the official exchange rate (prem) as a proxy of external constraints, all have a significant role in explaining domestic prices. The equations estimated are listed below. Of course, the author does not introduce any reason for special combination of these factors. Other possible combinations may well lead to different results.

$$\underset{}{\dot{P}_t} = \underset{(0.11)}{-0.05\dot{y}_t} + (\underset{(0.09)}{0.04} + \underset{(0.08)}{0.54D})\dot{M}_{2t} + \underset{(0.24)}{0.84\dot{A}_t} + \underset{(0.11)}{0.34\dot{W}_t}$$

$$R^2 = 0.77 \qquad \bar{R}^2 = 0.73 \qquad DW = 2.17$$

$$\dot{P}_t = \underset{(1.83)}{0.58} - \underset{(0.09)}{0.08\dot{y}_t} + (\underset{(0.06)}{0.14} + \underset{(0.09)}{0.29D})\dot{M}_{2t} + \underset{(0.18)}{0.25\dot{A}_t} + \underset{(0.10)}{0.54IMP\dot{P}_t}$$

$$R^2 = 0.88 \qquad \bar{R}^2 = 0.86 \qquad DW = 2.41$$

$$\dot{P}_t = \underset{(1.74)}{-0.19} - \underset{(0.085}{0.09\dot{y}_t} + (\underset{(0.06)}{0.19} + \underset{(0.09)}{0.24D})\dot{M}_{2t} + \underset{(0.17)}{0.23\dot{A}_t} + \underset{(0.09)}{0.57IMP\dot{P}_t} + \underset{(0.08)}{0.17\dot{F}_t}$$

$$R^2 = 0.9 \qquad \bar{R}^2 = 0.88 \qquad DW = 2.23$$

$$\dot{P}_t = -0.21\dot{y}_t + (0.29 + 0.41D)\dot{M}_{2t} + 0.35\dot{A}_t + 0.55\dot{prem}_t$$
$$\quad (0.11) \quad (0.05)\ (0.11) \quad (0.23) \quad (0.19)$$

$$R^2 = 0.79 \qquad \bar{R}^2 = 0.755 \qquad DW = 2.37$$

Makkian (1990) studying the effects of budget deficits on the money supply and the level of prices, uses Aghevli and Khan's (1978) model for the period 1966-1986. He estimates the equations of the model simultaneously using 3-SLS and reports these results for prices (P), government expenditure (G), government revenue (R) and money supply (M) :

$$\log P_t = 0.15 - 0.205 \log Y_t + 0.377\pi_t - 0.809 \log(M/P)_{t-1} + \log M_t$$
$$(0.39)\ (-2.64) \quad (1.61) \quad (-18.49)$$

$$R^2 = 0.993 \qquad S.E. = 0.063$$

$$\log G_t = 3.49 - 0.06 \log Y_t + 0.55 \log(G/P)_{t-1} + \log P_t$$
$$(3.51)(-0.32) \quad (4.08)$$

$$R^2 = 0.938 \qquad S.E. = 0.262$$

$$\log R_t = 0.84 + 0.51(\log Y_t + \log P_t) + 0.27 \log R_{t-1}$$
$$(2.02)\ (4.51) \quad (2.17)$$

$$R^2 = 0.901 \qquad S.E. = 0.324$$

$$\log M_t = \log m_t - 0.19 + 2.8 \log G_t - 2.4 \log R_t + 0.55 \log E_t$$
$$(-0.28)\ (9.12) \quad (-10.09) \quad (5.08)$$

$$R^2 = 0.982 \qquad S.E. = 0.184$$

where Y, π, m and E are respectively income, expected rate of inflation, the money multiplier, the lagged value of high-powered money plus current high-powered money minus claims on the government (t-ratios are in brackets). The unit coefficient of $\log M_t$ in the price equation and $\log m_t$ in money equation are imposed not estimated.

It can be seen that all coefficients are significant except the coefficient of expected inflation in the price equation and on income in the government expenditure equation. It seems that income has no role in explaining government expenditure. Although Makkian, applying a simultaneous approach, avoids biased estimation, the results are not reliable because he did not conduct integration and cointegration tests. If he applied those tests he would find that the model consists of I(1) and I(2) variables, thus the model should not be estimated in levels[57].

Tabatabaee-Yazdi (1991) also uses Aghevli and Khan's model. There are three differences between her work and the Makkian's study. First, she emphasizes inflation expectations and applies various form of expectations, two definition for money, and two indices for prices. Second, in addition to the 3-SLS, iterative 3-SLS is also used (the period is longer than the previous study). Finally, a causality test between money and inflation, resulting in a two-way causality, is conducted. Although the results for the price equations vary with various assumption of expectation formation, in the other equations the estimations show similar outcomes in different models. The important point is that the results are considerably different from those of Makkian's work. The estimates using adaptive expectation formation are as follows (p. 137-138) :

$$\ln P_t = \underset{(2.22)}{1.109} - \underset{(-2.59)}{0.182}\ln Y_t + \underset{(2.58)}{0.009}\pi_t - \underset{(-23.23)}{0.941}\ln(M/P)_{t-1} + \ln M_t$$

$$R^2 = 0.994$$

$$\ln G_t = \underset{(-1.51)}{-1.296} + \underset{(1.92)}{0.23}\ln Y_t + \underset{(11.61)}{0.735}\ln(G/P)_{t-1} + \ln P_t$$

$$R^2 = 0.935$$

$$\ln R_t = \underset{(-0.52)}{-0.119} + \underset{(4.33)}{0.366}(\ln Y_t + \ln P_t) + \underset{(6.2)}{0.586}\ln R_{t-1}$$

$$R^2 = 0.951$$

$$\ln M_t = \ln m_t - \underset{(-2.08)}{0.331} + \underset{(9.56)}{1.928}\ln G_t - \underset{(-8.61)}{1.549}\ln R_t + \underset{(13.63)}{0.62}\ln E_t$$

$$R^2 = 0.996$$

$$\pi_t = 0.58\, \Delta \ln P_t + 0.42\, \pi_{t-1}$$

The unit coefficient of $\ln M_t$ in the price equation and $\ln m_t$ in money equation are imposed not estimated.

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[57] All the variables are integrated of degree 1 (discussed in ch. 5) except M_2 which is integrated of degree 2.

Aghevli and Sassanpour (1991) define the domestic price level, P as a weighted average of the price of nontraded goods, P^n and traded goods, P^t:

$$\ln P = w \ln P^n + (1-w) \ln P^t$$

Assuming the exogeneity of P^t (determined in the world market), they provide the following mechanism for adjustment of P^n for domestic commodity market to equilibrum:

$$\Delta \ln P^n = \lambda_1 [\ln (M/P)_{t-1} - \ln m^*_t] + \lambda_2 \ln (P^t/P^n)$$

where M/P stands for actual real balances, m^* indicates its desired level and Δ shows changes . This equation implies that any increase in money supply more than the desired amount will raise the price of nontraded goods, and a relative rise in traded goods prices will increase the price of nontraded goods because it increases the demand for and decreases supply of nontraded goods. They assume that desired real money demand is only a simple linear function of income and derive inflation equation as:

$$\Delta \ln P^n = a + b \ln (M/P)_{t-1} - c \ln y_t + d \ln (P^t/P^n)$$

They estimate these equations with 4 other equations related to: government expenditure, government domestic revenue, real private expenditure and the volume of imports.

Their empirical findings related to prices are:

$$\ln P_t = 0.01 + 0.53 \ln P_t^n + 0.52 \ln P_t^t$$
$$(0.3) \quad (7.3) \qquad (7.6)$$
$$R^2 = 0.99 \qquad DW = 1.48$$

$$\Delta \ln P_t^n = 1.16 + 0.37 \ln(M/P)_{t-1} - 0.45 \ln Y_t + 0.60 \ln(P^t/P^n)_{t-1}$$
$$(1.7) \quad (2.4) \qquad (2.1) \qquad (3.6)$$
$$R^2 = 0.64 \qquad DW = 1.87$$

According to these results the domestic price is determined almost equally by traded and non-traded goods, where the latter is itself explained by real money supply (positively), real income (negatively) and relative price (positively). Concerning these results, there seem to be two important defects: First, despite the use of a simultaneous equation model, the OLS estimation method is used, which clearly leads to biased coefficients. This weakness is mentioned in the paper and the reasons offered are that a full-information maximum-likelihood or two-stage least squares methods were not applied so as to avoid a specification problem with a small sample. Second, the time series under consideration have unit root and the OLS method may lead to spurious regression.

Bahmani-Oskooee (1995) applies a model which is basically a monetarist one and includes import prices and the black (free) market exchange rate :

$$\log CPI_t = a_0 + a_1 \log M_{2\,t} + a_2 \log y_t + a_3 \log PXW_t + a_4 \log BEX_t$$

where CPI, M_2, Y, PXW and BEX stand respectively for consumer price index, broad money, real income, world export price (as a proxy for imports prices), and finally the exchange rate (units of Rials per one unit of dollar) on the black (free) market. His study is conducted in a cointergration context using Engle-Granger and Johansen procedures with annual data for 1959-1993. The Engle-Granger method shows that there are two long-run relationships among the variables which define price and exchange rate. According to the cointegrated vector estimated by normalizing for CPI, the long-run relationship between prices and the variables of interest is:

$$\log CPI = 5.17 + 0.01\, t - 0.3\, D + 0.52 \log M_2 - 0.71 \log GDP + 0.26 \log BEX + 0.04 \log PXW$$

$$R^2 = 0.99 \quad DW = 1.05$$

where t is a time trend and D stands for a dummy reflecting the revolutionary situation.

Since the Engle-Granger method suffers from some deficiencies in multivariate cases (see ch. 5), like this case, the researcher also used a Johansen procedure. This leads to inconclusive results, i.e. that the inclusion of different lags and dummies and using different test statistics leads to various number of ranks being significant. Although the author makes his conclusion based on the result of Engle-Granger tests, in fact there is no reliable outcome because the important uniqueness test of the Johansen procedure is not conducted (or at least not reported). According to Bahmani-Oskooee summation, inflation in the Iranian economy is determined by the money supply, Rial depreciation and the rate of growth of import prices.

4.3 The Model of Aghevli and Khan

Aghevli and Khan (1978) use a model consisting of three behavioural and two definitional equations to consider inflation in four developing countries: Brazil, Colombia, Dominican Republic and Thailand. There are at least three features in this study that make it preferable to the other investigations: first, it takes into account some feedback from inflation to money via government budgetary performance, thus reflecting some public sector imbalances. Second, by including a money supply equation, money is not treated as an exogenous variable, so this model allows foreign reserves to affect the money supply, reflecting some external constraints. Finally, the model is estimated by 2-stage least squares, leading to unbiased estimates. Although the model of Aghevli and Khan is in the monetarist tradition, it seeks the reasons behind the authorities decisions for implementing monetary accommodation to inflation.

In other words, the two-way linkage between money and inflation is shown initially. Then a model is set out to reflect explicitly the impact of government budget deficits on inflation. Moreover, this work considers a set of countries which experienced high as well as moderate inflation. The model introduces five equations respectively for: prices, government expenditure, government revenue, the money supply and the expected rate of inflation. The price equation in this model is similar to the traditional monetarist model derived from money demand function and used by Harberger (1963) (with the difference that the money supply has been supposed to be endogenous) so as to examine the two-way causality hypothesis between money and inflation. However, income is regarded as exogenous, implying a full-employment assumption. The complete model is:

$$\log P_t = -\lambda\partial_0 - \lambda\partial_1 \log Y_t + \lambda\partial_2\pi_t - (1-\lambda)\log(M/P)_{t-1} + \log M_t$$

$$\log G_t = \gamma g_0 + \gamma g_1 \log Y_t + (1-\gamma)\log(G/P)_{t-1} + \log P_t$$

$$\log R_r = \tau t_0 + \tau t_1(\log Y_t + \log P_t) + (1-\tau)\log R_{t-1}$$

$$\log M_t = \log m_t + K_0 + K_1 \log G_t - K_2 \log R_t + K_3 E_t$$

$$\pi_t = \beta\Delta\log P_t + (1-\beta)\pi_{t-1}$$ [58]

where:

P: domestic price

Y: real income

π: expected rate of inflation

M: nominal money stock

G : government expenditure

R : government revenue

m: money multiplier

E: the remaining elements of high-powered money consisting of : change in the central bank claims on private sector, international reserve change, lagged value of high-powered money and error item.

λ: adjustment coefficient of real money demand

g_1: real income elasticity of government expenditure

γ: adjustment coefficient of government expenditure

τ: adjustment coefficient of government revenue

The main hypothesis in this model is that government expediture increases with inflation but the real revenue of the government has a tendency to move behind it. In other words, the adjustment coefficient of the government revenue is less than that of expenditure due to tax collection lags (i.e. $\tau < \gamma$). Money creation to finance this inflation-induced deficit increases the money supply, leading to further inflation. This implies a two-way causality between money and inflation.

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[58] It seems $\Delta\log P_{t-1}$ is correct because when we are predicting π_t, P_t is not available.

Applying this model to the sample leads to the results shown in Table 1. The model is defined so that the adjustment coefficients can be found within estimation, shown in Table 2. The estimation findings confirm the hypotheses that the lags of revenue are sizeably longer than that of the expenditure, generating higher deficits in the higher inflation periods. The countries with longer lags experienced higher inflation.

Table 1 : Structural Equations Estimation[59]

Brazil : 1964/Q3-1974/Q4

$$\log P_t = -0.077 -0.248 \log Y_t + 0.502\, \pi_t - 0.737\, [\log M_{t-1} - \log P_{t-1}] + \log M_t$$
(-0.53) (-3.65) (2.81) (-11.02)

$R^2 = 0.995$ $S.E. = 0.047$

$$\log G_t = -1.682 + 0.886 \log Y_t + 0.046\, [\log G_{t-1} - \text{lpg}\, P_{t-1}] + \log P_t$$
(-3.44) (7.23) (0.43)

$R^2 = 0.970$ $S.E. = 0.170$

$$\log R_t = -1.656 + 0.654\, [\log Y_t + \log P_t] + 0.372 \log R_{t-1}$$
(-4.61) (6.98) (4.53)

$R^2 = 0.984$ $S.E. = 0.135$

$$\log M_t = \log m_t + 0.115 + 0246 \log G_t - 0.205 \log R_t + 0.952 \log E_t$$
(1.54) (13.63) (-6.67) (34.38)

$R^2 = 0.999$ $S.E. = 0.010$

$$\pi_t = 0.9\, \Delta \log P_t + 0.1\, \pi_{t-1}$$

Colombia : 1961/Q3 - 1974/Q4

$$\log P_t = -3.031 -0.487 \log Y_t + 0.627\, \pi_t - 0.552\, [\log M_{t-1} - \log P_{t-1}] + \log M_t$$
(-4.38) (-4.52) (3.93) (-5.21)

$R^2 = 0.992$ $S.E. = 0.040$

$$\log G_t = -4.683 + 1.278 \log Y_t + 0.050\, [\log G_{t-1} - \text{lpg}\, P_{t-1}] + \log P_t$$
(-8.77) (7.22) (0.48)

$R^2 = 0.948$ $S.E. = 0.176$

$$\log R_t = 2.563 + 0.723\, [\log Y_t + \log P_t] + 0.360 \log R_{t-1}$$
(7.10) (6.80) (3.94)

$R^2 = 0.982$ $S.E. = 0.103$

$$\log M_t = \log m_t + 0.037 + 0.331 \log G_t - 0.314 \log R_t + 0.981 \log E_t$$
(2.18) (37.82) (-25.32) (95.45)

$R^2 = 0.999$ $S.E. = 0.010$

$$\pi_t = 0.85\, \Delta \log P_t + 0.15\, \pi_{t-1}$$

(continued on the next page)

[59] Figures in parentheses are t-ratios.

Table 1 (continued)

Dominican Republic : 1961/Q3 - 1974/Q4

$$\log P_t = 0.183 - 0.260 \log Y_t + 0.668\, \pi_t - 0.879\, [\log M_{t-1} - \log P_{t-1}] + \log M_t$$
$$(2.17)\ (-2.19)\quad (1.96)\quad (-11.06)$$
$$R^2 = 0.817 \quad S.E. = 0.065$$

$$\log G_t = -1.412 + 0.779 \log Y_t + 0.087\, [\log G_{t-1} - \text{lpg } P_{t-1}] + \log P_t$$
$$(-7.12)\quad (5.95)\quad (0.81)$$
$$R^2 = 0.799 \quad S.E. = 0.172$$

$$\log R_t = -1.805 + 0.835\, [\log Y_t + \log P_t] + 0.236 \log R_{t-1}$$
$$(-4.91)\quad (7.61)\quad (2.50)$$
$$R^2 = 0.867 \quad S.E. = 0.138$$

$$\log M_t = \log m_t + 0.010 + 0.497 \log G_t - 0.419 \log R_t + 0.934 \log E_t$$
$$(0.53)\quad (37.04)\quad (-27.92)\quad (105.00)$$
$$R^2 = 0.999 \quad S.E. = 0.010$$

$$\pi_t = 0.9\, \Delta \log P_t + 0.1\, \pi_{t-1}$$

Thailand : 1961/Q3 - 1974/Q4

$$\log P_t = -0.201 - 0.447 \log Y_t + 0.551\, \pi_t - 0.675\, [\log M_{t-1} - \log P_{t-1}] + \log M_t$$
$$(-3.73)\ (-3.44)\quad (1.54)\quad (-7.06)$$
$$R^2 = 0.935 \quad S.E. = 0.037$$

$$\log G_t = 4.836 + 1.088 \log Y_t + 0.080\, [\log G_{t-1} - \log P_{t-1}] + \log P_t$$
$$(61.60)\quad (17.08)\quad (1.03)$$
$$R^2 = 0.919 \quad S.E. = 0.143$$

$$\log R_t = 4.250 + 0.843\, [\log Y_t + \log P_t] + 0.145 \log R_{t-1}$$
$$(-6.47)\quad (6.31)\quad (1.10)$$
$$R^2 = 0.944 \quad S.E. = 0.105$$

$$\log M_t = \log m_t + 0.097 + 0.369 \log G_t - 0.336 \log R_t + 0.961 \log E_t$$
$$(1.55)\quad (44.94)\quad (-14.54)\quad (43.82)$$
$$R^2 = 0.999 \quad S.E. = 0.010$$

$$\pi_t = 0.9\, \Delta \log P_t + 0.1\, \pi_{t-1}$$

Source: Aghevli and Khan (1978)

Table 2 : Individual Parameter Estimates

Parameter	Brazil	Colombia	Dominican Rep.	Thailand
		Price Level		
λ	0.263	0.448	0.121	0.325
a_0	-0.293	-6.766	1.512	-0.618
a_1	0.942	1.087	2.147	1.377
a_2	1.910	1.399	5.518	1.697
		Government Expenditure		
γ	0.954	0.950	0.913	0.920
g_0	-1.766	4.917	-1.553	5.271
g_1	0.930	1.342	0.857	1.186
		Government Revenue		
τ	0.628	0.640	0.764	0.855
t_0	-2.633	3.998	-2.365	4.973
t_1	1.040	1.128	1.094	0.986
		Money Supply		
k_0	0.115	0.037	0.010	0.097
k_1	0.246	0.331	0.497	0.369
k_2	0.205	0.314	0.419	0.336
k_4	0.952	0.981	0.934	0.961
		Expected Inflation		
β	0.900	0.850	0.900	0.900

Source: Aghevli and Khan (1978).

4.4 The Selected Model

As described in the previous chapter, oil export revenue has played an important role in the Iranian economy. Oil exporting developing countries are characterised by features somewhat different from other DCs. Considering the individual features of the Iranian economy compared to the sample examined by Aghevli and Khan, some modifications to their model seem necessary.

There are two modifications which characterise the model used in this study compared with their original model.

Aghevli and Khan assume that income is an exogenous variable while government expenditure is determined endogenously. Their model is basically a monetary model in which it is assumed that real income is exogenous. This means that real income changes are not influenced by other variables in the model, implying that the economy operates at or near full employment capacity. Bhalla (1981:18) states that this assumption might be acceptable for many developing countries where agriculture is the major sector, because agricultural production depends on exogenous factors like weather and the level of technology.

However, in an oil-exporting country like Iran, where unstable oil earnings have a major role in both government revenue and meeting the supply of intermediate and capital goods needed for production, the situation is different. As can be seen in the previous chapter, after the 1973 oil boom, government expenditure jumped several-fold in a way which did not reflect the absorptive capacity of the economy. This led to a worsening of the mismatched economic structure. As a result, government expenditure became an important factor influencing domestic income on the one hand and the dependence of domestic production on imports aggravated on the other. In consequence, real income has been influenced by the government's real expenditure and the oil sector's output. Moreover, in the early years of the period, government expenditures increased sharply, due to political motives, creating extensive commitments which could not be later eliminiated without giving rise to political difficulties. In fact, this situation had prevented government expenditure from being a function of an acceptable growth rate like most DCs as Aghevli and Khan (1977: 394) state. In particular, in the second part of the period (owing to the revolutionary situation and the war), there did not exist a stable planned programme for growth. So government expenditure was determined by the need to meet existing commitments plus new needs due tothe war. Thus, here it seems more appropriate to assume government expenditure to be exogenous.

Regarding income, as a result of oil earning fluctuations and the inflationary situation, real income has experienced high variability. Here, the endogeneity assumption of income allows some supply side factors such as import capacity, cost-push elements and lack of efficient intersectoral relationships, to impact indirectly on the variables of interest of the model. In fact, as Khan and Knight (1981; 13) state, when we are interested in a more detailed analysis of the supply side, (for example when programmes designed for structural adjustment are implemented) it is appropriate to allow income to be endogenous. Additionally, we emphasized the role of oil sector in determining income and government revenue. Apart from these differences, the features of the model of this study are the same as that of the model used by Aghevli and Khan (1978).

After these modifications the model consists of five equations which determine prices, real income, government revenue, money supply and the expectation of inflation. The money supply equation is derived from an identity and the last equation is a definitional one. The data are transformed to the logarithms because the stationarity of the difference of logarithms is more probable (Banerjee et al, 1993: 28). Also elasticities can be directly obtained in logarithmic functions.

4.4.1 Price determination

Following much empirical work, a traditional money demand function can be used to determine the price equation. This function, as Deutsch and Zilberfarb (1994) state, associates the desired level of real money balance with real income and the expected rate of inflation in a semilogarithmic form[60] :

(4.5) $$\log (M/P)^*_t = a_0 + a_1 \log Y_t - a_2 \pi_t \qquad a_1, a_2 > 0$$

where M = nominal money stock

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[60] Frenkel (1977) examines both double logarithmic and semilogarithmic forms of demand for money function for the German case and finds no clear difference. In this study, like Aghevli and Khan (1978), this form is prefered because inflation rate in some quarters is negative. Likewise, among others, these authors use the same form: Aghevli and Khan (1977), Aghevli, et al (1979), Khan and Knight (1981), Arize (1987), Fielding (1994) and Deutsch and Zilberfarb (1994).

P = price level

Y = real income

π = expected rate of inflation

and * refers to desired level.

Using the expected rate of inflation rather than interest rates in the money demand function for DCs has a long record in the literature. The main reason is the lack of an efficient market[61] for money and monetary assets in DCs.

As Khan, M. (1980) states, the money market is very limited in DCs. Also, due to banking restrictions (e.g. interest rates being controlled by the authorities), interest rates do not affect money demand where credit is available. In fact, in such a situation interest rates cannot reflect money market behaviour and Meier (1989:212) points out that, in such circumstances, a negative real interest rate is a prevalent phenomenon. Expressed differently, regulated interest rates are no longer a proper proxy for the opportunity cost of holding money, rather they may be regarded as a proxy for monetary restrictiveness (Harris, 1995:14). Interest rate data are limited and exhibit very little variation over time (Khan and Knight, 1981:9). In sum, as Ghatak (1995a:25) states, in DCs the wealth holders can either hold money or real physical assets like buildings and durable goods. Therefore, the expected rate of inflation plays the role of interest rate in money demand.

Iran exhibits the common features discussed above. Additionally, in the first few years of the period the government usually had a budget surplus and there was no active asset market. Moreover, in post revolution years, owing to interest rate prohibition, in conformity with Islamic law, the inactive market has almost been shut down. In the money demand function, empirical work related to Iran usually uses the inflation rate (expected or actual) instead of an interest rate[62]. Nezamzadeh (1983:135), considering the effect of interest rates

[61] For a discussion on this matter see Todaro (1994:40) and Ghatak (1995b:119).

[62] In addition to the work mentioed before, also see Pesaran (1995:20).

on demand for money in the Iranian economy, finds no significant role for it[63]. Income in the price equation is actual income rather than a permanent income measure. Using actual income is also supported by Nazemzadeh's study.

Equation (4.5) determines the target or long-run amount of real balances. It can be assumed that individual agents determine their target money balance according to this equation. In practice, they might be far from their target value[63/1]. Therefore one may argue that individuals face two kinds of costs

1. As they depart from target amount holdings, they have lower utility than otherwise.
2. Attempts to get back to equilibrium necessitate new transactions which are not costless. (Laidler, 1993:121).

Following Hwang (1985:690) and Deutsch and Zilberfarb (1994), a quadratic loss function is used to show total costs:

$$TC = \alpha_1 [\log (M/P)^*_t - \log(M/P)_t]^2 + \alpha_2 [\log (M/P)_t - \log(M/P)_{t-1}]^2$$

Agents try to control their money holdings so that these costs are minimised. The optimal amount of money holding can be derived by taking the derivative of TC with respect to $(M/P)_t$ which is under the control of private agents:

$$-2\alpha_1 [\log (M/P)^*_t - \log(M/P)_t] + 2\alpha_2 [\log (M/P)_t - \log(M/P)_{t-1}] = 0$$

$$\alpha_2 [\log (M/P)_t - \log(M/P)_{t-1}] = \alpha_1 [\log (M/P)^*_t - \log(M/P)_t]$$

adding $\alpha_1 [\log (M/P)_t - \log(M/P)_{t-1}]$ to both sides and rearranging gives:

(4.6) $$\log (M/P)_t - \log(M/P)_{t-1} = \frac{\alpha_1}{\alpha_1 + \alpha_2} [\log (M/P)^*_t - \log(M/P)_{t-1}]$$

[63] Although with respect to DCs, using inflation rather than interest rate for this purpose is a common tradition, Khan, A (1982) considering six Asian countries, finds some cases with sensitive interest rates and concludes that the cases must be individually checked.

[63/1] In this case and also in the income and revenue cases the partial adjustment process is used to derive the equations. In the partial adjustment process it is assumed that agents partially adjust any differences from the optimal position in each period. It is due to the cost of full immediate adjustment.

Substituting 4.5 in 4.6 for log $(M/P)^*_t$, and denoting $\frac{\alpha_1}{\alpha_1+\alpha_2}$ as λ we obtain:

$$\log (M/P)_t - \log(M/P)_{t-1} = \lambda a_0 + \lambda a_1 \log Y_t - \lambda a_2 \pi_t - \lambda \log (M/P)_{t-1}$$

$$\log (M/P)_t = \lambda a_0 + \lambda a_1 \log Y_t - \lambda a_2 \pi_t + (1-\lambda) \log (M/P)_{t-1}$$

Hence :

$$\log P_t = - \lambda a_0 - \lambda a_1 \log Y_t + \lambda a_2 \pi_t - (1-\lambda) \log (M/P)_{t-1} + \log M_t$$

Similarly, if we assume that the actual changes of stock is proportional to the difference between desired real money demand and real money balances in the previous period :

$$\Delta \log (M/P)_t = \lambda [\log (M/P)^*_t - \log (M/P)_{t-1}]$$

where λ specifies the adjustment coefficient, then substitute equation 4.5, the same result is obtainable.

4.4.2 Real Income

Based on theoretical analysis in the previous chapter, it is presumed that planned real income depends on real government expenditure and real oil sector income:

(4.7) $$\log Y^e_t = b_0 + b_1 \log OY_t + b_2 \log (G/P)_t$$

where OY denotes the real oil sector income. The actual change in real income can be defined as a proportion of the difference between the planned figure and the previous actual amount:

(4.8) $$\Delta \log Y_t = \theta [\log Y^e_t - \log Y_{t-1}]$$

where θ is the coefficient of adjustment ($\theta < 1$). Introducing Y^e_t from 4.7 into 4.8 and solving for real income yields :

$$\log Y_t = \theta b_0 + \theta b_1 \log OY_t + \theta b_2 \log G_t - \theta b_2 \log P_t + (1-\theta) \log Y_{t-1}$$

4.4.3 Government Revenue

Since in Iran during the period considered, about 90 percent of the total government revenues are accounted for by oil-induced revenue and taxes on national income, it is supposed that government revenue is defined by these two factors. Assuming desired government nominal revenue (R^d) is a function of oil-induced revenue (OR) and nominal income, we have:

(4.9) $$\log R_t^d = t_0 + t_1 \log OR_t + t_2(\log Y_t + \log P_t) \qquad t_1, t_2 > 0$$

It is expected that the revenue elasticities (t_1 , t_2) will be positive. Actual revenue changes proportionally with the difference between desired and actual revenue of the previous period:

(4.10) $$\Delta \log R_t = \tau [\log R_t^d - \log R_{t-1}]$$

where τ is the coefficient of adjustment, $1 > \tau > 0$. To obtain the nominal revenue equation, R^d from equation 4.9 must be substituted into equation 4.10:

$$\log R_t = \tau t_0 + \tau t_1 \log OR_t + \tau t_2 \log Y_t + \tau t_2 \log P_t + (1-\tau) \log R_{t-1}$$

As in previous chapters there is theoretical and empirical evidence for sluggishness of the response of the government revenue to an increase in nominal income. This point is supported by Aghevli and Sassanpour (1991:92) for Iran, so it can be expected that the adjustment coefficient, τ, is small.

4.4.4 Money Supply

Money supply, M, is defined by multiplication of the money multiplier, m, and high-powered money, H :

$$M_t = m_t H_t$$

Changes in the money stock depend on changes in the claim of the central bank on the government (ΔCG), changes in net foreign assets and changes in the central bank's claim on the banking system. If the last two are shown as a sum (ΔOA), ΔH can be written as:

$$\Delta H_t = \Delta CG_t + \Delta OA_t$$

or $$H_t = \Delta CG_t + \Delta OA_t + H_{t-1}$$

Since the government has financed its deficit through borrowing from the central bank, changes in the central bank's claim on the government reflects the budget deficit, so :

$$H_t = G_t - R_t + E_t$$

where $$E_t = \Delta OA_t + H_{t-1}$$

Thus, the equation for the money supply is :

(4.11) $$M_t = m_t\,(G_t - R_t + E_t)$$

Rewriting equation 4.11 in logarithmic form makes it non-linear. To make the model tractable we use an approximation of this equation which is log-linear. This new form is attained by linearizing around sample means. This gives us :

$$\log M_t = \log m_t + k_0 + k_1 \log G_t - k_2 \log R_t + k_3 \log E_t$$

The parameters ks are determined by functions of sample means of logarithms of G, R and E, such that :

$$k_0 = \log(e^{\overline{\log G}} - e^{\overline{\log R}} + e^{\overline{\log E}}) - \frac{1}{e^{\overline{\log G}} - e^{\overline{\log R}} + e^{\overline{\log E}}} \times [e^{\overline{\log G}}.\log G - e^{\overline{\log R}}.\log R + e^{\overline{\log E}}.\log E]$$

$$k_1 = \frac{e^{\overline{\log G}}}{e^{\overline{\log G}} - e^{\overline{\log R}} + e^{\overline{\log E}}}$$

$$k_2 = \frac{e^{\overline{\log R}}}{e^{\overline{\log G}} - e^{\overline{\log R}} + e^{\overline{\log E}}}$$

$$k_3 = \frac{e^{\overline{\log E}}}{e^{\overline{\log G}} - e^{\overline{\log R}} + e^{\overline{\log E}}}$$

where $\overline{\log G}$, $\overline{\log R}$ and $\overline{\log E}$ are the sample means. The parameters can be calculated directly.

4.4.5 Expectated Inflation

By an adaptive expectation approach the rate of expected inflation is defined as:

$$\Delta\pi_t = \beta\,[\Delta \log P_{t-1} - \pi_{t-1}] \qquad 1 > \beta > 0$$

where $\Delta \log P_{t-1}$ shows the previous inflation rate and β stands for the adjustment coefficient.

4.4.6 Complete Model

Now the whole model can be characterised as follows :

(4.12) $\log P_t = -\lambda a_0 - \lambda a_1 \log Y_t + \lambda a_2 \pi_t - (1-\lambda)\log (M/P)_{t-1} + \log M_t$

(4.13) $\log Y_t = \theta\, b_0 + \theta\, b_1 \log OY_t + \theta\, b_2 \log G_t - \theta\, b_2 \log P_t + (1-\theta) \log Y_{t-1}$

(4.14) $\log R_t = \tau\, t_0 + \tau\, t_1 \log OR_t + \tau\, t_2 \log Y_t + \tau\, t_2 \log P_t + (1-\tau) \log R_{t-1}$

(4.15) $\log M_t = \log m_t + k_0 + k_1 \log G_t - k_2 \log R_t + k_3 \log E_t$

(4.16) $\Delta\pi_t = \beta\,[\Delta \log P_{t-1} - \pi_{t-1}]$

where OY and OR stand respectively for real oil sector income and nominal oil-induced revenue of the government and the other variables are as defined in Aghevli and Khan's Model. All the variables are endogeneous except OY, OR and E determined exogeneously.

The system 4.12 to 4.16 can be used to explain the oil-oriented inflationary process in Iran. Initially the windfall of the 1973 oil boom increased E through net foreign assets and made it possible for government to extend its expenditures beyond its revenue. Consequently, the money supply increased through equation 4.15. Money supply increases raised prices through equation 4.12. The level of prices is also affected by income, which increased after the windfall via oil sector income rise and the government expenditure increase (as equation 4.13 implies). Increasing prices led to rises in government revenue. However, since the government found it difficult to increase its revenue to meet all the requirements of persistent commitments and the war, the budget deficit has been increasing. This in turn, led to an increase of money supply again, and the process repeated itself.

Regarding dependence on oil, equations 4.13 and 4.14 reflect some aspects of the structural problems. It can be seen that the system is sensitive to oil income. Every adverse shock influences the economy in both monetarist and structuralist ways. After the oil price fall in 1985, the real production of the oil sector reduced sizably. This decreased real income through equation 4.13. With regard to money, this event decreased government revenues via equation 4.14. Bearing in mind that government expenditure was not very flexible due to persistent commitments and the war, the money supply increased, as equation 4.15 confirms. Uncertainty, induced by several factors mentioned in the previous chapter, aggravated the process by affecting expectations through equation 4.16. The money increase and output fall caused the price level to increase considerably from equation 4.12.

5 *Econometric Investigation*

5.1 Introduction

This chapter sets out to evaluate the model via empirical evidence. In doing so, it deals with *Time series* econometrics, its difficulties and solutions. Time series in economics, as Doornik and Hendry (1994a: 188) explain, are generated by extremely general as well as complex processes. The reason is that they are the result of millions of individual behavioural interactions. The results of economic activities are measured by different levels of accuracy, "*but rarely perfectly and sometimes not very well*". The merging of the mechanism of economic performance and the system of measurements is called the *Data Generation Process (DGP)*. Modelling the main characteristics of the data generation process is the purpose of econometrician. This is carried out in a simplified representation, based on real observation and in association with theoretical economic analysis. In this conection chapter 4 dealt with a part of this process and the remainder will be considered in this chapter.

This objective will be achieved in the following order. Firstly the database will be discussed: data collection, data definitions, dealing with the lack of quarterly data for one or two variables, and also filling a few gaps are covered. Then the nonstationary nature of the time series is considered.Tests for unit root(s) and seasonal features of the data are conducted. Thirdly, the procedure of estimation of the unobservable variable of the model, the expected rate of inflation, is provided. In section four. the long-run relationship among the variables of the model is discussed. A brief conceptional review of cointegration and the proper tests to obtain the long-run relationships as well as the resulting evaluation are provided. Finally, the whole model is estimated. The preferred estimation method is described and the results are evaluated.

5.2 The Database

All relevant data, in Iran, have been published regularly since 1959/1960 (1338 in the Iranian calendar). With the exception of price index which is reported monthly, others are usually announced annually in most statistical sources. Fortunately, as far as this research is concerned, the majority of the necessary data in quarterly figures are available in a quarterly publication of the Central Bank of the Islamic Republic of Iran called "Majalleh-e- Bank-e Markazy" (The Magazine of the Central Bank). National output and its components are exceptions: only their annual figures are available.

As for data accuracy, although weakness in economic data is normal in developing countries, and Iran is not an exception, the monetary data have been reported at relatively sophisticated levels. The same is almost true about the budgetary data. Of course, earlier in the period there were some difficulties about the government expenditure and its components owing to changes in data definition and sources of record. This problem was solved with the help of the record of the Treasury of the Finance Ministry.

5.2.1 Data Definition

For some variables of the model like money supply and prices, there are various measures which could be used as their proxies. Here the reasons for preferences are described. With regards to price, the consumer price index, CPI, is preferred. As Shamsul Alam and Kamath (1986) explain, both the consumer price index and the wholesale price index, WPI, may be used to constract an inflation rate. However, the prices of services are not reflected in the WPI. On the contrary they are reflected in the CPI , thus the WPI cannot show perfectly the general level of prices. Moreover, it reflects to some extent, government regulated prices, so, its appropriateness relies upon the extent to which formal prices approximate the prices in the free market. In fact, with strict government control on prices, the majority of the quotations included in WPI are formal quotations, which are in turn further from actual free market prices. Thus the CPI, which is closer to actual prices, is considered more appropriate for obtaining the inflation rate.

Some argue that using the GNP deflator is better because it includes more commodities than the CPI. However, this does not seem acceptable due to several reasons: First of all, the GNP deflator only takes account of the price of goods and services produced currently, this means that it excludes second-hand goods prices which are important in the markets of the developing countries, while the CPI covers both. Secondly, unlike the CPI, the GNP deflator is derived as an aggregate. This means that, some components of it are inputs. Thirdly, in practice, the quarterly GNP deflator is not available in developing countries, (like Iran) whereas the CPI is in hand even in monthly figures in these countries.

With regard to money, the definition is not clear. This is a subject of long debate in the monetary literature[64]. A survey about the money demand functions carried out by Laidler (1977) results in a narrow definition of money, M_1, including currency and demand deposit, which might be appropriate for quarterly data and either M_1 or a broader defined money, M_2, is preferred for annual data. Nazemzadeh (1983) comparing the appropriateness of M_1 and M_2 for money demand functions in Iran, Nigeria and Venezuela, shows that M_1 is slightly perferable. Thus in this study M_1, is used as a proxy for money.

Government expenditure and revenue excludes those of public firms, institutes and state-owned banks. Although the increasing share of these excluded parts in the total government budget has reached more than half in recent years, the measure of general budget of the government approved

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[64] Which is why Gordon (1993: 444) says " *the M_2 definition of money includes a hodgepodge of different financial instruments...* ".

annually by the parliament [Majles-e-Shora-ye-Eslamy] is used. This is due to lack of the quarterly data of the other part. As there is no significant difference between the gross domestic product and gross national product, the former is applied.

5.2.2 Conversion of GDP from Annual to Quarterly Figures

The National income account is as yet estimated annually in Iran. The model in this study deals with quarterly data for variables, so that of the GDP (Y) and oil GDP (OY) are required as well. Therefore a way to transfer the annually data to quarterly figures is needed. As nothing is known about the quarterly seasonal pattern of GDP and oil GDP process, assuming a smooth trend, the simple method provided by Lisman and Sandee (1964) has been applied to obtain the quarterly estimation of the data. This method is applied when there is no information about the required quarterly figures and no assumption can be made about actual movement or some seasonal patterns in the quarterly data. Thus one is only able to assume that the quarterly figures are placed in a smooth trend. Dividing the annual totals X_t (t=1,2,...,n) by 4 ($x_t = 1/4\ X_t$), and assuming the quarterly figures y_t^i ($\sum_{i=I}^{IV} y_t^i = 4x_t$) are a weighted sum of x_{t-1}, x_t and x_{t+1}, they construct the equations :

$$\begin{vmatrix} y_t^I \\ y_t^{II} \\ y_t^{III} \\ y_t^{IV} \end{vmatrix} = \begin{vmatrix} a & e & d \\ b & f & c \\ c & f & b \\ d & e & a \end{vmatrix} \begin{vmatrix} x_{t-1} \\ x_t \\ x_{t+1} \end{vmatrix}$$

They used 6 different coefficients instead of 12 based on a logical symmetry in time. Calculation of the matrix of coefficients enables us to derive the quarterly figures from annual ones. Then assuming the changes in the quarterly data, y_t^i, to be a quarter of the changes of annual amounts, X_t, and that the trend is a sinusoid, they calculate the coefficients as:

$a = 0.291 \quad b = -0.041 \quad c = -0.166$

$d = -0.084 \quad e = 0.793 \quad f = 1.207$

Now constructing y_t^i equations leads to the required data. Table 1 shows the first ten figures.

Table 1: Some Illustrations of Quarterly Data

	1971				1972				1973	
	Q_1	Q_2	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_1	Q_2
Y	6672	6932	7157	7440	7781	8138	8472	8765	9016	9265
OY	3107	3297	3462	3603	3821	3933	4083	4272	4512	4734

5.2.3 Filling a Few Scattered Gaps

11 quarterly observations for three variables: expenditure, revenue and oil-induced revenue of the government, in the early years of the period were not obtainable, hence, they have to be estimated. So far as is apparent, there is no empirical work to fill some scattered gaps in a data process. Lack of stochastic seasonality in the data generation process and simplification permits their estimation, based on the assumption of existence of a fixed deterministic seasonal pattern. The estimation model can be formulated as :

$$y_t = \sum_{j=1}^{s} \gamma_j z_{jt} + u_t \qquad t=1,2,\ldots,T$$

where $z_j = 1$ in season j, but zero otherwise and γ_j are the coefficients of dummy variables (Harvey. 1993:137). Using 14 observations of each time series under discussion close to the missing ones, the above equation is estimated. The coefficients estimated are used to calculate the share of each quarter in the annual figure. Finally, the formula:

$$y_t = \frac{\gamma_j z_j}{\sum_1^4 \gamma_j} * \sum_1^4 y_t$$

is used to calculate the missing figures from the annual data. A comparative table of estimated figures and actual values among gaps are provided in Appendix 1.

5.3 Estimation of the Expected Rate of Inflation

The first equation of the model which determines prices involves the expected rate of inflation, π :

$$\log P_t = -\lambda a_0 - \lambda a_1 \log Y_t + \lambda a_2 \pi_t - (1-\lambda)\log(M/P)_{t-1} + \log M_t$$

It is assumed that the expected rate of inflation is formed by an adaptive expectations. Estimation of this unobservable variable is the topic of this section.

As Granger and Newbold (1986: 140) state, the behaviour of individuals is usually a response to the future rather than the present and/or the past. In other words, they often make decisions according to an anticipation of the future. Variation of anticipation covers from an intuitive prediction based on near-to-hand information without analysis to a complicated forecasting model. As a result, econometric theories frequently involve expectations. Although expectations are affected by subjective information which is not quantifiable, economists and econometricians have introduced some models to show how individuals form their expectations of the future using quantifiable information from the past and present time. One popular model is the adaptive expectations model :

$$x^*_{t+1} = \beta x_t + (1-\beta)x^*_t$$

This is a fractional error learning mechanism as Azariadis (1994: 25) states. This method demonstrates that if the prediction of x for time t, x_t^* (anticipated at t-1) is different from the actual value, x_t, individuals adapt their predictions about time t+1 by a proportion of $(x_t - x_t^*)$ such that :

(5.6) $$x^*_{t+1} - x^*_t = \beta(x_t - x^*_t)$$

β is an arbitrary fixed fraction which satisfies $0 < \beta < 1$. This constant measures the speed of learning. In other words, it describes the individual's reactions to the error. Progressive substitution in (5.6) entails a model to calculate the unobservable variable x^*_{t+1} using its present and past values :

$$x^*_{t+1} = \beta \sum_{i=0}^{\infty} (1-\beta)^i x_{t-i}$$

This is an infinite lag distributed model in which the weight of lags, going towards the past, declines geometrically. Since the infinite past values of x_t are not observable, the expectation can be approximated using a model suggested by Cagan (1956).

Cagan introduced adaptive expectations for a continuous variable as :

$$\frac{dx^*}{dt} = \beta(x_t - x^*_t)$$

and for discrete variables suggested a model which approximately defines expectations as:

$$x^*_{t+1} = \frac{1-e^{-\beta}}{e^{\beta t}} \sum_{t=-T}^{t} x_t e^{\beta t}$$

where x^*_{t+1} stands for expectation of time t+1 formed at time t, x_t stands for actual values, β is the coefficient of expectation and -T is an arbitrary time before which prices were almost constant, so it can be reasonably supposed that the expectation was zero at time -T.

There are two problems associated with β , the coefficient of expectation. The first is the assumption of β being constant through time. In a study concerned with inflation, Khan (1977) points out that the expectation coefficient is sensitive to the level and variability of the actual rate of inflation. That means individuals revise the coefficient of expectation itself. Expressed differently, in a hyperinflation era or at least in a situation of a relatively high level of inflation and long inflationary process, agents respond to a discrepancy between predicted and actual inflation more quickly than in a situation with moderate inflation (Silveira, 1973). The second problem is the arbitrariness of β . Obviously each arbitrary β generates a new series of expectations while it seems there is no theoretical preference[65]. Nevertheless, this method of expectation is commonly applied and the conclusion of Blanchard and Fischer (1992: 618) can be accepted when they report Frenkel's(1975) judgement :

" *In the absence of a more closely specified model of expectations, there is no general basis for assuming one form rather*

65 Also see Aghevli and Khan (1977) and Diz (1970).

than the other, or indeed more sophisticated expectations hypotheses such as the adaptive-regressive formation."

Similar to many DCs, in Iran during the period, economic information was not easily available for individuals and also sophisticated forecasting methods were not prevalent, so agents relied on past actual information for expectation, rather than rationally using the available information to predict the future without any systematic mistake (Dornbusch and Fischer, 1994: 475). As a result an adaptive expectation model is used.

Concerning this empirical work, in which inflation was moderate in DCs standards, making β a constant seems acceptable. In selecting a proper size for β, the Cagan (1956) approach is used. Cagan attributes a sequence of 0.1, 0.2, ..., 0.9 to β and computes the related series of the expected rate. Then using these series in estimating the underlying regression model (in the Cagan case the money balance equation) he derives different residual sum of squares, RSS. He chooses the β yielding minimum RSS.

In our case the prices before the begining of the sample period did not vary considerably (the average quarterly rate of inflation during a decade before 1971 was 0.37% or 1.5% annually). Therefore, it is assumed that -T = 0, and the model is :

$$\pi_{t+1} = \frac{1-e^{-\beta}}{e^{\beta t}} \sum_{t=0}^{76} I_t e^{\beta t}$$

where I and π represent respectively the actual and expected rate of inflation and β determines the coefficient of adjustment. This model is used to calculate different series of expected rate of inflation. Finally these series of π_t are applied to estimate the equation :

$$\log P_t = -\lambda a_0 - \lambda a_1 \log Y_t + \lambda a_2 \pi_t - (1-\lambda)\log(M/P)_{t-1} + \log M_t$$

Different β s and the associated RSS are set out in Table 2. According to these results based upon the Cagan approach β = 0.9 is preferred. After this, the related series of expectation can be used in the model. In the computer output. provided in Appendix 2. P^* stands for π.

Table 2 : β s and Associated RSS

β	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RSS	0.245	0.232	0.219	0.210	0.204	0.200	0.198	0.197	0.196

5.4 Stationarity and Nonstationarity

Exposition of the concepts associated with *time series analysis* seems to be useful to perceive the work conducted in this chapter. It will be detailed to certain extent to which time series is connected with this thesis.

Most statistical methods, as Granger and Newbold (1986:1) explain, are built to be applied to a series of data originated by independent experiments or survey interviews. The data set, or sample, is regarded as representative of some population. Statistical analyses try to extrapolate the population properties from the sample. In these kinds of data, the order of the sample data is not important. However, with time series the case is completely the opposite. A time series is a sequence of numbers in which each of them is related with a particular moment or interval of time (Maddala,1992:525) so the data order is now very important. Each observation in time series x_t, t = 1, 2,..., n, is supposed to be a *realization* of random variables X_t, t =1, 2,..., n respectively. This finite sequence is also assumed to be a part of an infinite sequence. This sequence is known as a *stochastic process*[66](Judge et al. 1988: 676). Noting the difference between a random variable and its observed value, each observation in series x_t is a sample of size 1 of related X_t (Maddala,1992: 527). However, by analogy, in time series analysis the concept of realization and stochastic process are considered equivalent to sample and population in classical statistics. The time series analysis attempts to infer the properties of a stochastic process from the features of the observed series. The final purpose is to build a *model* from data which it is hoped can represent the data generation process or the stochastic process (Granger and Newbold,1986: 2).

Econometric modelling, in its traditional sense, tends to formulate a regression equation with explanatory variables suggested by economic theory, to explain or forecast the behaviour of time series data. Moreover, it is implicitly assumed that the stochastic properties of the data are invariant with respect to time. Time series analysis on the other hand, tries to describe or

66 *"The word stochastic has a Greek origin and means 'pertaining to chance."* Maddala (1992: 527)

forecast the behaviour of a variable by using only its past values neglecting any economic theory. In addition, based on the fact that the majority of economic time series do not hold fixed stochastic properties through time, time series analysis provides new methods to deal with data generation process modelling[67]. The univariate time series model can be presented in the simplest autoregressive of order one form, AR(1), in which the variable y_t is affected only by its previous value and a random white noise process which explains the effect of excluded variables from the model. By white noise we mean that it is a stochastic process with zero mean and constant variance distributed independently :

$$y_t = \varnothing y_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim IN(0, \sigma^2)$$

Another simple form is the moving average of order one form, MA(1) :

$$y_t = \varepsilon_t + \theta\varepsilon_{t-1}, \qquad \varepsilon_t \sim IN(0, \sigma^2)$$

A more general form is :

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \phi_p y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}$$

where ε_t is again identical independently distributed error. This model is known as an autoregressive-moving average of order p, q, abbreviated ARMA(p,q). Using lag operation notation ARMA(p,q) model can be compacted as :

$$A(L)y_t = B(L)\,\varepsilon_t$$

where A(L) and B(L) are polynomial operators ; $1 - \varnothing_1 L - \varnothing_2 L^2 - \ldots - \varnothing_p L^p$, and $1 + \theta_1 L + \theta_2 L^2 + \ldots + \theta_q L^q$, respectively, such that $L^p y_t = y_{t-p}$ and ε_t is white noise. (Judge et al,1988: 675, Kennedy,1992: 247 and Harris,1995: 3).

In this kind of ARMA model no economic information is used to build the model. However when the (causality) relationship between different variables is examined univariate ARMA model is not useful to apply. Therefore AR(1) can be expanded to comprise other stochastic and deterministic variables. For instance:

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67 These two chracteristics of time series analysis clearly show the importance of time order and the dynamic nature of this type of econometric approch.

$$y_t = \alpha_0 + \gamma x_t + \alpha_1 y_{t-1} + \varepsilon_t$$

where x_t can be defined as (for example) :

$$x_t = \lambda x_{t-1} + u_t, \qquad |\lambda| < 1 \text{ and } u_t \sim IN(0, \sigma^2)$$

As with the univariate case this simple instance may be generalized to obtain an autoregressive distributed lag model, ADL :

$$A(L)y_t = B(L) x_t + \varepsilon_t$$

Replacing y_t and x_t by $\mathbf{y}_t$ and $\mathbf{x}_t$, vectors of variables, leads to a general multivariate model (Harris,1995: 4). In multivariate time series analysis the relationships among a set of time series are dealt with. In this case assuming that the exogenous variables are generated by ARMA process, each endogenous variable in the econometric model may be considered as a univariate ARMA model (Kmenta,1986 and Kennedy,1992: 249).

An important question arises from these descriptions : when a time series is a set of values which are samples of size 1 of an unknown stochastic process, how would one estimate the mean and the variance (or covariance) of the time series ? Granger and Newbold (1986: 3) point out that theoretically it is possible only if some assumptions are imposed about the way that the mean and the covariance change over time and introduce *stationarity* as a restrictive but useful assumption. As mentioned above the basic feature of time series analysis is the reliance on past values of a variable to explain the present or forecast the future. So, the values of a variable over time are not independent, this means the covariances must exist and the structure of the data generation process must be considered fixed (also see Mills,1993: 8). In fact, when one associates stationarity with a stochastic process, it means that the data generation process is itself invariant with regard to time so that the form and the value of parameters of the generation process do not change through time. Although obviously this assumption is not always realistic, it does empower econometricians to construct some basic theories (Granger and Newbold,1986: 4, and Judge et al, 1988: 677).

The ARMA models provided earlier rely on the *weak stationarity* assumption (Mills, 1993: 31). A weakly stationary stochastic process X_t can be defined as a series with constant mean and variance, and a covariance invariant with respect to time, and depending only on lag length (Charemza and Deadman,1992: 118)[68]. This means we have :

$$E(X_t) = \mu$$

$$Var(X_t) = \sigma^2$$

$$Cov(X_t, X_{t+j}) = \sigma_j$$

This type of stationarity is also called second-order or covariance stationarity. A series even with a constant mean around a deterministic trend and a covariance independent of time, can be asymptotically stationary (Spanos, 1986 and Mills, 1993: 59). That means some stationary economic time series do actually comprise deterministic trends (Banerjee et al, 1994: 84 and Mills, 1993: 57).

However, when dealing with macroeconomic time series, a high majority of them do not fulfil these assumptions. This means nonstationarity is an accepted characteristic for macroeconomic time series. In these circumstances, applying conventional methods like Ordinary Least Squares, OLS, may well present misleading interpretations (Bhaskara Rao, 1995: 2). In fact classical estimation methods with nonstationary variables might lead to a problem which is well known as *nonsense* or *spurious* regression. Mills (1993:166) states that, according to the studies of Granger and Newbold (1974), if there are two completely independent nonstationary time series y_t and x_t, the standard regression of y_t on x_t :

$$y_t = \alpha + \beta x_t + u_t$$

leads to rejection of the null hypothesis $\beta = 0$ on 76 per cent of occasions. The rate of rejection of the correct null of no relationship reaches even 96 per cent when five independent nonstationary variables are included as regressors.

68 While weak stationarity requires only constant mean and variance (first two moments), for strict stationarity all existing moments of the stochastic process must be constant over time (Banerjee et al, 1994: 11). Thus, a strictly stationary process is also weakly stationary but the opposite does not always hold (Mills, 1993: 9).

Thus, conventional econometric tests are biased seriously towards acceptance of existence of a relationship. Spurious regression is often accompanied by high R^2 and low Durbin-Watson (high autocorrelation in error terms). A stationary series, as Cuthertson et al (1992) explain, has a tendency to revert to its mean and fluctuate almost inside constant bounds. In contrast, a nonstationary series would have various means in passing time. This seems to be true about the variables of the underlying model as can be seen in Figure 1. Nowadays it is generally accepted that to avoid misleading inference of time series analysis, nonstationary features of the series must be removed before any sensible regression is possible.

5.4.1 Unit Root Tests

A widespread and convenient means to remove nonstationarity from a time series is first differencing of the levels of the variables (once, or more if necessary). A nonstationary series which by differencing d times transfers to a stationary one, is called integrated of order d and shown I(d) (Engle and Granger,1987). Indeed, when a series y_t is integrated of order 1 it means that it is not itself stationary, but its *changes* (difference, Δy_t) are (Banerjee et al, 1994: 6), so that the estimation can be carried out on the difference, Δy_t. To obtain the estimate of y_t it is necessary to integrate over (sum up) the estimates of Δy_t (Kennedy,1992: 248). Hence, getting rid of the nonstationary feature of the underlying variables, we need to know the correct degree of integration, d.

The Dickey-Fuller (DF), and the Augmented Dickey-Fuller (ADF) tests are very common simple procedures in determining the order of integration of a series (Maddala, 1992). In a study conducted by Dejong et al (1992) the power of different unit root tests are examined. They conclude that in practice, the ADF test is likely the most helpful. These tests, following Charemza and Deadman (1992), can be explained briefly as follows. Suppose the series has been generated by the simplest type of autoregressive model, AR(1) :

(5.7) $$y_t = \rho\, y_{t-1} + \varepsilon_t \qquad \text{or} \qquad (1-\rho L)\, y_t = \varepsilon_t$$

where ε_t is white noise (identically independent distributed with zero mean) and L is lag operator, $Ly_t = y_{t-1}$. The condition for stationarity of such a process is $| \rho | < 1$. The above test, which also called *Unit Root Test*[69], considers the hypothesis that $\rho = 1$. To do so, an equivalent equation :

(5.8) $$\Delta y_t = \delta\, y_{t-1} + \varepsilon_t$$

is used. This can be rewritten as :

(5.9) $$y_t = (1+\delta)\, y_{t-1} + \varepsilon_t$$

with $\rho = 1+\delta$. Equations (5.7) and (5.9) are identical, therefore the null hypothesis $\rho = 1$ in equation (5.7) can be changed to $\delta = 0$ in testing equation (5.9). The alternative hypothesis is $\delta < 0$ which implies that $\rho < 1$ that in turn means the time series has no unit root and is stationary.

It is probable that there is autocorrelation in the error term, ε_t in equation (5.8). In this case, the OLS estimator does not generate efficient results. Solving this problem the test can be conducted with the regression model below which contains the lagged values of the dependent variable as regresssors called augmented Dickey-Fuller test, ADF[70] :

(5.10) $$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + e_t$$

Here again, stationarity can be accepted by the acceptance of negativity of δ in equation (5.10). According to a general belief, in many macroeconomic time series MA terms are contained after first differencing. However, Harris (1995: 34) says an AR(k) process can approximate an unknown ARMA(p,q) if k is sufficiently large to give approximately white noise error terms[71]. Keeping the principle of parsimony, the number k has to be as large as necessary to solve the autocorrelation problem. Although this can be done by performing autocorrelation tests on the estimated residual of an AR(k) model, model

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69 If the polynomial of lag operator, $(1-\rho L)$ has a unit root, i.e. $L = 1/\rho = 1$, it necessitates that $\rho = 1$. Being time series stationary the root(s) of polynomial must be out of the unit circle, this means $L = 1/\rho > 1$, so $|\rho| < 1$.

70 It is equivalent to being y_t AR(K) (Banerjee et al, 1994: 106).

71 See also Banerjee et al (1994: 107-108).

selection procedures may be applied simutaneously to determine the lag order, k, and to test for unit root (Banerjee et al,1994:107). In equation (5.9), as well as (5.10), assuming y_t is I(1), an I(0) variable regresses on an I(1) variable. Hence, the standard t-statistic does not have its normal distribution and for each case the distribution and associated critical values should be calculated.

Note that the data generation process representing a time series is never known precisely and an econometrician in an attempt to discover it, has to propose the best approximation of it (Gilbert,1993). As Banerjee et al (1994:100-108) explain, a data generation process underlying a time series might well not be AR(1) or AR(k) without nuisance parameters. Therefore the regression model can be modified by adding a constant term (drift) and/or a deterministic time term to permit other possibilities for the data generation process. Regarding this important point, Harris (1995: 29-31) says that a condition, *inter alia*, for the validity of a unit root test using an AR(1) model is that the initial value of the variable, y_0 equals zero. However, usually the actual value of y_0 is unknown. In order to remove this fault it is better to add a constant to the model used for unit root test.

This in turn implies that testing stationarity of a series y_t, supposedly generated by an AR(1) model :

$$y_t = \rho\, y_{t-1} + \varepsilon_t$$

by :

$$\Delta y_t = \alpha + \delta\, y_{t-1} + \varepsilon_t$$

rather than equation (5.9) or the corresponding ADF model, where $\delta = \rho - 1$ and ε_t is white noise. If the null $\rho = 1$ ($\delta = 0$) can be rejected, the time series y_t can be treated as stationary around a constant (or zero, depending on y_0) mean, but there is no trend in the data generation process.

Accordingly, if the data generation process is assumed to include a constant as follows :

$$y_t = \alpha + \rho\, y_{t-1} + \varepsilon_t$$

the proper model to test for a unit root is :

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \varepsilon_t \ . \qquad \delta = \rho - 1$$

or the ADF model:

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + e_t \ \cdot \qquad \delta = \rho - 1$$

Of course, it is of particular importance to note that the distribution of test statistics achieved are determined not only by the data generation process, but also by the model applied in investigation. Thus, for valid DF or ADF tests, the appropriate critical values of test statistic must be used.

Harris (1995: 30) also points out that the critical values of DF test statistic increase in absolute value, when a constant, or constant and trend, are included in the model used to test unit root. So when a model used includes only a constant while the constant and trend is proper the hypothesis of nonstationarity is more likely to be rejected (over-rejection). Obviously, it is also correct that if the appropriate model is one in which only a constant must be entered, inclusion of an unnecessary deterministic time trend leads to under-rejecting the null hypothesis. The reason is that in this case the corresponding critical value is greater in absolute value thus the probability of acceptance of nonstationarity increases. As the data generation process is unknown, the general model which contains all deterministic components is appropriate for the test because the risk of using this general form is under-rejection of a false null. So if this test can reject the null it will be trusted and the test stops, otherwise the test can continue with a more restricted form step by step (i.e. without trend, then even without constant and trend). The test stops whenever the null can be rejected.

5.4.2 Seasonality Features

Harvey (1993) points out that when quarterly (or monthly) observations are dealt with attempts should be made to consider the seasonality effects. There may be two kinds of seasonality; deterministic and stochastic. In the former the pattern in the series reiterates almost regularly year to year, while in the latter the pattern changes over time. Moreover, Charemza and

Deadman (1992) say a shock in the deterministic seasonal time series has a transitory effect and dies out in the long run, whilst the impact of a shock in the stochastic form is permanent. This means a shock in time t, in addition of changing y_t, has the same effect on y_{t+s} , y_{t+2s} ,...(s is the seasonal interval).

Harvey (1990) states however, that the existence of a deterministic seasonality in a time series model creates no new problems in respect of estimation and specification . However, this is not the case when a stochastic seasonality exists. As Hylleberg et al (1990) point out most of the unit root tests like the DF and the ADF are based on the absence of stochastic seasonality. Thus, in order to achieve stationary, a test must be undertaken for checking whether or not a seasonal differencing, in addition to first differencing, is necessary.

There is a test provided by Hylleberg, Engle, Granger and Yoo (1990), (hereafter HEGY test) which is more general than the DF and ADF tests because it determines both the order of integration and the stochastic seasonality. A simple version of it from Fielding (1994) is applied to the variables under study. The model is built as:

(5.11) $$\Delta_4 y_t = \mu + \beta t + \sum_{i=1}^{3} \gamma_i Q_i + \sum_{j=1}^{4} \lambda_j Y_{j(t-1)} + e_t$$

where Q_i stands for quarterly dummy variables and Y_{jt} is defined as:

$$Y_{1t} = y_t + y_{t-1} + y_{t-2} + y_{t-3}$$

$$Y_{2t} = - y_t + y_{t-1} - y_{t-2} + y_{t-3}$$

$$Y_{3t} = - y_t + y_{t-2}$$

$$Y_{4t} = - y_{t-1} + y_{t-3}$$

If λ_1 and λ_2 and either λ_3 or λ_4 are significantly negative, the null hypothesis of the nonstationarity of y_t is rejected. If λ_2 and either λ_3 or λ_4 are significantly negative, the null hypothesis of stochastic seasonality can be rejected. Hence this model, which can be estimated by OLS, determines the necessary number of first differences, d, as well as seasonal differences, b, namely the seasonal integration of orders d and b, SI(d, b). Like other tests the critical t-values differ. The corresponding t-values for 1%, 2.5%, 5% and 10% levels from Hylleberg et al (1990) are tabulated in Table 3[70]. Concerning the variables of this study included in the first three behavioural equations, the general and complicated tests of HEGY procedure are conducted. The detailed computer output for HEGY tests are provided in Appendix 3 and summarised in Table 4. To solve the error autocorrelation problem the necessary lags of the left-hand side variable in equation (5.11) are added to its right-hand side (Charemza, Deadman, 1992).

As Table 4 clearly shows, all variables are SI(1, 0). This means that the HEGY tests reject the presence of stochastic seasonality in the time series of the model and at the same time confirm the integration of order one for all of them. We also conducted the DF and ADF tests. The results were the same except for price, government oil-induced revenue and income where stationarity cannot be rejected by these simple tests. This is, as Dickey et al (1995) state, a weakness of these tests in some samples. The nonstationarity of all the variables is also confirmed by the integrated Durbin-Watson (IDW) procedure (Charemza and Deadman, 1992:130). All these tests show that there are no unit roots for the first differences of the variables. The results for the DF and ADF tests are reported in Appendices 4 and 5. According to the outcomes of the exhaustive tests of HEGY procedure the first differences of all our I(1) variables are I(0) and can be applied to estimate the model, eliminating any concerns about nonsense regression problems. Inspection of Figures 1 and 2 which respectively plot the levels and first differences of the variables suggest the same conclusions.

70 This corresponds λ_1 to Hylleberg et al's π_1, λ_2 to π_2, λ_3 to π_4 and λ_4 to π_3. T, sample size of the reported critical values is 48.

Table 3 : Critical Value of λs' t-statistics

Coeficient	1%	2.5%	5%	10%
λ_1	-4.46	-4.04	-3.71	-3.37
λ_2	-3.80	-3.41	-3.08	-2.73
λ_3	-2.75	-2.26	-1.91	-1.48
λ_4	-4.46	-4.02	-3.66	-3.28

Table 4 : HEGY Test for Stochastic Seasonaliy and Integration Order

		t-value of			
Δx	λ_1	λ_2	λ_3	λ_4	**Inference**
$D_4 m$	0.017	-5.972****	-3.359****	-4.892****	SI(1,0)
$D_4 p$	-2.400	-8.026****	-3.053****	-4.956****	SI(1,0)
$D_4 g$	-1.902	-3.122**	-2.094**	-5.036****	SI(1,0)
$D_4 r$	-2.221	-2.840*	-3.591****	-4.207***	SI(1,0)
$D_4 or$	-2.120	-2.755*	-4.215****	-4.494****	SI(1,0)
$D_4 y$	-2.928	-8.388****	-1.541*	3.234	SI(1,0)
$D_4 oy$	-1.652	-6.673****	-4.500****	1.722	SI(1,0)

Figure 1 : Time Series of the Model

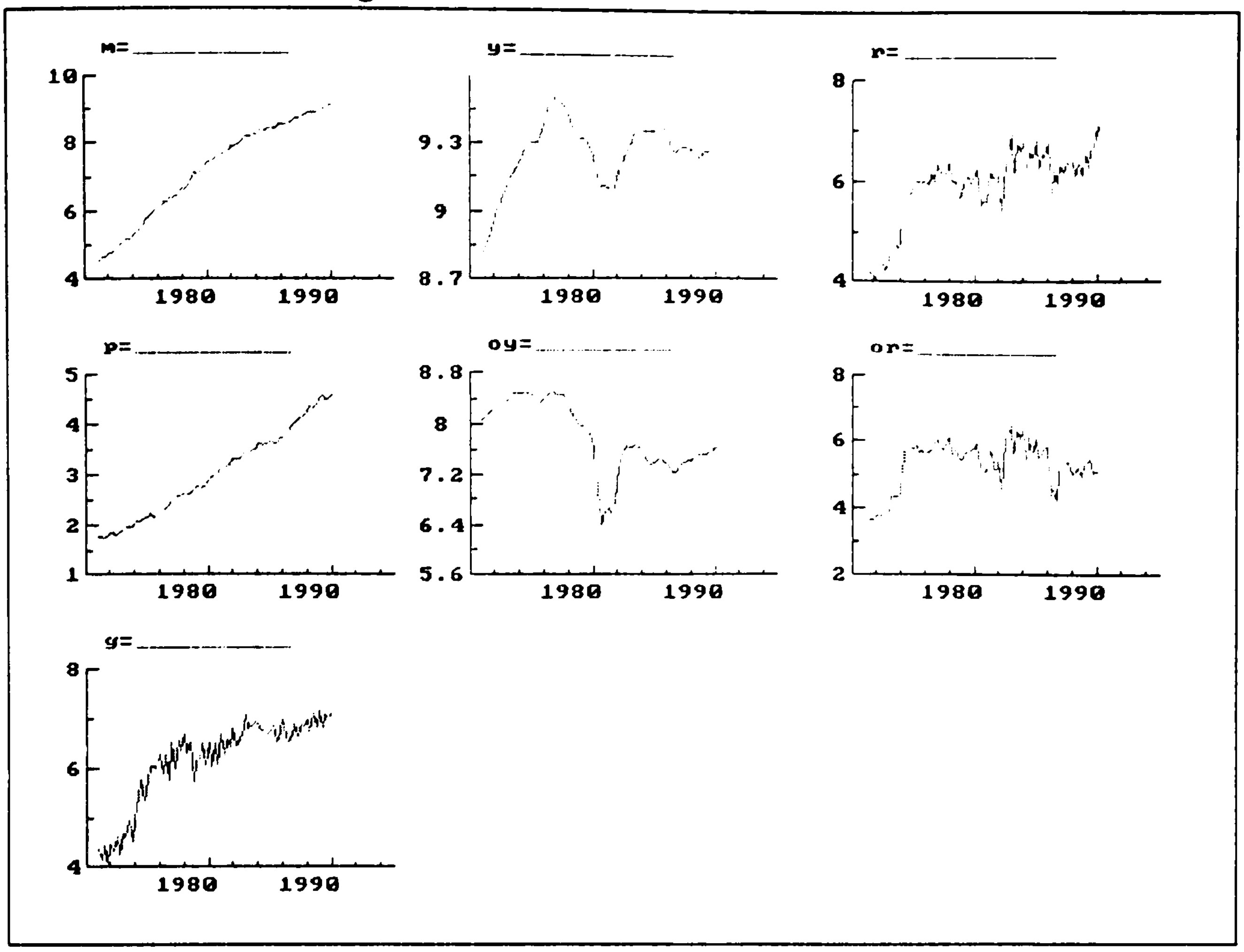
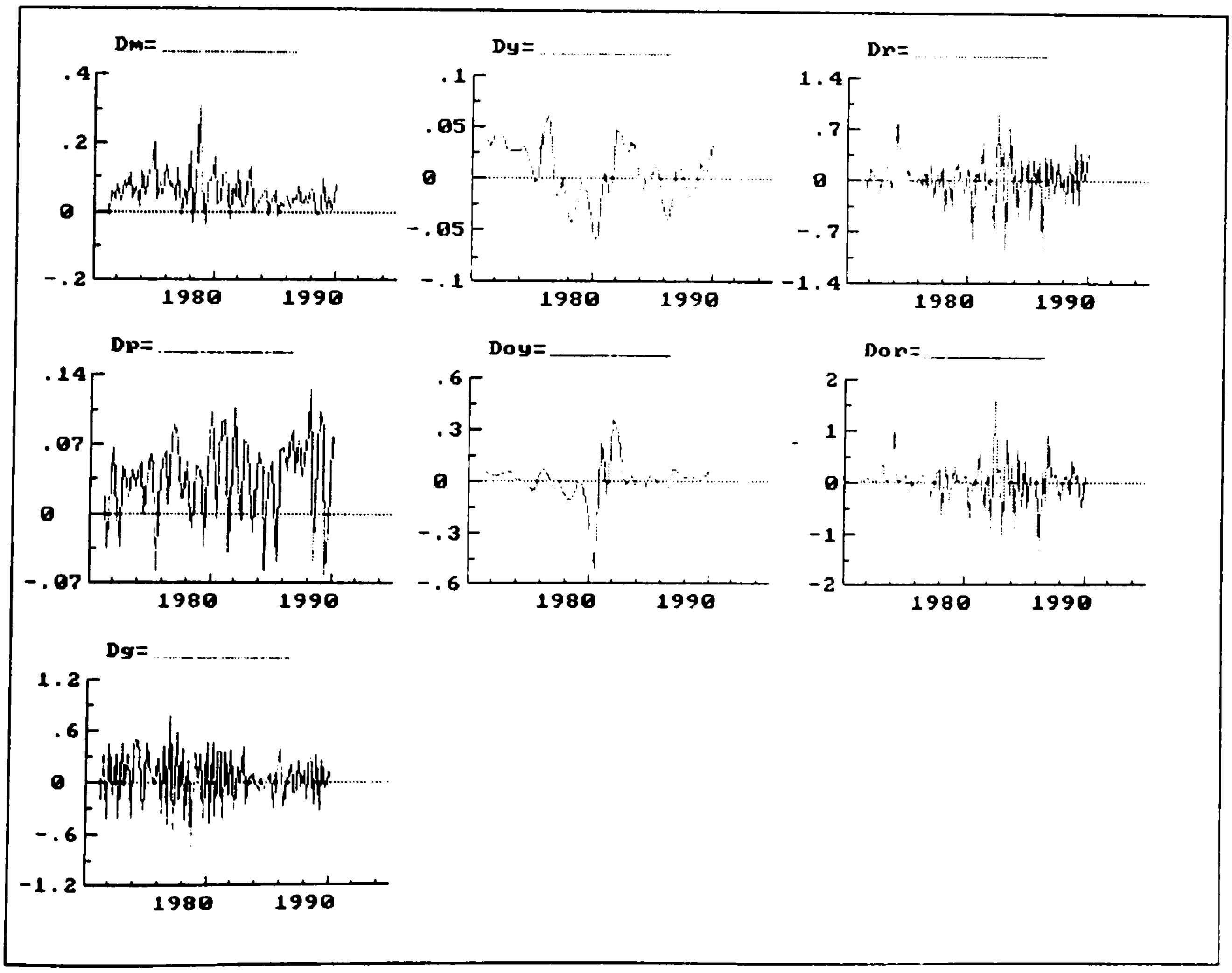


Figure 2 : First-differenced Time Series of the Model



5.5 Short-run Vs Long-run Relationships : Cointegration

Granger (1986) says that it is an applicable belief in advanced level economic theory that the path of certain pairs of variables should not diverge, at least in the long-run, though they may diverge in the short-run due to seasonal factors, for example. However, if they continue to drift apart, market forces or government performance commence to cause them to converge again. Wages and prices, government expenditure and revenue, and prices of a commodity in different parts of a country are some examples. Such long-run relationships reflect equilibrium in which a system converges over time. In other words, a long-run relationship induces a methodical co-movement amongst some variables so that an exact economic system is exemplified in the long-run (Banerjee et al,1994: 2). In this case it can be also said these variables have a common trend.

However, as described in the section above, to achieve an interpretative estimation the regressions are usually carried out on the first differences of the variables rather than the levels. This means, they have been detrended by differencing before regression. The trend shows the long-run movement of the series, hence the differencing operation omits the long-term relationship among the series. What can be done if one is interested in explaining the relationship between the trends of the variables?(Maddala, 1992)

In other words, in the long-run, when the system is in a steady state of equilibrium, the variables have no tendency to change, say $y_t = y_{t-1} = y^e$ (y^e stands for equilibrium) so $\Delta y_t = 0$ and if the regression is applied on the differences of the variables the long-term relationship is not apparent. As Mills (1992) says although there may not be such relations, it seems of particular importance to allow for their possibility when the time series model is being built. The *cointegration* concept was developed in the 1980s to solve this problem and to test any argument about a long-run relationship hypothesised in economic theory, as Granger (1986) emphasises.

According to Granger (1986) and Engle and Granger (1987) the cointegrated variables can be defined as follows: if x_t and y_t are both I(1), then although any arbitrary linear combination of them, say:

$$z_t = y_t - \beta x_t$$

is generally integrated of the same order, I(1), it is not impossible that z_t is stationary, I(0). In this case the variables cannot move divergently and are called cointegrated of order one . CI(1.1). In this circumstance estimating a cointegration regression, $y_t = \beta x_t + z_t$ leads to a superconsistent β estimate. Consequently, the relationship :

$$y_t = \beta x_t$$

may be viewed a long-term relationship between x and y. In such a case 'β' is called the cointegration coefficient and vector (1.-β) named the cointegration vector, which can prameterize an equilibrium relationship proposed by an economic theory. Miller (1991:141) notes that in the bivariate case, β must be unique because another cointegration coefficient, say for example $\alpha=\beta + \delta$ brings about a new term $(-\delta x_t)$ which is by definition nonstationary. Consequently

$$z_t = y_t - \alpha x_t + \delta x_t$$

is now a combination of stationary $(y_t - \alpha x_t)$ and nonstationary (δx_t) terms, so not stationary any more. That means that integrated variables can have unique long-run relationships in a bivariate context if they are cointegrated (obviously the order of integration of the variables must be identical). In fact, as Harris (1995: 23) says, conventional regression dealing with nonstationary variables can make sense and provide useful information about long term relationships if they are cointegrated, otherwise the problem of a spurious relationship will be faced . Mills (1992) points out that in these circumstances interpretation can be conducted on models estimated in levels otherwise the analysis *should* be applied on their differences (p. 271).

5.5.1 Error Correction Mechanism

Monte Carlo investigations, as Kennedy (1992: 254) says, indicate that the cointegration regression estimates in small samples have sizeable bias, though they have superior properties in large samples. These studies imply that the estimation of the long-run relationship combined with the short-run dynamic, *error-correction mechanism* (ECM), is better than to individual estimation of each. Inder (1993: 53,68) explains that although the Engle and Granger OLS approach to modelling the relationship among cointegrated variables is easy and straightforward, in finite samples the elimination of dynamics may generate some problems. His Monte Carlo studies suggest that encompassing the dynamics within a long-run coefficient estimation (ECM) gives a more powerful procedure with more reliable results.

With a stable equilibrium $y_t = \beta x_t$, the deviation $\{ y_t - \beta x_t\}$ obviously contains helpful information because the system will move towards the equilibrium point unless it is already there. So that $(y_{t-1} - \beta x_{t-1})$ shows the magnitude of previous disequilibrium, the error of y_t from its long-run path. For instance, a positive $(y_t - \beta x_t)$ confirms that y_t is high relative to its trend of growth. Thus the error term, $(y_t - \beta x_t)$, can be a beneficial explanatory variable for the future direction of the path of y_t and can be incorporated in dynamic regressions (Banerjee et al, 1994: 5)

The error correction mechanism as an adjustment process, incorporates the dynamic movement of two (or more) variables to their long-run equilibrium, in other words, the change in y_t is explained by the change in x_t and the disequilibrium in the past period, thus it has a close relation with the cointegration concept (Lutkepohl, 1991). In fact, as Banerjee et al (1994: 6) remark "*...error correction behaviour on the part of economic agents will include cointegration relationships among the corresponding time series and vice versa*". Given the previous I(1) variables x_t and y_t , with a long-run relation defined as $y_t = \beta x_t$, the ECM can be formulated as:

$$\Delta y_t = \alpha \Delta x_t + \gamma (y_{t-1} - \beta x_{t-1}) + e_t \quad (5.12)$$

As Δy_t and Δx_t are I(0), assuming e_t to be white noise, the regression of equation (5.12) has an interpretable result if the variables are cointegrated with the cointegration vector $(1,-\beta)$ (Holden and Perman, 1995) because in this case all variables have the same order of integration. In fact, as Charemza and Deadman (1992) point out, the implication of two (or more) cointegrated variables is that there is some process which adjusts the error in the long-run to prevent it becoming increasingly large. To include more complicated dynamic processes, this simple ECM can be extended to a general form :

$$A(L)\,\Delta y_t = B(L)\,\Delta x_t + \delta(y_{t-1} - \beta x_{t-1}) + \varepsilon_t$$

where A(L) and B(L) are lag operators and ε_t is a white noise error term (Harris, 1995: 25).

5.5.2 The Cointegration Test

A widely used test to examine the existence of cointegration among a pair (a group) of variables is the test provided by Engle and Granger (1987). This test is described by Holden and Perman (1995) as follows.

Regression of y_t on x_t, supposing there is one cointegration vector, is called cointegation regression: $y_t = \beta x_t + u_t$. In order to examine whether the long- run relationship exists, it is enough to consider the existence of a unit root in the residual of the cointegration regression. This means that the null hypothesis, nonstationarity of the residual. is tested against the stationarity alternative. In other words, null hypothesis rejection means the variables are cointegrated. This resembles the question of stationarity of the variables y_t and x_t, hence it seems that the proper approach is the DF or the ADF test. The problem here is that the residual u_t is not observable. Therefore the estimated values $\hat{u}_t$ are used. Engle and Granger (1987) also consider Durbin-Watson statistic for cointegration regression (CRDW) and show that a very low CRDW (near zero) rejects the existence of cointegration and an estimate close to 2 confirms it. Of course they prefer the ADF test.

Cointegrated nonstationary variables can also be applied to formulate and estimate an ECM model. To do so, first the cointegration coefficient(s) is (are) estimated by running an OLS cointegration regression, say

$$y_t = \beta x_t + u_t$$

After confirmation of y_t and x_t being cointegrated, $\hat{\beta}$ can be used to estimate the ECM as:

$$\Delta y_t = \alpha \Delta x_t + \gamma (y_{t-1} - \beta x_{t-1}) + e_t$$

In consequence, $\hat{\alpha}$ and $\hat{\gamma}$, the coefficients estimated by OLS in the equation above show the share of current changes in the explanatory variable, x_t, and the adjustment process, (y_{t-1} - βx_{t-1}), in the changes in y_t. The rationale of OLS is, as described above, the cointegrated feature of the variables which made their linear combination (y_t - βx_t) an I(0) process, similar to other variables in ECM above (Δy_t and Δx_t) as Charemza and Deadman (1992) explain. As noted above the lags of Δy_t and Δx_t can be added to the model ensuring e_t is white noise.

According to Phillips and Loretan (1991), there is another approach to estimating a long-run relationship (cointegration coefficient β) like autoregressive distributed lag model, ADL. The unrestricted ADL(n) representation for the variable y_t and x_t can be formulated as:

$$y_t = \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{i=0}^{n} \beta_i x_{t-i} + e_t$$

this equation might be estimated by OLS rather than the above static equation of cointegration regression. It is worth noting that in this case the long-run coefficient, β* must be calculated by :

$$\beta^* = \frac{\sum_{i=0}^{n} \hat{\beta}_i}{1 - \sum_{i=1}^{n} \hat{\alpha}_i}$$

Then β* as an estimator of β will be used to estimate the ECM model.

5.5.3 Multiple Time Series Cointegration

Although the implementation of the Engle-Granger procedure is straightforward, some problems are confronted. First. in this procedure, the ordinary least squares method is used to estimate the cointegration vector. In conducting this estimation it is necessary to assume one variable of the underlying model as the regressand, and the other(s) as regressor(s). This arbitrary normalisation, as Hafer and Jansen (1991:158) and Kennedy (1992: 259) say, will affect the estimation results. Following Enders (1995: 385) this defect can be described as follows. Where there are two variables in the model, for example, the Engle-Granger test may be conducted by using the residuals estimated from either of two long-run regressions:

$$y_t = \beta_{10} + \beta_{11} x_t + e_{1t}$$

or

$$x_t = \beta_{20} + \beta_{21} y_t + e_{2t}$$

In the very large sample ($t \rightarrow \infty$) asymptotic theory shows a unit root test on e_{1t} time series amounts to one on e_{2t}. However, this property may not be applicable in small samples. Researchers do not often have large samples and it is not surprising that by changing the left hand-side variable the results differ. In other words, while the unit root test on $\hat{e}_{1t}$ indicates y_t and x_t are cointegrated, that of $\hat{e}_{2t}$ shows they are not. This is an unacceptable property of the procedure because the cointegration test must be invariant to the selected variable for normalisation.

The second defect is associated with the two step estimation of the Engle-Granger procedure. In the first step it is assumed that the two (or more) $I(1)$ variables have a long-run relationship (or are cointegrated) in order to estimate the coefficient(s) of the long run relationship and the residual sequence. Then in the second step these estimates are used in the cointegration test (or ECM). In such a circumstance, as Dickey et al (1995:13) say, rejecting the null hypothesis of nonstationary is difficult. Alternatively stated, the first stage generates the residual terms $\hat{e}_t$ which is then used in the regression

$\Delta\hat{e}_t = \delta\ \hat{e}_{t-1} + \ldots$ to estimate the coefficient δ and its t-statistic for the unit root test. Thus, any errors created in the first step of the research carry over into the second stage (Enders, 1995:385). Dickey et al (1995:14) emphasise that only if the cointegration vector(s) is (are) fully specified by economic theory, would conventional unit root test be appropriate for the cointegration tests.

The third problem associated with the Engle-Granger procedure is that this method of cointegration test does not discern whethere there is one or more than one cointegration vectors (Hafer and Jansen, 1991:158). In fact, when there are more than two variables in the model (n variables) there may be (n-1) linearly independent combinations of them cointegrated and only if n = 2, will the cointegration vector be unique (as mentioned before). As such, it might not be possible to recognise the differences between the behavioural relationships and those that have no economic interpretation (Enders, 1995: 359).

Finally, Harris (1995: 62) points out that even with the existence of only one cointegration relationship , a single equation estimation potentially leads to an inefficient result. This means that the procedure does not derive the smallest variance relative to the other procedures. In other words, when there are more than two variables in the model, there may be more than one set of cointegrating parameters, which means that it is possible that more than one disequilibrium influences the dynamics in the ECM (Kennedy ,1992: 259) .

The most popular procedure used to tackle these defects is one developed by Johansen and Juselius(1990). Here a Vector Autoregressive Model (VAR) such as:

(5.13) $$y_t = A_1 y_{t-1} + \ldots + A_k y_{t-k} + u_t, \qquad u_t \sim IN\,(0, \Sigma)$$

is used, where y_t is $n \times 1$ matrix of variables. This is similar to the autoregressive distributed lag model, ADL introduced in section 5.4 and a similar reformulation leads to the Vector-Error Correction Model (VECM):

(5.14) $$\Delta y_t = \Pi_l\, \Delta y_{t-1} + \ldots + \Pi_{k-1}\, \Delta y_{t-k+l} + \Pi y_{t-1} + u_t$$

where $\Pi_i = -(I - A_1 - \ldots - A_i)$, $i = 1, 2, \ldots, (k-1)$ and $\Pi = -(I - A_1 - \ldots - A_k)$. The model (5.14) is only a first difference of VAR model which contains an extra term Πy_{t-1}. The procedure concentrates on matrix Π to investigate whether or not it includes the information about a long-run relationship among the variables y_t. The centre of the issue is the rank of the matrix Π, the impact matrix. The hypothesis of the presence of cointegration vectors amounts to reducing the rank of the matrix Π. The estimation method is the Maximum Likelihood procedure. Likewise, the precise number of cointegration vectors is tested by likelihood ratio tests. This test is also used to examine the linear hypothesis suggested by economic theory about the long-run relationship and their weights (Johansen and Juselius, 1990: 206). The reason for preference of these estimation methods, as Johansen (1988) says, is that they take into account the structure of the underlying time series neglected by the regression estimates. In other words, their procedure considers the cointegrating issue in a multivariate model, enabling a test of the number of cointegration vectors explicitly, and does not depend upon arbitrary normalisation. Finally, it examines the restrictions provided by economic theory like the magnitudes and sign of the estimated coefficients (Hafer and Jansen, 1991: 157 and Enders, 1995: 385).

Although there are some competing procedures, Gonzalo(1994), comparing five of the most widely used methods in empirical research, points out that Maximum Likelihood in a fully specified error correction model by Johansen generates the most reliable results when there are more than two variables in the model. This study shows that the estimates of the coefficients are distributed symmetrically with unbiased median, and standard asymptotic chi-squared tests might be implemented for the hypothesis tests. The other methods do not have these properties. In addition, although these properties rely on asymptotic theory, this comparison, via Monte Carlo experimentation, suggests that the same is true of finite samples.

The Johansen Procedure

As mentioned above, in the Johansen procedure attention is focused on the rank of the impact matrix, Π in a VECM like equation (5.14). Actually, the model used by Johansen and Juselius(1990) , contains an intercept and other deterministic components:

(5.15) $$\Delta y_t = \Pi_1 \Delta y_{t-1} + \ldots + \Pi_{k-1} \Delta y_{t-k+1} + \Pi y_{t-k} + \phi D_t + \varepsilon_t$$

or compactly:

$$\Delta \boldsymbol{y}_t = \Sigma \Pi_i \Delta y_{t-i} + \Pi y_{t-k} + \phi \boldsymbol{D}_t + \varepsilon_t$$

where $\boldsymbol{y}_t$ is a matrix of the I(1) variables, Π_i, Π and ε_t are as defined in equation (5.14) and $\mathbf{D}_t$ is the matrix of deterministic variables. Using Enders (1995:367) description, relationships between the rank of the matrix Π and cointegration vectors can be revealed. Rearranging equation (5.15) gives :

$$\Pi \boldsymbol{y}_{t-k} = \Delta y_t - \Sigma \Pi_i \Delta y_{t-i} - \phi \boldsymbol{D}_t - \varepsilon_t$$

Supposing all variables in y_t are I(1) and the equation (5.15) represents a VECM, the left-hand side factor of the above equation must be a set of stationary linear combinations of the variables because all the right- hand side factors are I(0). It is said that Π is a matrix of constants, so the rows of Π are cointegrated vectors of y_t. As an example, the first linear stationary combination of nonstationary variables in y_t is ($\Pi_{11} y_{1(t-1)} + \Pi_{12} y_{2(t-1)} + \ldots + \Pi_{1n} y_{n(t-1)}$). There are three possibilities with three key points:

1. The rank of Π is zero, which in turn means that Π_{ij} equals zero for all $i=j=1,2,\ldots,n$. Thus there is no impact of the deviation of each y_{it} from its long run path on Δy_{it}. In other words, there is no cointegration vector and also the VECM changes to a traditional VAR.
2. If the impact matrix is of full rank, this means that $r = n$, and there are n independent linear combinations which are stationary. Since an n dimension space is defined by at most n independent vectors therefore in this instance every linear combination of the variables in y_t is stationary, in other words, these n independent vectors *span* the whole space of y_t. This means that

every other vector is only a linear combination of those n independent stationary vectors, hence they definitely must be stationary (Hafer and Jansen, 1991:158). This is impossible unless all variables in y_t are stationary which violates the initial assumption of nonstationarity of the variables.

3. The alternative case is $0 < r < n$, which, with satisfaction of the assumptions of I(1) for the variables and the representation of the VECM (existence of long-run relationships) means that, there must be at least one and at most (n - 1) independent cointegration vectors. In other words, only when Π has reduced rank can the long run relationships between I(1) variables be acceptable.

In other words (Harris, 1995: 79), for the error terms ε_t in equation (5.15) to be white noise, I(0), it is necessary that Πy_{t-k} also be stationary. Only in three cases this condition is met. First when y_t contains only stationary variables, which is not consistent with the initial assumption. As such, there is no spurious regression problem, the model (5.15) is not appropriate and the estimation can be conducted on levels in a VAR. The second case is when there is no stationary linear combination of y_t which implies there is no cointegration vector at all. This in turn implies that Π is a n×n matrix of zeros. In this instance the proper model is VAR in first differences not involving long-run terms. The third and interesting case in the cointegration context is the circumstance in which there exist up to (n-1) cointegration vectors, implying that the rank of Π is $r \leq (n-1)$.

Once this is the case, the n×n matrix of cointegration vectors may be written as:

$$\Pi = \alpha\beta'$$

where α and β are both reduced form of (n×r) such that α reflects the speed of adjustment to disequilibrium and β contains the long-run coefficients so that $\beta' y_t$ introduces up to (n-1) cointegrated combinations of the variables in the multivariate model which guarantee the convergence of the nonstationary variables of the model to their long-run equilibrium [analogous to γ and (1. – β), respectively in the single equation case, (5.12)].

After all, it must appear that Πy_{t-k} in equation (5.15) can only contain the cointegration vectors in β , otherwise it cannot meet stationary condition. In fact, β has r columns which make r independent linear combinations and (n-r) columns which form I(1) common trends. In consequence, the last (n-r) columns of α must be zero in order for Πy_{t-k} to be stationary in equation (5.15). Therefore, in order to know the precise number of cointegration vectors the rank of Π should be known, which amounts to the number of independent columns of β to be determined and this corresponds to testing how many columns of α are zero. In order to determine the rank of Π, the number of its characteristic roots or eigenvalues should be ascertained. Eigenvalue of an n×n matrix Π, can be defined as λ in :

$$\Pi y_t = \lambda y_t$$

where y_t refers to a n×1 non-zero matrix. Rearranging , **I** being an n×n identity matrix, gives :

$$(\Pi - \lambda \mathbf{I})\, y_t = 0$$

A non-zero y_t entails the matrix ($\Pi - \lambda \mathbf{I}$) to be singular, then its determinant must equal zero, $|\Pi - \lambda \mathbf{I}| = 0$. This introduces an equation of degree n which gives n roots for λ. For each non-zero λ there is an independent row (column) in matrix Π. As the rank of the matrix, say r , is defined as the number of the independent rows (columns) of the matrix, the number of non-zero λs introduces the rank r and for each (n-r) remaining dependent rows, λ equals zero (Enders, 1995: 412).

Now, the test of reduced rank can be introduced. Actually solving the determinant equation $|\Pi - \lambda \mathbf{I}| = 0$ derives n roots $\hat{\lambda}_1 \rangle \hat{\lambda}_2 \rangle ... \rangle \hat{\lambda}_n$ .Testing the hypothesis that at most r rows (columns) of impact matrix Π are independent, in other words, there are at most r cointegration vectors, is equivalent to testing $\hat{\lambda}_i$ to be zero for the remaining (n-r) nonstationary processes :

$$H_0 : \hat{\lambda}_i = 0 \quad \text{for } i = r+1, \ldots, n.$$

This restriction can be set for different r (Harris, 1995: 87). The testing path is specified by Enders (1995: 390) as follows. Assume the n eigenvalues of the matrix Π are obtained and ordered as $\hat{\lambda}_1 > \hat{\lambda}_2 > \ldots > \hat{\lambda}_n$. The variables in y_t being not cointegrated necessitates that the rank of Π equals zero and in turn all $\hat{\lambda}$ s will be zero. As ln(1) = 0, each of the terms $\ln(1 - \hat{\lambda}_i)$ equals zero for all i if y_t does not contain cointegrated variables at all. Analogously, if the rank of Π is r, that means $0 < \lambda_r < 1$, and the terms $\ln(1 - \hat{\lambda}_i)$ for i = 1,2,...,r will be negative but all λ corresponding to (r+1), ... ,n equal zero. This means $\ln(1 - \hat{\lambda}_{r+1}) = \ldots = \ln(1 - \hat{\lambda}_n) = 0$.

Checking the number of eigenvalues which are significantly different from zero can be implemented by the two test statistics :

$$\lambda_{trace}(r) = - T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i)$$

$$\lambda_{max}(r, r+1) = - T \ln(1 - \hat{\lambda}_{r+1})$$

where $\hat{\lambda}$ s are the estimates of eigenvalues gained from the estimated Π and T is the number of observations. If $\hat{\lambda}_i = 0$ it is clear that λ_{trace} will equal zero. However, $\ln(1 - \hat{\lambda}_i)$ will be more negative if the estimated characteristic root is further from zero, in consequence, the magnitude of λ_{trace} will be larger. Comparison of this λ_{trace} with its corresponding critical value provided in Johansen and Juselius (1990) completes the test. If the estimated value is greater than the critical value the restriction rank(Π) = r is rejected and the next test is conducted. The λ_{trace} statistic tests the null that there are less than or equal to r distinct cointegrating vectors against a general alternative. This means that rejection of the null amounts to concluding that the rank of the impact matrix will be r +1, or r +2, ..., or n. The other statistic (maximal eigenvalue, λ_{max}), tests the null hypothesis that there are r cointegration vectors against the explicit alternative (r +1). Similarly, λ_{max} will be small when the estimated values of the characteristic roots are close to zero. Note that, as Harris (1995: 89) states, some Monte Carlo studies show that the trace test statistic is more powerful than the use of λ_{max}. Nevertheless, Enders (1995: 393) says that λ_{max} is usually preferred in order to clarify the number of the cointegration vector(s) via its explicit alternative.

Lag Length and Non-modelled Components

There are some noteworthy issues associated with this procedure. First, the Johansen procedure assumes that the error terms in equation (5.15), ε_t, are Gaussian. That means, they are normally distributed and are not autocorrelated. Hence the proper lag length of y_t must be set. This subject is itself related to the presence of the variables in the model which only influence the short-run movement of the variables under consideration. This means that the component(s) of $\mathbf{D}_t$ in model (5.15) should also be determined when the length of lag is being examined (Harris, 1995: 81).

Enders (1995: 396) states that the outcomes of the test can be sensitive to the length of lagged variables due to the fact that maximum likelihood estimation used in this procedure is based upon the multivariate normality assumption. However, Holden and Perman (1995: 83) are of the opinion that this assumption is not necessary in asymptotic arguments. The Johansen procedure framework is intended to introduce sufficient lags to make sure that the error terms behave well.

To ascertain the proper lag, the VAR model (equation 5.14) is commonly used. Enders (1995: 396) suggests that the VAR model with the longest lag which seems appropriate is estimated first, then repeated estimation determines whether the lags can be shortened. Harris (1995: 81) states that lag order determination is affected by the existence of weakly exogenous variables in $\mathbf{D}_t$ in model (5.15), which though not significant in long-run relationship, are important in the short-run. In other words, in some circumstances there may be some I(0) variables which have an effect on the short-run path of the underlying variables so that the model can be conditioned on them. Incorporating variables in the model enables one to take account of the impact of short-run shocks like policy intervention and some other transitory events such as the two oil-price jumps in 1970s. In Johansen and Juselius (1992) the changes in oil prices have been included in their model for PPP using UK data and show that this conditioning makes the model residual close to normally distribution. In addition to such I(0) variables, $\mathbf{D}_t$ may include intercept, trend and seasonal dummies as well. Seasonal dummy variables are centred to guarantee that they totalize to zero through time and hence do not influence the asymptotic distributions on which the tests rely. Harris (1995: 81) states that including any other dummy variable can change the distribution of the test statistic, which in turn changes the critical values relating to the number of these kind of variables. In this situation the critical values reported in Johansen work are only indications, though they are used for testing in this procedure.

Another relevant issue is the inclusion of a constant and time trend in the model, or into cointegration space. Adding a constant in the model (5.15) permits the data generation process to have a linear time trend. Since in the long-term $\Pi y_t = 0$, it is expected that each Δy_{it} equals α_{0i} (the constant associated with ith variable in the system). Summing all such changes through time entails the deterministic term $\alpha_{0i}t$ (Enders, 1995: 387). It is also possible to restrict the constant to be included only in cointegration space. Once this is done, the linear time trend will be eliminated from the system y_t (Holden and Perman, 1995: 83 and Enders, 1995: 387). With respect to the time trend, like the constant it can be shown that the existence of a time trend in the model such as equation (5.15) leads to a quadratic trend in the process in long-run which does not seem possible. Thus the trend usually is restricted to lie only in the cointegration relationship, restricting the system to contain at most a linear deterministic trend as a result of the existence of an unrestricted constant term (Doornik and Hendry, 1994b: 73).

So far the issues relevant to estimation of the rank of the impact matrix have been considered. Before discussing an important subject concerning the uniqueness of cointegration vector(s) it seems useful to propose a model introduced by Harris (1995: 96). This model enables one to consider the number of the rank and a constant and trend which might be included in short and / or long-run jointly. For simplicity it is assumed that k = 2 and $\mathbf{D}_t$ does not comprise other variables except constant and trend. Therefore, the VECM (equation 5.5) can be rewritten as :

(5.16) $\Delta y_t = \Gamma_1 \; \Delta y_{t-1} + \alpha \, [\, \beta \;\; \mu_1 \;\; \delta_1 \,] \, \tilde{y}_{t-2} + \mu_2 + \delta_2 t + \varepsilon_t$

where $\tilde{y}_{t-2} = [\, y_{t-2} \;\; 1 \;\; t \,]$. Now four models can be examined :

1. There are deterministic terms neither in data generation process nor in the cointegration space, which means $\mu_1 = \mu_2 = \delta_1 = \delta_2 = 0$. Of course, Harris (1995) emphasises that this is unlikely to happen in practice (Model 1).
2. There is no tendency in the level of the data to move upward or downward; that means there is no linear trend and in turn the first differenced sequence has a zero mean, $\mu_2 = \delta_1 = \delta_2 = 0$. Therefore, the constant μ_1 is restricted to the cointegration vector(s) (Model 2).
3. There is a drift term (linear trend) in the nonstationary data but it is assumed that the constant in the cointegration space is cancelled by the drift term in the short-run model, so $\delta_1 = \delta_2 = 0$ and in the estimation, μ_2 incorporates μ_1 (Model 3).
4. There is no quadratic trend in the level of the data which means the short-run model does not include a time trend. However there is some unknown long-run exogenous growth which is not explained by the model. Thus a time trend is restricted to the cointegration space. So in this case $\delta_2 = 0$ and the constant of cointegration vector(s), μ_1 is cancelled out by μ_2 , the intercept of the short-run model (Model 4).

Apart from the model 1 which is unlikely to occur, all models 2-4 are estimated and the estimates of λ_{trace} and λ_{max} are ordered from the most restricted alternative which is the case of $r = 0$ and Model 2, to the least restrictive case, which means $r = (n-1)$ and Model 4. Then the results are compared with the corresponding critical values and the test stops only when the null hypothesis cannot be rejected.

The Uniqueness Test

As Doornik and Hendry (1994b: 75) state the Johansen approach estimates a set of cointegration vectors representing cointegration space. Thus any linear combination of these estimated vectors makes a new cointegration vector . However, the matter of interest is to determine a unique set of cointegration vectors associated with an economic theory. Otherwise, the estimated cointegration vectors as Harris (1995: 95) points out , do not provide any information about the long-run economic relationships. Alternatively expressed, in order to interpret the cointegration vectors there must be a unique set of estimates for any individual column in β. Since the reduced rank regression approach only determines the number of unique stationary combinations which span the space of cointegration, and any linear combination of these stationary combinations is itself stationary , the interesting combination(s) can not be obtained straightforwardly. In sum "*... the Johansen approach only provides information on the uniqueness of the cointegration space, it is necessary to impose restrictions motivated by economic arguments to obtain unique vectors lying within that space.*" (Harris, 1995: 110). In fact, in this procedure, the rank of $\alpha\beta'$, the impact matrix, can only be determined while identification of specific elements of α and β requires the imposition of arbitrary constraints (Dickey et al , 1995: 24).

Following Harris (1995: 98) the implications of imposing restrictions on α and β can be indicated. As has been discussed above, $\Pi = \alpha\beta'$ contains two kinds of information; while β consists of the coefficients of the long-run relationship, α shows the speed of adjustment from disequilibrium. Moreover, it has been also shown that when $r \leq (n-1)$ cointegration vectors exist in β , this amounts to the existence of up to (n-1) zero columns in α. In consequence, the problem of determining r, number of cointegration vectors, is equivalent to examining how many columns of α are zero.

Based upon this description, the role of non-zero columns of α can be clarified; each non-zero column of α shows which cointegration vector affects which short-run path and how fast is the speed of effect. For example, if r = 1 and :

$$y_t = [\, y_{1t} \;\; y_{2t} \;\; x_t \,]'$$

then : $$\alpha = [\alpha_{11} \;\; \alpha_{21} \;\; \alpha_{31}]'$$

because other (n-r) = 2 columns of α will be zero. Consequently, there is a single long-run relationship represented by $(\beta_{11}y_{1t-1} + \beta_{21}y_{2t-1} + \beta_{31}x_{t-1})$ and α_{21}, for instance, corrresponds to the cointegration vector in modelling Δy_{2t}: this variable adjusts to disequilibrium with the speed of α_{21}. As an another example, the case r = 2 and k = 2 can be also explained in full VECM model :

$$\begin{bmatrix} \Delta y_{1t} \\ \Delta y_{2t} \\ \Delta x_t \end{bmatrix} = \Gamma_1 \begin{bmatrix} \Delta y_{1t-1} \\ \Delta y_{2t-1} \\ \Delta x_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \\ x_{t-1} \end{bmatrix} + \varepsilon_t$$

If $\alpha_{31} = \alpha_{32} = 0$ then neither of the two cointegration vectors enter into the equation for Δx_t so it contains no information about the long-run relationships. More generally, the existence of *all* zero α_{ij} , j = 1, 2, ..., r, for row i shows that the long-run vectors are not included in Δy_{it}. In such a case, weak exogenity to the system is acceptable for Δy_{it} and this variable can be transferred to the right-hand side of VECM. Not modelling Δy_{it} does not lead to loss of any information, though it remains in cointegration space.

Regarding β, what is interesting from an economic theory point of view is that some particular relation between variables in long-run can be examined, for example proportionality or a special size or sign of the coefficients motivated by theory. Restrictions such as $\beta_{11} = - \beta_{21}$ and $\beta_{31} < 0$ are two cases in point.

Enders (1995: 393) believes that the most attractive view of the Johansen approach is that it permits the restricted forms of cointegration vector(s) to be tested straightforwardly. The important point to understand, is that imposing constraints must not decrease the number of stationary combinations of the variables. In other words, if r cointegration vector(s) exist the restrictions do not jeopardise the stationarity of these r combinations and all remaining linear combinations stay nonstationary. Consequently, if the restricted form is estimated, the corresponding eigenvalues are ordered $\hat{\lambda}^*_1 \rangle \hat{\lambda}^*_2 \rangle ... \rangle \hat{\lambda}^*_r$ and the unrestricted eigenvalues $\hat{\lambda}_1 \rangle \hat{\lambda}_2 \rangle ... \rangle \hat{\lambda}_r$, then (for the validity of the restrictions) all values of $\ln(1 - \hat{\lambda}^*_i)$ should be insignificantly different from $\ln(1 - \hat{\lambda}_i)$. The statistic:

$$- T \sum [\ln(1 - \hat{\lambda}^*_i) - \ln(1 - \hat{\lambda}_i)]$$

asymptotically has a χ^2 distribution. The degrees of freedom are equal to the number of constraints imposed on β and α. The null hypothesis is the validity of restrictions, which can be rejected if the estimated χ^2 statistic exceeds the corresponding amount of the critical value.

5.5.4 Seeking a Long-run Relationship in the Model

Based on the analysis in the previous section, and bearing in mind the whole model, three long-run relationships may exist among the variables as far as the cointegration test is concerned :

1. Corresponding to the price equation (4.12), since in the long-run $(m_{t-1} - p_{t-1}) = (m_t - p_t)$ a cointegration relation may exist among real money stock, real income and the expected rate of inflation : $(m - p)$, y, π.
2. Regarding the income equation (4.13), for the same reason there may be a long-run relationship between real income , real oil income and real government expenditure: y, oy, $(g - p)$.
3. With regard to the government revenue equation (4.14), as R and OR are in nominal terms and $(\log Y_t + \log P_t)$ is also nominal income, dividing the two sides by price, there may be a long-run relation between real government revenue, real oil-induced government revenue and real income : rr, ror, y.

Concerning the money equation and the equation for the expected rate of inflation (eqs. 4.15 and 4.16), the former is derived from the definition of the money stock and is an identity, and the latter is specified by the assumption of adaptive expectations. Thus, it does not need to be tested for existence of a long-run relationship.

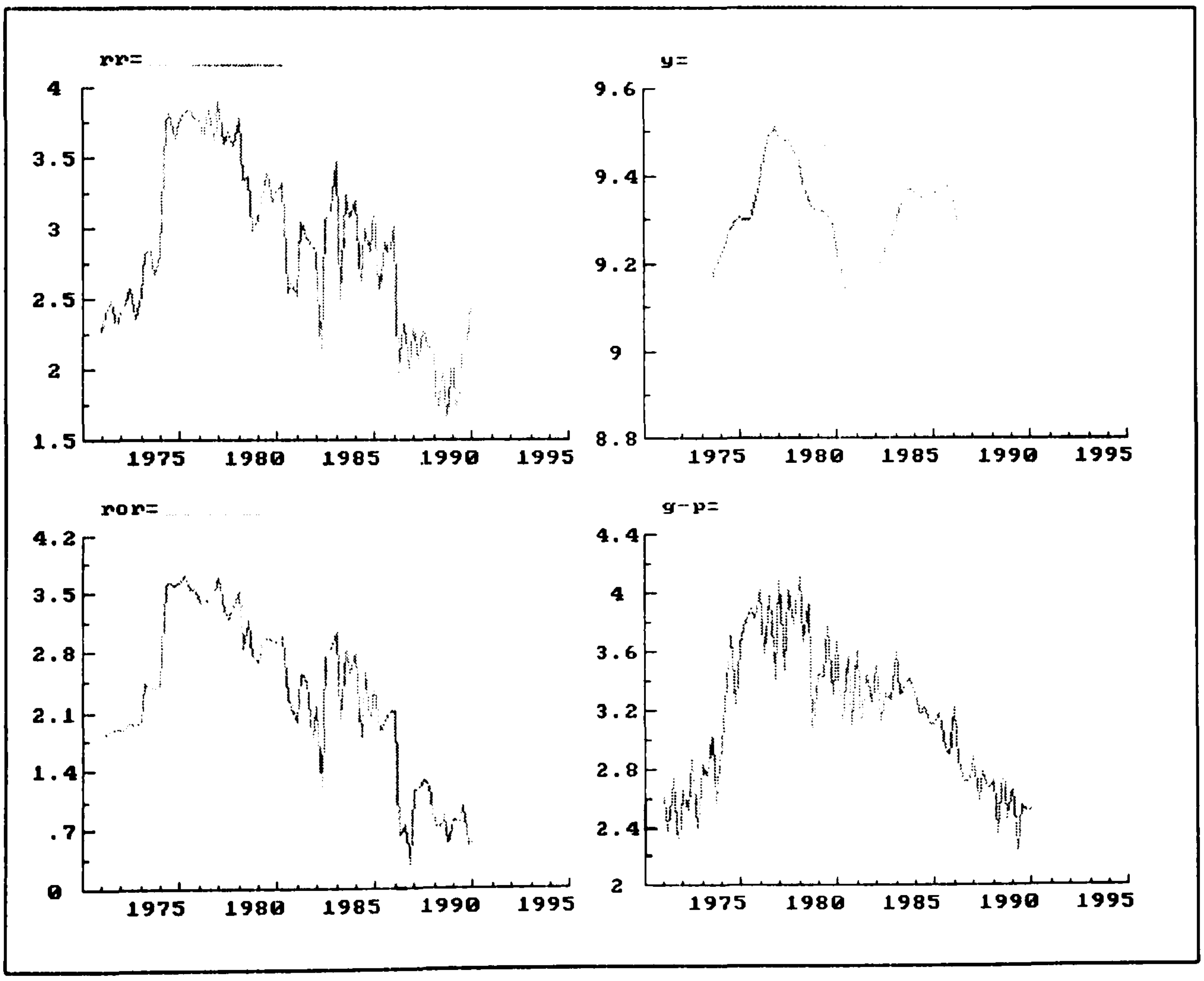
The first stage of the cointegration test is identification of the order of integration of the variables. In the previous section we saw that all the variables are I(1). Given this, the tests continue for possible long-run relationships among the three sets of variables mentioned above individually. We do not use one big VAR to seek cointegration relationships because the associated tests would have very low power.

Long-run Relation(s) Among y, (g-p) and oy

First , the existence of cointegration vector(s) between real income, real oil income and real government expenditure is considered. The model is treated as a system represented by a VAR with five lags on each of y, oy and (g-p), plus a constant imposed onto cointegration space: equation (5.15) with $k = 5$ and D_t contains only an intercept imposed onto cointegration vector(s). In other words, the model is represented by equation (5.16) with $\mu_2 = \delta_1 = \delta_2 = 0$. This seems appropriate because there are linear trends in the level of the data; in other words, the first-differenced data have a zero mean (Figure 2). This is the first practical model according to Harris (1995: 96). The length of lag is selected by starting at eight lags on every variable and testing sequentially from the highest order conducted until $k = 4$ to be sure about lag specification. In other words, in a small sample over-rejection is a problem in Johansen approach which worsens when the order of lag increases (Reimers, 1992), thus, the parsimonious principle has to be adopted.

The well-behaved residual of the model with five lags implies it is probably specified correctly (but an autocorrelation problem appears with $k = 4$). However, the cointegration test indicates there is no long-run relationship between the variables, in other words, $r = 0$, which means all three vectors are nonstationary. Inspecting the plots of these variables (depicted in Figure 3) suggests there might well be a structural break around 1976. There are some analytical reasons which confirm this suspicion. After the windfall induced by oil price jump in 1973, government expenditure and imports sharply increased. These increases were not consistent with the absorptive capacity of the economy. Consequently, after two or three years increasing prices reversed the path of government expenditure. Bottlenecks and shortages of infrastructure began to constrain production. In addition, world price increases, affected by the oil price rise, reduced oil income which in turn, put new pressures on production. Likewise, the increase of world prices aggravated domestic inflation, worsening government real revenue, which had started to decrease earlier. For the first time in the period the government experienced a sizeable budget deficit (which has continued thereafter) because the decline of revenue was faster than that of expenditure.

Figure 3 : Structural Break in some variables of the model



In accordance with this analysis, supported by the plots, appropriate dummies will enter into the model. Analogously to the work of Perron (1995) in unit root test context, the VECM changes to :

$$(5.17) \qquad \Delta y_t = \sum_{i=1}^{5} \Pi_i \Delta y_{t-i} + \Pi y_{t-5} + \delta \boldsymbol{DU}_t + \lambda \boldsymbol{DT}_t + \varepsilon_t$$

where ***DU*** = 1 and ***DT*** = t - T_1, if t > T_1 and are zeros otherwise. T_1 is the break time, the second quarter of 1976, y_t = [y_t $(g\text{-}p)_t$ oy_t]' and Π contains constant terms. Encompassing these dummies leads to the cointegration test showing the expected relationship. Estimating equation (5.17) and using diagnostic checking generate the results summarised in Table 5. These tests have been conducted because before the cointegration test the residuals being white noise must be demonstrated.

The diagnostic tests involve *F*-test for the null that the coefficient of the i-period lag ($F_{k=i}$) is zero; that there is no error autocorrelation (F_{au}, from lag 1 to 5); that there is not autoregressive conditional heteroskedasticity (F_{arch}, from lag 1 to 4); that there is no heteroskedasticity (F_{het}); and finally a χ^2-test for normality. The results for the system are labelled as "multivariate tests". F_{un}-statistics also show the significance of the regressors in $\mathbf{D}_t$.

Table 5: Model Evaluation Diagnostics: y, g-p, oy

Statistic	y	(g-p)	oy
$F_{k=1}(3, 52)$	143.95**	0.861	78**
$F_{k=2}(3, 52)$	30.72**	1.35	18.05**
$F_{k=3}(3, 52)$	9.68**	0.732	7.29**
$F_{k=4}(3, 52)$	3.42*	6.34**	4.39**
$F_{k=5}(3, 52)$	1.52	1.13	2.84*
F_{au} (5, 49)	2.44*	1.35	1.11
$F_{arch}(4, 46)$	0.91	1.8	3.51*
$F_{het}(30, 23)$	0.77	0.73	1.89
$\chi^2_n(2)$	5.78	2.21	42.35**
Multivariate tests: F_{au} (45, 110) = 1.3, F_{het}(180, 114) = 0.62, $\chi^2_n(6)$ = 71.66**, F_{un}(48, 155) = 1430.3**			

Table 5 introduces a significant fifth lagged-value for oy, therefore five lags of all the variables enter into the model, owing to the necessity of a similar lag in the cointegration analysis (Harris, 1995: 82). The other diagnostic results introduce an acceptable model with respect to the residuals being white noise. Single equation diagnostics indicate the normality problem for oy, oil-GDP. However, according to the argument of Johansen and Juselius (1992) non-normality of a variable is not important if its weak exogeneity can be proved, as is the case for oy (See below). Applying the Johansen approach to a reduced rank regression leads to the results cited in Table 6[71]. This Table shows the various hypotheses tested, from no long-run relationship or no cointegration, r = 0, to the highest rank. r = 2 which means that there are two cointegration vectors. The rank hypotheses are represented in column 1. The

Table 6 : Tests of cointegration rank on y, oy, (g-p)

$H_0 : r$	$\hat{\lambda}_i$	$\hat{\lambda}_{max}$	Adjusted	95%	$\hat{\lambda}_{trace}$	Adjustd	95%
r =n-3=0	0.265	22.21*	17.58	22.0	46.89**	37.12*	34.9
r ≤n-2=1	0.239	19.69*	15.59	15.7	24.68*	19.54	20.0
r ≤n-1=2	0.067	4.993	3.953	9.2	4.993	3.953	9.2

various characteristic roots (eigenvalues) corresponding to three combinations of I(1), levels of the underlying variables, are ordered from highest to smallest in column 2. The maximal eigenvalue statistics are reported in column 3 and their adjusted values (described below) are reported in the next column. The corresponding critical values of $\hat{\lambda}_{max}$ are shown in column 5. Columns 6-8 are related to the trace statistic.

The associated eigenvectors (β') are represented in the rows of Table 7, and the corresponding adjustment coefficients (α) are reported in the columns of Table 8.

Table 7 : Normalised Characteristic Vectors, β'

	y	(g-p)	oy	constant
β_1'	1.000	-0.278	-0.191	-6.794
β_2'	-5.099	1.000	1.272	32.13
β_3'	-0.18	-0.394	1.000	-5.245

71 Here PcFiml 8.0 is used, the approach in which determining the rank and related cointegrating vectors is based upon Johansen (1988).

Table 8 : Adjustment Coefficients, α for y, (g-p) and oy

	α_1	α_2	α_3
y	-0.066	-0.003	-0.004
(g-p)	0.474	-0.268	0.02
oy	0.226	-0.011	-0.045

Table 6 indicates that the $\hat{\lambda}_{max}$ and $\hat{\lambda}_{trace}$ statistics are significant at 5% level testing the null hypotheses r =0 and r ≤ 1 but insignificant for r ≤ 2. In other words, r ≤ 1 is rejected while r ≤ 2 is not, therefore it seems there may be two cointegration vectors. However, Reimers (1992) by Monte Carlo investigation points out that in small samples the Johansen approach over-rejects null hypotheses and states that this problem can be remedied by a modification proposed by Reisel and Ahn (1988). Their suggestion of using (T - nk) rather than T adjusts the test statistic consistent with small samples, where, T is sample size, n is number of the underlying variables and k is lag order. Using the adjusted values of the test statistics, only r = 0 is rejected according to the trace-test statistic whilst r ≤ 1 is not, that means there is one cointegration vector. Consideration of the columns of α reported in Table 8, confirms this conclusion. As mentioned above if r = 1 the last n - r = 2 columns of α should be insignificantly small, which is the case in the columns α_2 and α_3 in Table 8. Moreover, imposing a restriction r = 2 changes the impact matrix, Π more than when r = 1 is imposed, that implies that r = 1 is preferable (Doornik and Hendry, 1994b: 78).

The approach terminates with exogeneity tests on (g-p) and oy which implies the uniqueness of the cointegration vector. Imposing the two rows restrictions $\alpha_i = 0$, for i = 2 and 3 gives rise to a LR-test, $\chi^2(2) = 1.09$ which strongly confirms the validity of the restrictions. Thus, real national income in the long-run is described by real government expenditure and the real oil sector income as:

$$y = 6.95 + 0.3\ (g\text{-}p) + 0.17\ oy$$

with a new restricted value of adjustment coefficient α_{11} = -0.07. The details of the tests are provided in Appendix 6.

Long-run Relationship Between rr, ror and y

Analogous to the previous section, equation (5.15) with an intercept imposed onto cointegration space has been used to examine whether any cointegration vector exists for real government total revenue (rr), real government oil-induced revenue (ror) and real income (y). A zero mean of the first-differenced variables (Figure 2) confirms the appropriateness of the model (Harris, 1995:96). The lag-length is k = 4, determined by diagnostic checking. It seems there is a structural break during 1974. The earlier break time in the path of real oil revenue and total revenue relative to the previous model is not unexpected. As discussed in the theoretical analysis, in developing countries there are credible reasons why increasing price affects revenue faster than expenditure. In developing countries, the tax system has a low nominal income elasticity and taxes are paid with long lags (Aghevli and Khan, 1978). Furthermore, in Iran's case, a considerable part of the revenue is oil revenue which is an exogenous variable (as discussed below). In consequence, the impact of increasing prices on revenue commenced earlier than other variables like income and government expenditure (Figure 3).

The model evaluation diagnostics are set out in Table 9. Single equation tests indicate plausible results. Although the income equation shows autocorrelation even with four lags the desired outcomes of the multivariate tests introduce uncorrelated normally distributed residuals for the whole system. The significant fourth lagged-value for y persuades us to enter the same lagged values of the two other variables into the model in keeping with the need for equal lag-lengths in a cointegration context.

Cointegration tests generate the outcomes summarised in Tables 10-12. Table 10 indicates that by examining the adjusted maximal eigenvalue test statistic ($\hat{\lambda}_{max}$) and the adjusted trace statistic ($\hat{\lambda}_{trace}$) at the 5 percent level the

Table 9: Model Evaluation Diagnostics; rr, ror, y

Statistic	rr	ror	y
$F_{k=1}(3, 56)$	2.2	3.47*	180.84**
$F_{k=2}(3, 56)$	1.1	1.92	38.73**
$F_{k=3}(3, 56)$	2.74	1.38	15.59**
$F_{k=4}(3, 56)$	0.77	0.052	9.02**
F_{au} (4, 54)	0.85	0.28	3.74**
$F_{arch}(4, 50)$	0.12	0.48	2.44
$F_{het}(24, 33)$	0.74	1.55	0.64
$\chi^2_n(2)$	8.27*	4.07	1.99
Multivariate tests: $F_{au}(36, 130) = 1.27$, $F_{het}(144, 171) = 0.84$, $\chi^2_n(6) = 6.9$, $F_{ur}(39, 166) = 384.64$**			

hypothesis of no cointegration vector, r = 0, is strongly rejected but r ≤ 1 is not. Thus, it can be concluded that there is one cointegration vector among the three variables justified by the two last relatively small eigenvalues ($\hat{\lambda}_2, \hat{\lambda}_3$). The small magnitudes of the elements of α (α_2 and α_3 in Table 12) is another reason.

Table 10 : Tests of cointegration rank on rr, ror, y

H_0 : r	$\hat{\lambda}_i$	$\hat{\lambda}_{max}$	Adjusted	95%	$\hat{\lambda}_{trace}$	Adjusted	95%
r =n-3=0	0.388	35.85**	29.96**	22.0	58.62**	48.98**	34.9
r ≤n-2=1	0.195	15.85*	13.24	15.7	22.77*	19.02	20.0
r ≤n-1=2	0.090	6.917	5.78	9.2	6.917	5.78	9.2

According to Table 11 and corresponding to the first eigenvalue, the long-run relationship is :

$$rr = -4.5 + 0.3\, ror + 0.7\, y$$

Table 11 : Normalised Characteristic Vectors, β'

	rr	ror	y	constant
β_1'	1.000	-0.300	-0.697	4.456
β_2'	-1.466	1.000	1.791	-14.67
β_3'	0.499	-0.527	1.000	-9.250

Table 12 : Adjustment Coefficients, α

	α_1	α_2	α_3
rr	-1.353	0.059	0.0017
ror	-1.464	-0.181	0.473
y	-0.007	-0.021	-0.015

and the adjustment coefficient in the short-run model is α_{11} = -1.35 (Table 12). The results are consistent with the predicting of the theoretical analysis.

Testing for weak exogeneity of y and ror in this model shows that y is weakly exogenous but ror is not. In other words, the row restriction $\alpha_{ij} = 0$, for i = 3 and j =1,2 is not rejected while the two rows restriction $\alpha_{ij} = 0$, for i = 2,3 and j =1,2 is rejected. Likewise, thr row restriction for i = 2 and j = 1,2 corresponding to weak exogeneity of ror is rejected, that in turn means, the weak exogeneity assumption about y is valid while as for ror weak exogeneity does not seem acceptable. In other words, in the long-run the real oil-induced revenue depends on total revenue.

However, actual evidence confirms that government oil-induced revenue should be exogenous in this model. As mentioned in chapter 3 the oil revenue of the government is the oil export earning equivalent in Rials. Oil production of the country is limited by the decision of the Organization of Petroleum Exporting Countries, OPEC, and oil prices are determined in world markets. Therefore, in a fixed exchange rate regime, which was the case in Iran, it is obvious that oil revenue has been determined exogenously. Here, it seems worth considering a question about the production of oil, that is whether the government has decided the volume of oil production according to its earning policy based on the OPEC Quota system. In that case the oil revenue would have depended on total revenue. However, the government during the period, had continuously attemped to produce as much as possible up to Quota amount, though in some periods the Iraq - Iran war presented new limitations. The reason was that even with full production a high budget deficit was experienced owing to the huge expenditure. In consequence, the weak exogeneity of oil revenue can confidently be concluded analytically.

Some reason can be proposed in order to interpret the contradictory econometric result. Total revenue defined as a sum of non-oil revenue and oil revenue in other words, there is an identity like :

$$R = \gamma_1 \, OR + \gamma_2 \, NOR$$

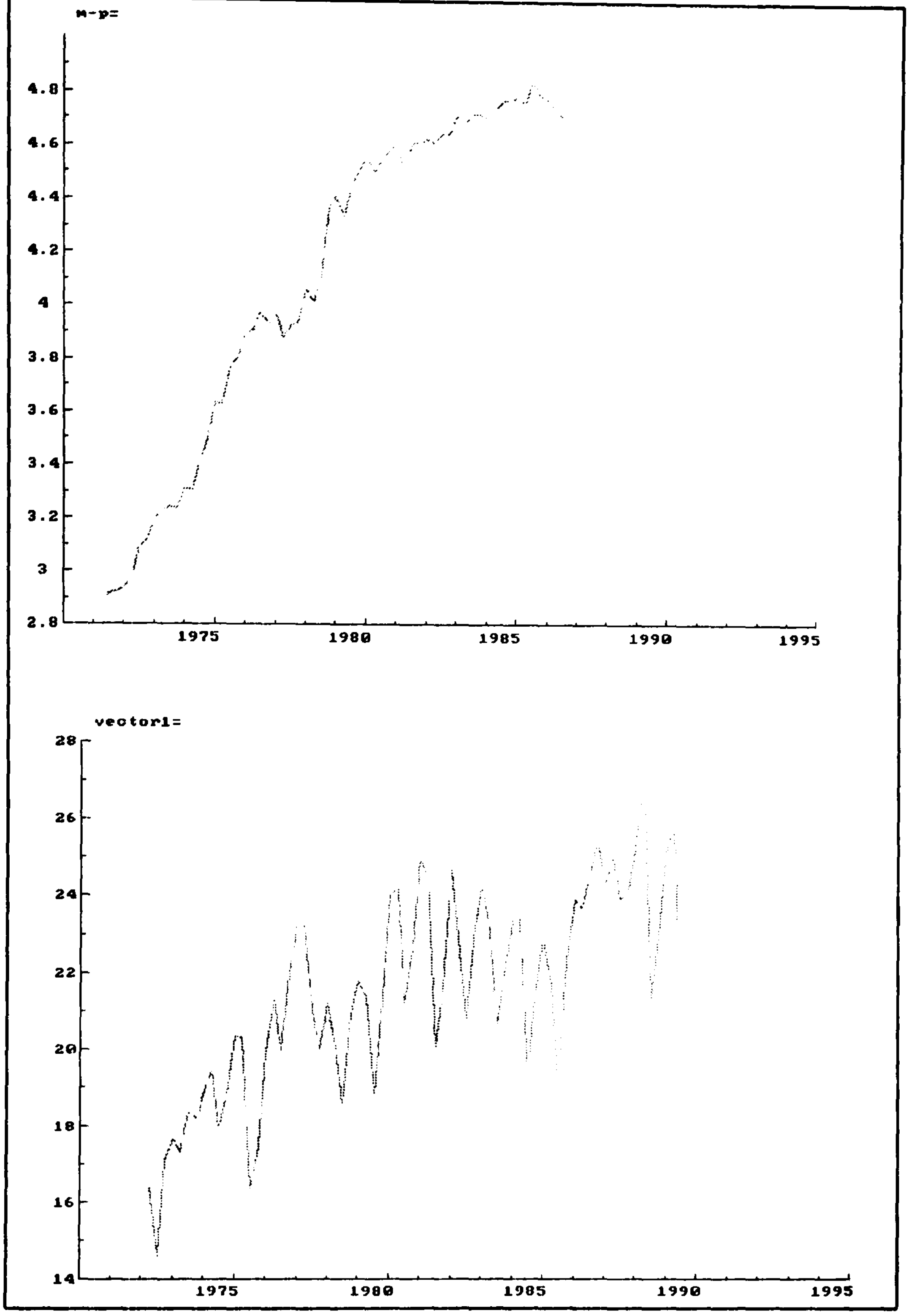
In an identity it is not surprising that the variables show two sides dependent in an econometric sense. Appendix 7 proposes detailed associated tests.

Long-run Relation Among (m-p), π and y

In this section the existence of a long-run relationship between real money balances (m-p), the expected rate of inflation (π) and real income (y) is investigated. Following the proposed procedure, equation (5.15) is applied but with an unrestricted constant and a trend imposed onto the cointegration space, the fourth model suggested by Harris (1995: 96). This is preferred because contrary to the two previous cases the first-differenced series do not have a zero mean but show a downward trend. Additionally, since π is I(0) it is regarded non-modelled and entered in the cointegration space (Banerjee et al, 1994). Diagnostic checking of the model indicates a high serial correlation between the residuals.

However, inspecting the path of real money balance and also the long-run graph (Figure 4) persuades one to consider a structural break around 1980. There seems to be some acceptable reason for this suspicion. After the Islamic revolution, the new government came into power in 1979. Revolutionary circumstances with significant implementation like comprehensive nationalisation induced uncertainty to dominate private economic activities.

Figure 4: Real Money Path and Cointegration Vector (First Model)



Iraq's invasion in 1980 and the partial occupation of several border provinces including the important oil province, Khozestan, worsened the uncertainty. In addition, as vital military and non-military merchandises had to be met by import, real foreign assets decreased more than 5-fold during the post-war period. The banking system's claim on the private sector reflects uncertainty . In real terms claims were Rials 40.4 bn at the first quarter of 1971, increased at an average rate of 15.5 per cent per year to 148.1 bn the first quarter of 1980 but decreased during the following decade ending 1990, at an annual rate of

-3.7 per cent to Rials 101.8 bn. Regarding narrowly defined money, M_1 which is the definition used inthe model, Table 13 illustrates the growth rate of high-powered money's components in the two subperiods. The claims of central bank on the banking system and foreign assets display negative changes and government obligations, although remaining positive, decline sizeably. That is why a structural break in 1980 seems acceptable.

Table 13 : Annual growth rate of M_1's components 1980-1988 (%)

M_1	Pre-war Period 1971-1980	Post-war Period 1980-1990
Banks Obligations	18.1	-12
Foreign Assets	33	-16.5
Govt. Obligations	16.6	6.7

Entering the break dummies into the model removes the autocorrelation problem. Six lags are chosen for the variables. Although the sixth lag seems insignificant, if it is omitted autocorrelation problems again arise. Owing to the complex interrelation between the variables, in an unrestricted statistical system a low t-ratio does not always mean the corresponding variable is redundant and can be eliminated (Harvey, 1990:113). As Gonzalo (1994) points out , choosing too long a lag does not lead to lower efficiency of maximum likelihood estimation (MLE) but using too short a lag makes MLE no longer the best method. The results of the diagnostic checking are summarised in Table 14.

The cointegration test results are set out in Table 15-17. According to Table 15 both criteria, maximal eigenvalue and trace test ($\hat{\lambda}_{max}$ and $\hat{\lambda}_{trace}$) strongly reject the hypothesis of no cointegration vector, r = 0, and since their corresponding values do not reject the hypothesis r = 1 or r ≤ 1 respectively, that means there is one cointegration vector. Relatively small values for the second eigenvalue and the elements of the corresponding column of α (α_2 in Table 17) confirm this conclusion. Table 16 represents the normalised eigenvectors (β') associated with the rank of the impact matrix. Uniqueness of the cointegration vector is validated by a test of weak exogeneity of real income in this context. In other words, one row restriction is placed on α. The

Table 14 : Model Evaluation Diagnostics; m-p and y

Statistic	m-p	y
$F_{k=1}(2, 53)$	18.975**	235.857**
$F_{k=2}(2, 53)$	0.515	52.141**
$F_{k=3}(2, 53)$	0.704	19.675**
$F_{k=4}(2, 53)$	3.034	8.679**
$F_{k=5}(2, 53)$	2.231	4.098*
$F_{k=6}(2, 53)$	0.215	2.177
$F_{ar}(6, 48)$	4.02**	0.620
$F_{arch}(4, 46)$	0.358	1.764
$F_{het}(31, 22)$	0.54	0.61
$\chi^2_n(2)$	23.32**	4.57
Multivariate tests: $F_{ar}(20, 86) = 1.22$, $F_{het}(174, 137) = 0.63$, $\chi^2_n(4) = 28.75$* $F_{ur}(32, 106) = 573.76$**		

outcome indicates the validity of the restriction. Consequently, according to the reduced and final form of β there is a long-run relation among the variables with an adjustment coefficient $\alpha = -0.28$ as:

$$(m\text{-}p) = 0.106\ y - 5.679\ \pi + 0.05\ t + 2.06\ DU - 0.056\ DT$$

Table 15 : Tests of cointegration rank on (m-p), π and y

H_0 : r	$\hat{\lambda}_i$	$\hat{\lambda}_{max}$	Adjusted	95%	$\hat{\lambda}_{trace}$	Adjusted	95%
r =n-2=0	0.365	32.2**	26.76**	19.0	43.52**	36.16**	25.3
r ≤n-1=1	0.147	11.31	9.40	12.3	11.31	9.40	12.3

Appendix 8 details the related tests.

Concluding the cointegration discussion, it seems that there is a long-run relationship among every set of the variables involved in each equation of the model. Thus, the whole model can be estimated without worrying about spurious regression problems.

Table 16 : Normalised Characteristic Vectors, β'

	(m-p)	y	π	trend	DU	DT
β_1'	1.000	-0.062	5.734	-0.05	-2.053	0.056
β_2'	0.025	1.000	1.316	0.001	0.167	-0.008

Table 17: Adjustment Coefficients, α

	α_1	α_2
(m-p)	-0.284	0.049
y	0.019	-0.038

5.6 Model Estimation

As discussed in chapter 4, the chosen model contains five behavioural or definitional equations:

$$p_t = -\lambda a_0 - \lambda a_1 y_t + \lambda a_2 \pi_t - (1-\lambda)(m-p)_{t-1} + m_t$$

$$y_t = \theta b_0 + \theta b_1 oy_t + \theta b_2 g_t - \theta b_2 p_t + (1-\theta) y_{t-1}$$

$$r_t = \tau t_0 + \tau t_1 or_t + \tau t_2 (y+p)_t + (1-\tau) r_{t-1}$$

$$m_t = mm_t + k_0 + k_1 g_t - k_2 r_t + k_3 e_t$$

$$\pi_t = \beta \Delta p_{t-1} + (1-\beta) \pi_{t-1}$$

where

p_t = Consumer price index, CPI

y = real income (GDP)

g = nominal government expenditure

r = nominal government revenue

m = nominal money stock

π = expected rate of inflation

oy = real income of oil sector

or = oil-induced revenue of the government

mm = money multiplier

e = remainder elements of high powered money consisting of: change in central bank claims on private sector, international reserve change, lagged value of high-powered money and error item included because ΔCG may differ from (G-R)

All the variables are in logarithms except π. The last two are derived by definition. The coefficients of the money equation, m_t are approximated by :

$$k_0 = \log[\exp(\bar{g}) - \exp(\bar{r}) + \exp(\bar{e})] \frac{1}{\exp(\bar{g}) - \exp(\bar{r}) + \exp(\bar{e})} *$$
$$[\exp(\bar{g}) * \bar{g} - \exp(\bar{r}) * \bar{r} + \exp(\bar{e}) * \bar{e}]$$

$$k_1 = \frac{\exp(\bar{g})}{\exp(\bar{g}) - \exp(\bar{r}) + \exp(\bar{e})}$$

$$k_2 = \frac{\exp(\bar{r})}{\exp(\bar{g}) - \exp(\bar{r}) + \exp(\bar{e})}$$

$$k_3 = \frac{\exp(\bar{e})}{\exp(\bar{g}) - \exp(\bar{r}) + \exp(\bar{e})}$$

Thus the money stock equation is:

$$m_t = mm_t - 4.34 + 0.19\, g_t - 0.149\, r_t + 0.95\, e_t$$

and the equation for expectated inflation, based on Cagan approach (see 5.3), is calculated as :

$$\pi_t = 0.9\Delta\, p_{t-1} + 0.1\, \pi_{t-1}$$

In return, only the first three equations should be estimated. As they depend upon one another contemporaneously, it is a simultaneous equations model.

The concept of simultaneous equations, as Judge et al (1985:563) state, has emerged from the fact that in reality usually all variables are independent: it is difficult to isolate a specific relation while the associated data are so frequently passively generated. Contrary to single equation models, which address one-way causality, in a simultaneous equations system the variables are jointly determined. In other words a variable which appears in an equation of a system as an explanatory variable must contemporaneously be described by some other dependent variable(s) of the system. That means the current and past values of endogenous variables of a system have a role in explaining each other's behaviour.

To introduce the method of estimation of simultaneous equations with which this thesis is concerned, following Harvey (1990: 280), Hendry and Doornik (1994) and Doornik and Hendry (1994b:chp8), a general-to-specific approach is applied. This approach begins with a statistical system defined in terms of all the variables, both modelled and non-modelled, along with their lag polynomials :

$$(5.18) \qquad \mathbf{y}_t = \sum_{i=1}^{r} \Pi_{1i} \mathbf{y}_{t-i} + \sum_{j=0}^{q} \Pi_{2j} \mathbf{z}_{t-j} + \mathbf{v}_t, \quad \mathbf{v}_t \sim \mathbf{N}(\mathbf{0}, \Omega) \qquad \text{for } t = 1, \ldots, T$$

(5.18) represents a general unrestricted dynamic system which contains all the variables of interest. Under certain conditions, this system can be used as a baseline to construct the econometric model. An econometric model is a set of simultaneous structural equations which are regarded as a descriptive model of the system. This structure can be defined as a set of essential invariant characteristics of the economic mechanism. The existence and identification of such a structure is an unresolved issue in econometrics. However, it is argued that the model derived from the statistical system can describe the structure (provided, of course, the reduction procedure is carried out successfully).

The most important point in the procedure is that the system is congruent. This is necessary for both subsequent simplification and model evaluation.

Congruency for equation (5.18) requires that:

(i) $\mathbf{v}_t$ is a homoscedastic white noise process.

(ii) $\mathbf{z}_t$ contains variables which are weakly exogenous to the parameter of interest, Π

(iii) all parameters of interest are constant (Hendry et al. 1988:207)

As the system (5.18) has only predetermined variables as explanatory variables it can be estimated by OLS, obtaining consistent estimates. Then to ensure congruency the following procedures must be conducted:

1) The first requirement can be met by specifying a long enough lag structure. Selection of lag lengths r and q are data based or *a priori* or a mixture of the two. Here, in a statistical model, parsimony is not as important as ensuring that the residual is a white noise process (Hendry et al, 1988:208). It is worth notting that the system need not contain all lagged values (Doornik and Hendry, 1994b:169).
2) The weak exogeneity of $\mathbf{z}_t$ can be addressed within the cointegration discussion. It is necessary to mention that estimation of the system by OLS is valid if the variables involved are integrated of order zero, I(0) or cointegrated. It is assumed that the integration and cointegration issues have already been addressed.
3) Regarding constancy of the parameters, Hendry and Doornik (1994:3) state that recursive estimation has had a central role in many recent empirical investigations. In order to avoid a huge set of information as a result of recursive estimation, they recommend inspection of the associated graphs. Graphical analysis provided in this work is used to examine parameter constancy (Doornik and Hendry, 1994a: 141). Harvey (1990: 159, 152-53) suggests inspection of the cumulative sum of squares (CUSUMSQ) plots as a way of testing heteroscedasticity and parameter constancy. This is similar to the tests provided in this work (Doornik and Hendry, 1994b: 268) [72].

Given congruency of the system, the dimension of the system can be reduced. This transformation reduces the dependency of the estimated system on the sample size and increases its invariance to change (Hendry and Doornik, 1994:22).

Once all this is done, the econometric model can be constructed to separate the autonomous relations, based on an economic theory with interpretable parameters. This is only possible if some restriction is imposed on

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[72] Furthermore, Kmenta (1990: 269) states that " *unless there are some special circumstances or the time period covered is very long, the assumption of homoscedasticity in aggregate models seems plausible* ".

Π_1 and Π_2 in (5.18). In other words, a restricted representation emerging from a congruent unrestricted system is an econometric model which has an economic interpretation and is in harmony with the relevant theory. A likelihood ratio statistic of over-identifying restrictions is a powerful way of evaluating the validity of the reduced form of the system, i.e., if the LR statistic is not rejected in the reduced form, the structural econometric model is an acceptable parameterization emerging from the VAR system (Hendry and Mizon, 1993: 273,283).

The progress can be summarised (Doornik and Hendry, 1994b: 286) as:

1) Formulation of a dynamic system.
2) Examining the integration and cointegration features of the data.
3) Transformation to a group of variables with low intercorrelations but interpretable parameters.
4) Testing the validity of the system.
5) Moving to dynamic model formulation.
6) Removing unintended regressors to obtain a parsimonious model.
7) Examining the model's validity by a complete set of tests, in particular of parsimonious encompassing through over-identifying restrictions.

5.6.1 Empirical Results

As the variables of interest are all I(1), as shown in the preceding sections, an error correction version of the system such as equation (5.15) is used :

(5.19) $$\Delta y_t = \Sigma \Pi_i \Delta y_{t-i} + \Pi y_{t-1} + \phi D_t + \varepsilon_t$$

There are two noteworthy issues :

1. Because of their significant role, integration and cointegration are discussed independently in the previous sections and the resulting model is used to combine the short-run and long-run. The system contains all the variables of the first three theoretical equations, which define price, income and government revenue. The other variables are taken as weakly exogenous with respect to the

parameters of interest for the reasons provided in the cointegration discussion.

2. Estimation of the system including expected rates of inflation results in a strange magnitude of t-statistic for expected inflation variable ($t = 154.24$). Three reasons may be suspected for this exceptional characteristic. Firstly, recalling the adaptive expectation formation:

$$\pi_t = \beta \Delta p_{t-1} + (1-\beta)\, \pi_{t-1}$$

the weight β, based on Cagan approach, is set at 0.9. This leads to the expectated inflation series being very close to actual inflation (Δp_t) which is itself a dependent variable of the system. In other words, we are almost regressing a variable on itself. In such a situation a very large t-ratio does not seem surprising. Secondly, it may be associated with a deficiency of the Cagan approach in deriving the expected rate of inflation (discussed in section 5.3). One important defect of the Cagan method is that the initial equation used to choose minimum RSS may contain nonstationary time series which leads to OLS estimation not being reliable any more. Here, the original price equation used for this purpose contains a mixed set of I(1) and I(0) variables. Thirdly, it may have arisen because of the semi-logarithmic form of the price equation in Aghevli and Khan's model in which price, money and income were presented in logs but the expected rate of inflation was in levels. This was necessary because expectation of inflation in some quarters was negative.

For these reasons, contemporaneous expected inflation is eliminated from the right hand side of the system. Figure 5 plots the time series for the dependent variables.

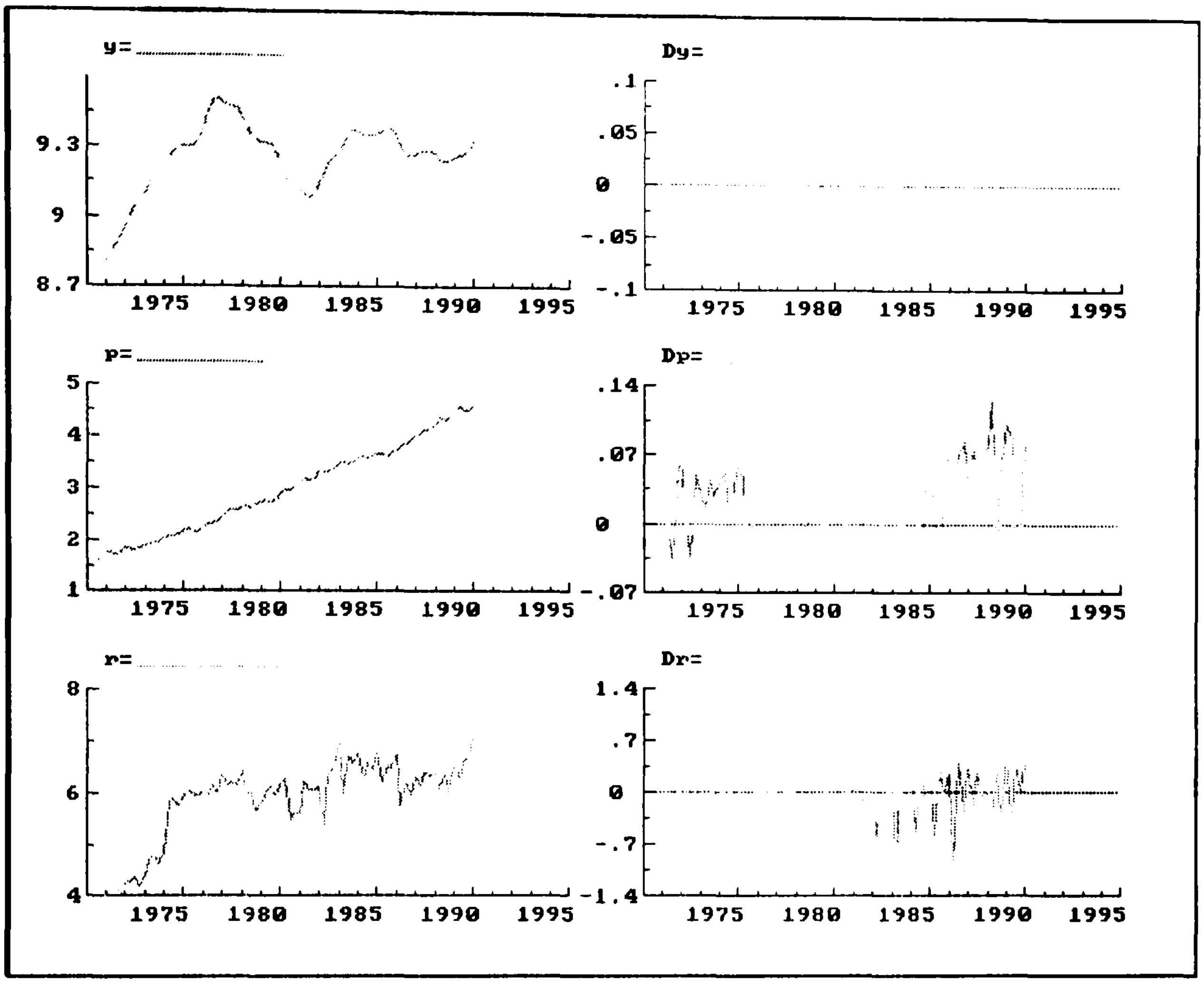
The lag length is selected by starting from 5 lags for all variables. Finally, three lags for all variables are selected (the lower lag lengths arsise autocorrelation problems) . D_t in (5.19) contains seasonals. Πy_{t-1} consists of three cointegrated combinations obtained in the previous sections:

$$CI_p \quad (m-p) + 5.679\, \pi - 0.106\, y - 2.06\, DU + 0.056\, DT - 0.05\, t$$

CI_y y - 6.95 - 0.3 (g-p) - 0.17 oy

CI_r rr + 4.5 - 0.3 ror - 0.7 y

Figure 5: Endogenous Variables of the Model



The outcomes of system 1 estimation suggest that the system is reasonably well specified. The descriptive power of the system can be viewed compactly in Figure 6, which displays fitted and actual values, their cross plots and the scaled residuals for the three equations.

Congruency requirements can be checked by considering the statistics and graphs resulting from the system 1 estimation. The statistics presented in Table 18 confirm that the residuals are homoscedastic white noise errors in each single equation and vector autocorrelation and vector normality tests show no problem[73]. Fulfilment of that requirement can also be justified by

73 The computer programme used, does not conduct a vector heteroscedasticity test if there are not a large number of observations compared with the number of the variables in the regression (Doornik and Hendry, 1994a: 336). Ours is such a case. However, according to the ARCH tests statistics (F_{arch}, reported in Table 18) the hypothesis of no autoregresive conditional heteroscedasticity fails to be rejected in every individual equation.

inspection of the graphs of single equation diagnostics for serially correlated residuals, correlograms, and normality plotted in Figure 7.

Figure 6. Fitted and actual values and scaled residuals

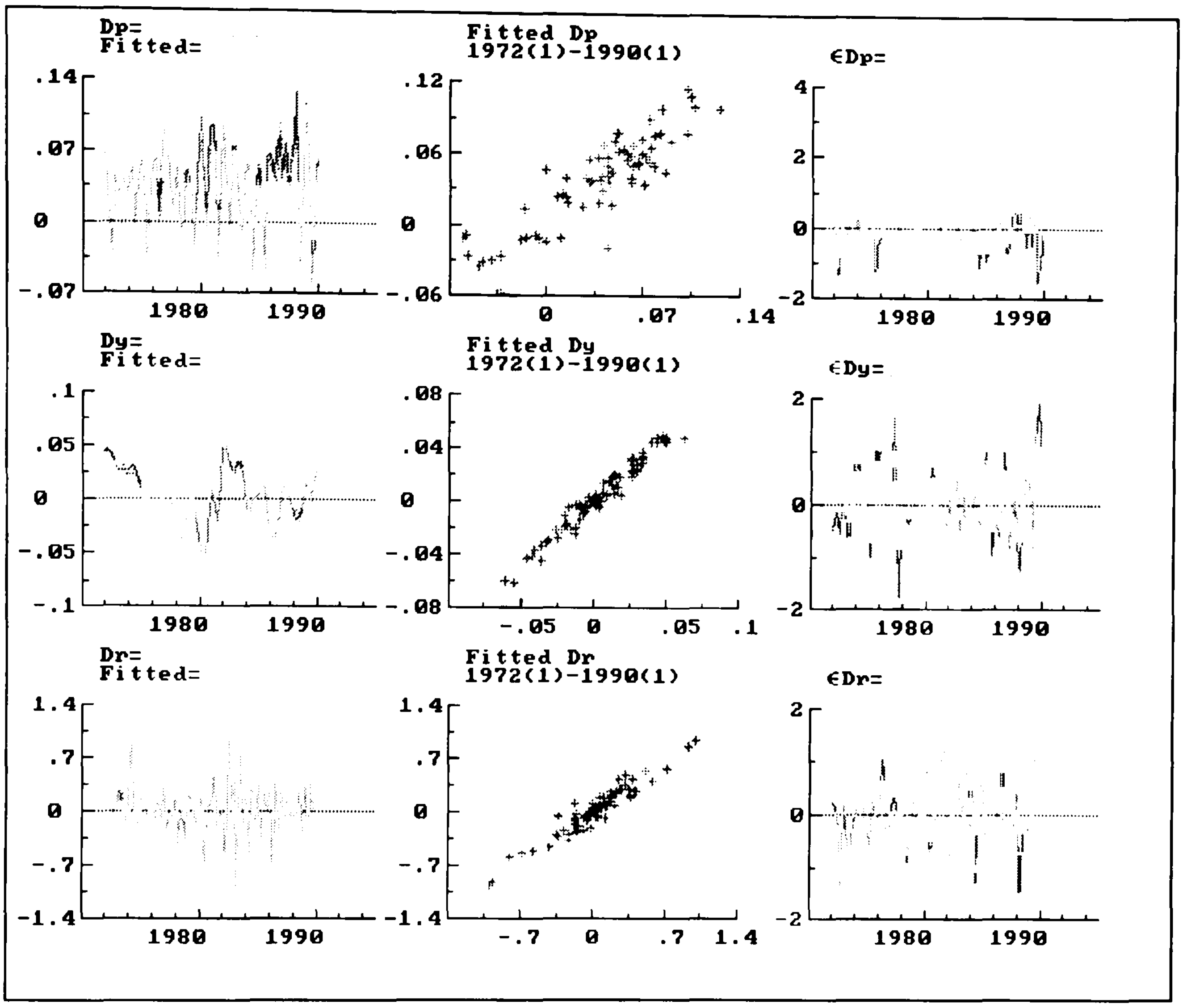


Table 18: System 1 Evaluation*

Statistic	Dp	Dy	Dr	VAR
F_{ar} (3, 35)	2.60	1.87	0.08	
F_{arch} (4, 32)	0.24	0.86	0.04	
χ^2_{nd} (2)	13.77	2.35	1.32	
F^v_{ar} (27, 79)				0.88
χ^2_{nd} (6)				7.20

* ar, arch, and nd stand respectively for autocorretaion, ARCH and normully distributed.

The first three graphs in Figure 8 show reasonable constancy for parameters and residual standard errors. The other graphs in this Figure indicate the individual equation break-point Chow (1960) F-tests scaled by their significant levels (1%) : their values do not exceed unity in the price and revenue equations. Although it slightly exceeds unity in income equation at the end of the period, that of the whole system shows reasonable features. These

Figure 7. Graphical diagnostic information

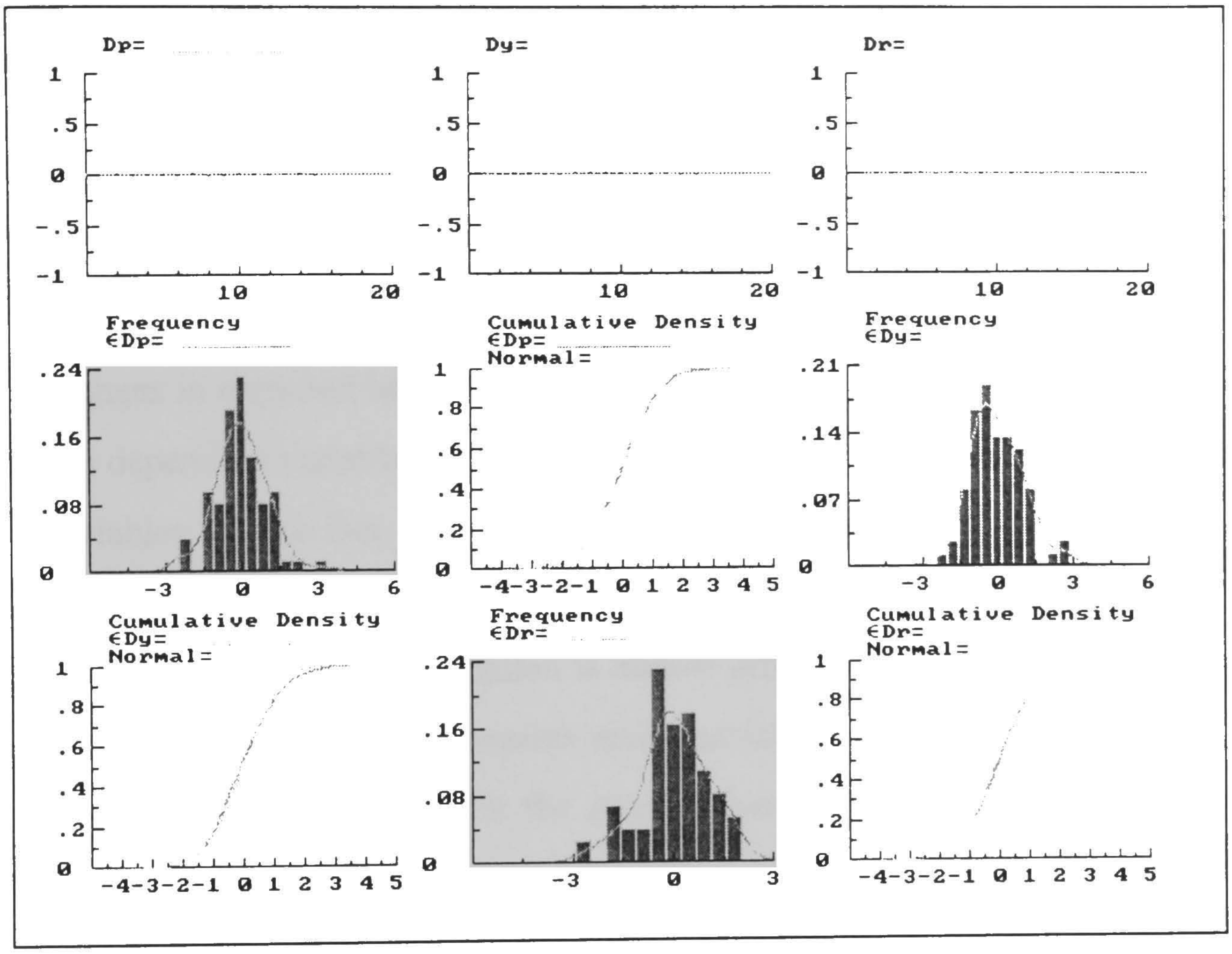
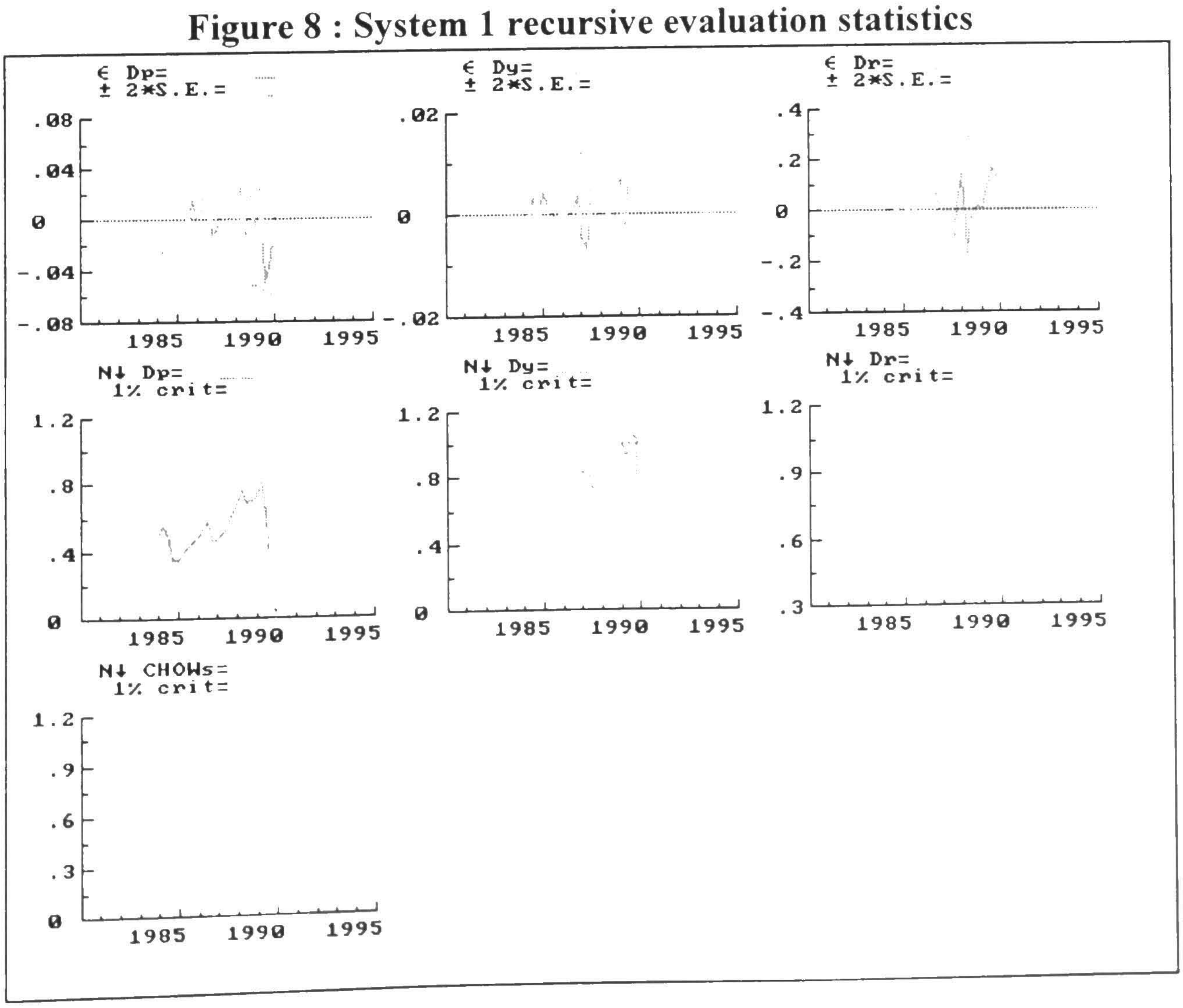


Figure 8 : System 1 recursive evaluation statistics



tests also confirm parameter constancy. Since weak exogeneity of non-modelled variables has been shown in the cointegration discussion section, all the congruency requirements of the system 1 seem to be fulfilled.

By checking the t-values of the estimated coefficients of the first unrestricted reduced form (URF), system 1 , it seems that the first lag of oil-induced government revenue ($Dor_{\_1}$) and the third lag of the all non-modelled variables (Dm_3, Dg_3, Dor_3, and Doy_3) are redundant in all three URF equations. Further, all lags of actual inflation ($Dp_{\_1}$, $Dp_{\_2}$ and $Dp_{\_3}$) and those of changes in expected inflation ($D\pi_{\_1}$, $D\pi_{\_2}$ and $D\pi_{\_3}$) seem to have no effect on the dependent variables, even in the price equation. However these two sets of variables, unlike $Dor_{\_1}$ and the third lag of non-modelled ones, have very high standard errors. A probable reason for this might be multicolinearity: as described above, expected inflation is almost proportionate to actual inflation. Using this information, we impose zero restrictions on actual inflation lags (Harvey, 1990:113) along with the other redundant variables and keep the lagged values of expected inflation in order to consider the whole impact of expectations on price behaviour. Although some other variables (like the second lag of government expenditure) are not significant in the system, they are kept because their elimination causes autocorrelation. Estimation of this new system (system 2), yields more reasonable results with respect to congruency. The related statistics and graphs are presented in Table 19 and Figure 9-11. This reduction is also validated by a progress test (F_{mr}).

Table 19 : System 2 Evaluation

Statistic	Dp	Dy	Dr	VAR
F_{ar} (3, 43)	0.94	2.04	0.36	
F_{arch} (4, 38)	0.48	1.16	0.45	
χ^2_{nd} (2)	0.90	1.54	2.75	
F^v_{ar} (27, 102)				1.28
χ^2_{nd} (6)				5.57
System 1 → System 2, F_{mr} (24, 105) = 1.02				

Figure 10: Graphical diagnostic information, system 2

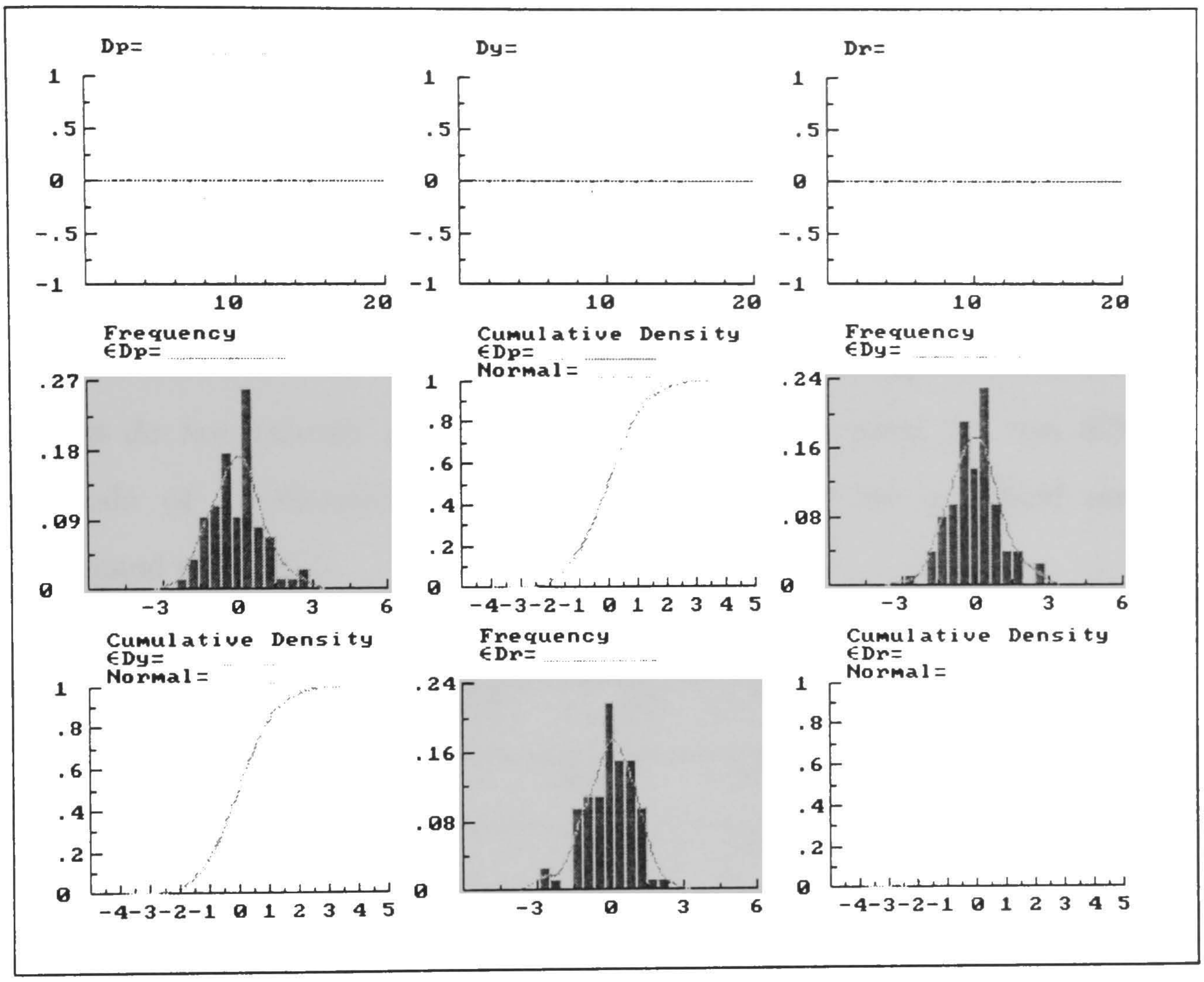
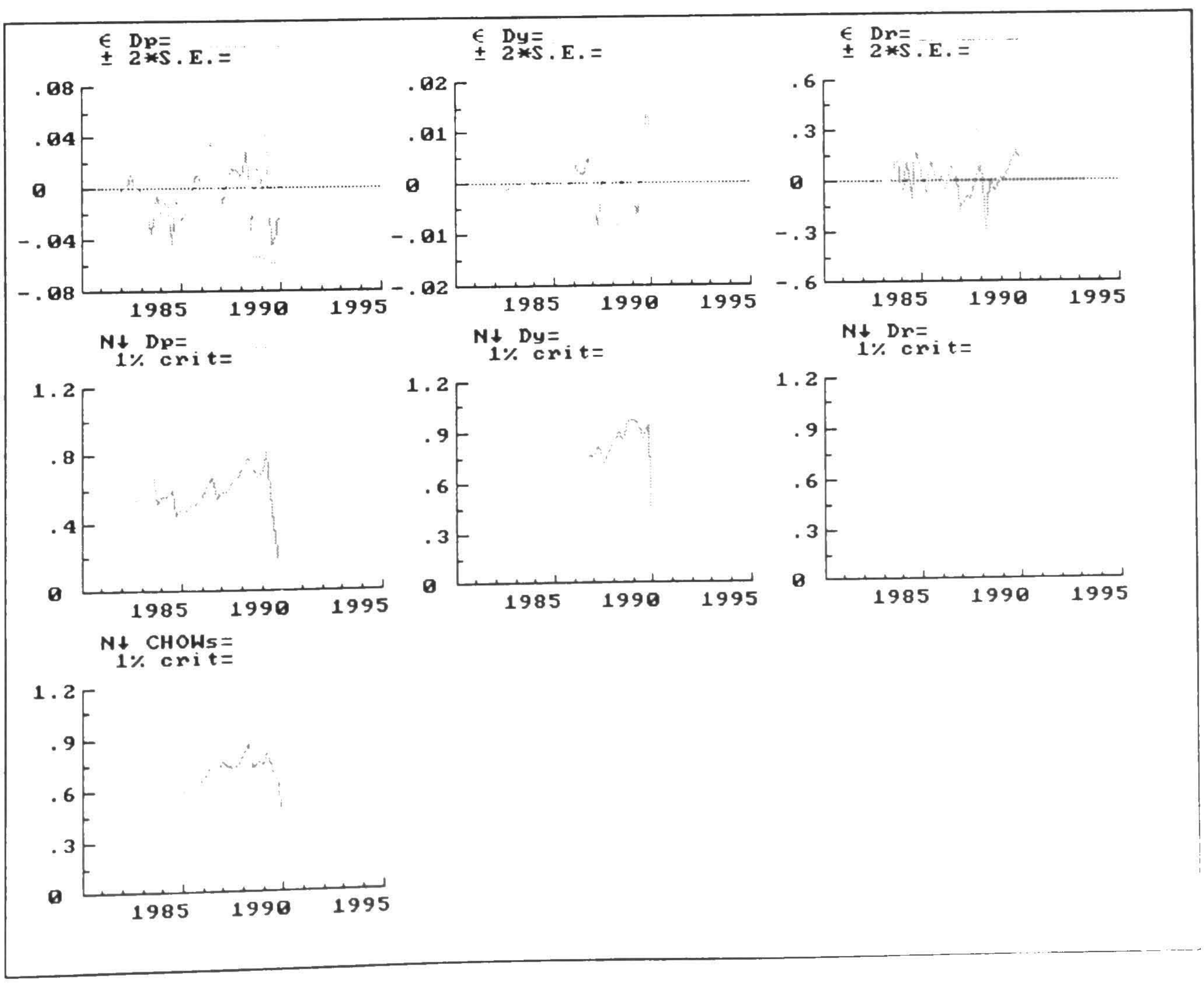


Figure 11 : Recursive estimation statistics, system 2



System 2 is accepted as a parsimonious system, and provides the baseline for the construction of the econometric model. Then in the light of the analysis and the result of estimation of system 2, an econometric model can be constructed. 3SLS and 2SLS are used to estimate Model 1 and 2 respectively. Table 20 cites the outcomes of the relevant tests. The over-identifying tests (χ^2_{oi}) and model reduction test (χ^2_{mr}) are acceptable for both models. Likewise, the residuals are consistent with being white noise. The results do not indicate any considerable differences using the two different methods of estimation. Figure 12 and 13 show the graphical analysis associated with 3SLS.

Table 20 : Model Evaluation

	$F_{ar}(27, 129)$	$\chi^2_{nd}(6)$	$\chi^2_{oi}(27)$	$\chi^2_{mr}(24)$
3SLS	1.01	5.00	24.65	24.65
2SLS	1.00	5.43	25.53	25.53

Figure 12 : Fitted and actual values and scaled residuals

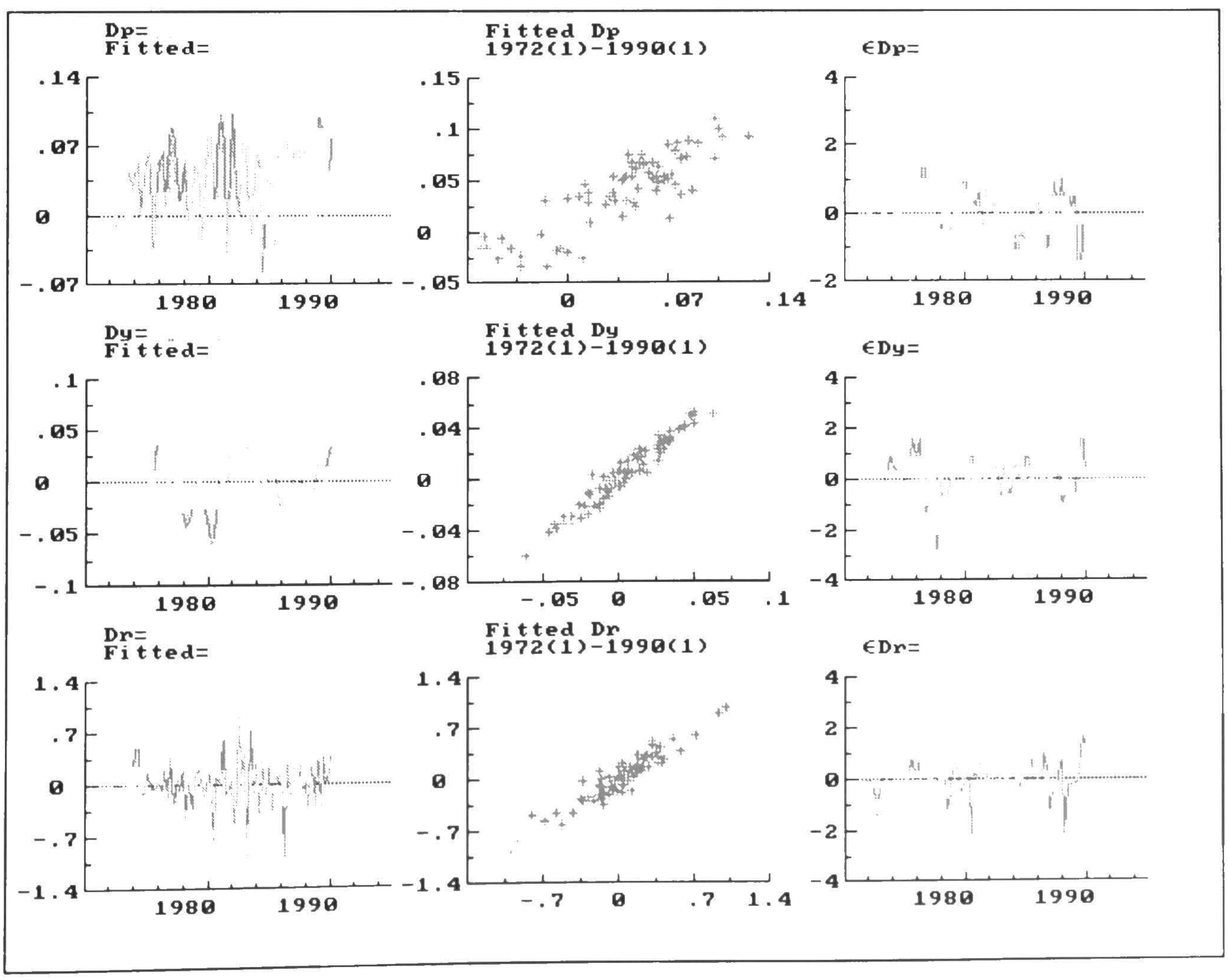
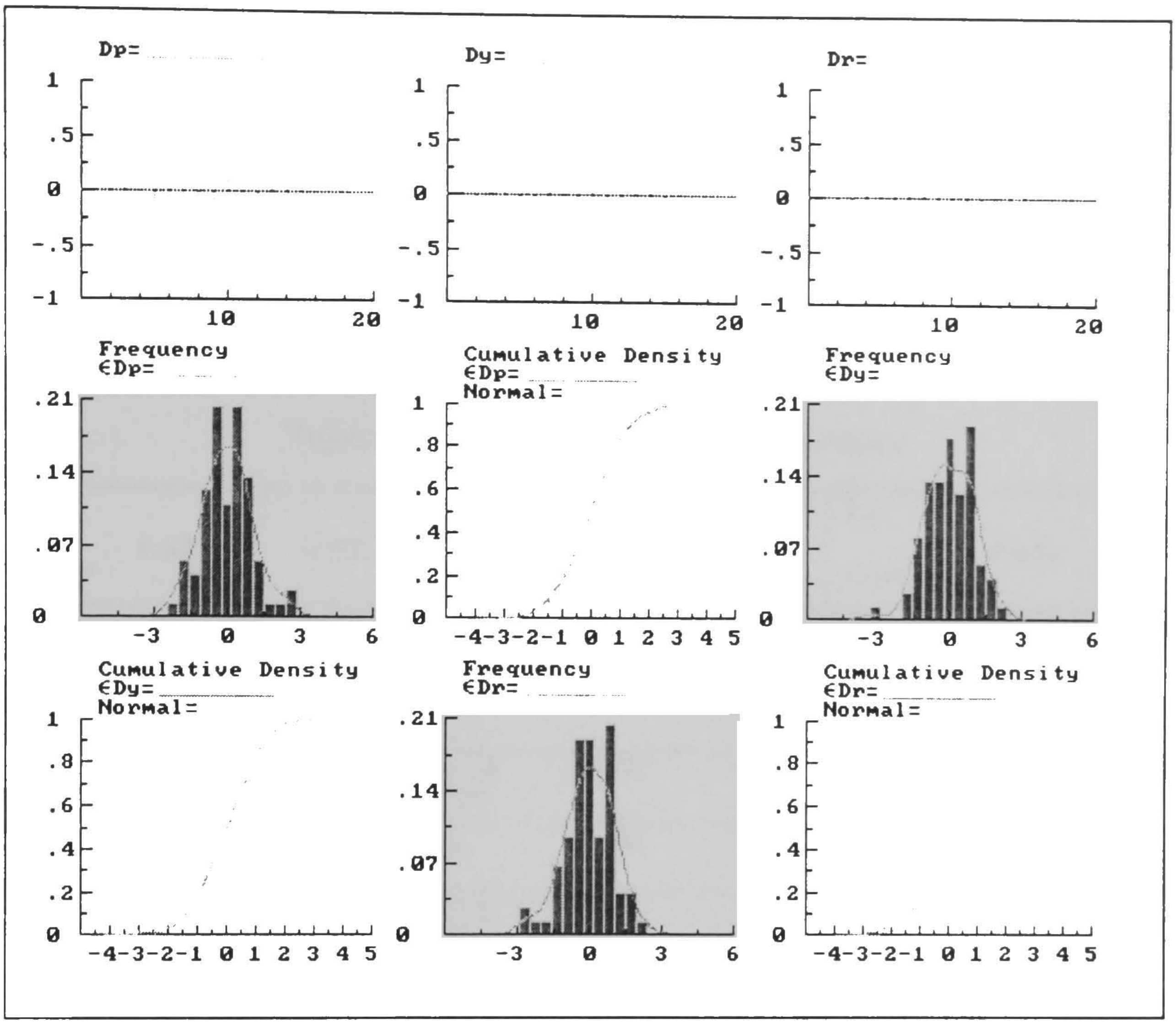


Figure 13 : Graphical diagnostic information



5.6.2 Results Interpretation

Table 21 portrays the result of the 3SLS estimation method. At the outset, there are some points which seem applicable to all three equations of the model :

1. Most of the coefficients are insignificant at the 5% confidence level.
2. Many of the coefficients of the variables and their lagged values have opposite signs. Insignificant coefficients can be ignored as different versions of zeros, for example income in the revenue equation. However, there are some significant cases such as oil sector income (Doy) in the income equation which would call for interpretation. The discussion is given in the section devoted to the income equation (see below).

3. Leaving aside a few peculiar coefficients, coefficients in the equations for price and government revenue are roughly as expected. However, income equation contains more problematic features.
4. The adjustment coefficients (the coefficients of cointegration terms, CIs) of price and income are small, which implies that they converge to their equilibrium very slowly, while that of revenue converges relatively quickly.

Table 21: Results of 3SLS estimation

Dp			**Dy**			**Dr**		
Regressor	**Coeffs.**	**t-ratio**	**Regressor**	**Coeffs.**	**t-ratio**	**Regressor**	**Coeffs.**	**t-ratio**
Dy	0.005	0.03	**Dy_1**	1.602	15.52	**Dr_1**	-0.203	-2.59
Dy_2	-0.419	-1.48	**Dy_2**	-1.232	-8.29	**Dr_3**	-0.120	-1.88
Dy_3	0.382	1.48	**Dy_3**	0.410	4.88	**Dp**	-1.29	-0.99
Dr_2	-0.032	-1.51	**Dp**	0.040	0.67	**Dy**	-0.098	-0.05
Dr_3	-0.015	-1.17	**Dr_1**	0.007	1.76	**Dy_1**	-2.534	-0.67
Dm	0.229	2.79	**Dr_2**	0.007	1.62	**Dy_2**	3.700	1.55
Dm_2	0.080	1.10	**Dg_1**	-0.010	-1.63	**Dm**	0.653	1.57
Dg_2	0.037	2.24	**Dg_2**	-0.009	-1.47	**Dg**	0.330	3.02
Dor	0.012	1.39	**Doy**	0.082	6.48	**Dg_1**	0.128	1.07
Dor_2	0.014	0.93	**Doy_1**	-0.100	-5.79	**Dg_2**	-0.134	-1.37
Dπ_2	-0.394	-2.30	**Doy_2**	0.060	4.03	**Dor**	0.472	8.55
Dπ_3	0.266	1.52	**Dπ_1**	-0.091	-1.82	**Doy_1**	0.396	1.28
$CI_{(p)}$_1	0.085	4.10	**$CI_{(y)}$_1**	-0.014	-2.00	**Doy_2**	-0.373	-1.25
Seal	-0.156	-2.97	**Seal**	0.000	0.03	**Dπ_2**	-2.605	-2.62
Seal_1	-0.116	-2.44	**Seal_1**	0.004	1.00	**Dπ_3**	2.140	2.01
Seal_2	-0.223	-4.38	**Seal_2**	0.005	1.57	**$CI_{(r)}$_1**	-0.158	-2.37
Seal_3	-0.132	-2.97	**Seal_3**	0.004	-0.89	**Seal**	-0.006	-0.06
						Seal_1	0.183	1.60
						Seal_2	0.035	0.53
						Seal_3	0.047	0.58

The equations can be considered individually as follows:

Price Equation

With regard to prices, the results suggest that they are determined by money, government expenditure, expected inflation and deviation from long-run equilibrium as follows :

$$\Delta p_t = \underset{(2.79)}{0.23}\,\Delta m_t + \underset{(2.24)}{0.04}\,\Delta g_{t-2} - \underset{(-2.3)}{0.4}\,\Delta\pi_{t-2} + \underset{(4.1)}{0.09}\,[(m-p) - 0.1\,y + 5.7\,\pi - 0.05\,t - 2.06\,DU + 0.06\,DT]_{t-1}$$

Rearranging this equation leads to :

$$p_t = 0.77\,p_{t-1} + 0.23\,m_t - 0.14\,(m-p)_{t-1} - 0.009\,y_{t-1} + 0.49\,\pi_{t-1} + 0.04\,\Delta g_{t-2} - 0.4\,\Delta\pi_{t-2} + \text{deterministic components}$$

The equation implies that the previous level of actual price has a large impact on the current level. This might well be interpreted as prices being subjected to control policies implemented during the whole period except for the first few years. The signs of money, lagged value of real money, income and expected inflation are consistent with the theoretical model and similar to the findings of Aghevli and Khan (1978), Makkian (1990) and Tabatabaee-Yazdi (1993), though it is the lagged values of the latter two which have a significant role, not the contemporaneous values. The results suggest that changes in government spending (after a lag) affect prices positively. This seems not surprising when a government spends much money on goods and services in the form of consumption and given the long gestation in investment as discussed in 3.2.2. A peculiar outcome is the negative effect of changes in expected inflation after two quarters which seems to have no conceivable interpretation. Overall, the results concerned with price determination seem generally consistent with the theoretical model.

Government revenue equation

As regards government revenue, the implications of the estimated equation are more or less consistent with the theoretical model:

$$\Delta r_t = -\underset{(-2.59)}{0.2}\,\Delta r_{t-1} + \underset{(3.02)}{0.33}\,\Delta g_t + \underset{(8.55)}{0.47}\,\Delta or_t - \underset{(-2.6)}{2.6}\,\Delta\pi_{t-2} + \underset{(2.01)}{2.14}\,\Delta\pi_{t-3} - \underset{(-2.37)}{0.16}[(r-p) - 0.3\,(or-p) - 0.7\,y + 4.5]$$

where (r-p) and (or- p) signify real revenue and real oil-induced revenue, respectively. Rearranging this equation yields :

$$r_t = 0.64\, r_{t-1} + 0.2\, r_{t-2} + 0.05\, or_t + 0.47\, \Delta or_t + 0.11\, (y + p)_{t-1} + 0.33\, \Delta g_t - 2.52\, \Delta\pi_{t-2} + 2.14\, \Delta\pi_{t-3}$$

This rearranged equation is generally consistent with the model. As expected, oil-induced revenue, nominal income and the lagged values of revenue, have a significant positive effect on government revenue. Likewise, the role of oil-induced revenue is greater than nominal income and nominal income affects it after a while. The former reflects the importance of oil receipts in government revenues and the latter implies a tax collection lag, the two issues emphasised in chapter 3.

There are two exceptions; government expenditure and expected inflation. The positive effect of the former, though not nested in the economic model, may occur because an increase in expenditure motivates the government to increase its revenue. Another reason may be the new taxable sources created by increases in government expenditure. However, expected inflation is problematic, bearing in mind that revenue is in nominal terms. The anticipated sign on inflation coefficients was positive because it is usual that price increases, actual or predicted, magnify the relevant nominal variables. While price and the second lag of expected inflation have negative coefficient (the former is insignificant) the third lag of expected rate has a positive coefficient, so, the aggregate effect, which is close to zero, may be more reliable.

Income equation

Income depends on just its lagged values, oil income (including lagged values) and its deviation from long-run equilibrium, while other variables seemingly have no significant impact:

$$\Delta y_t = \underset{(15.52)}{1.6\, \Delta y_{t-1}} - \underset{(-8.29)}{1.23\, \Delta y_{t-2}} + \underset{(4.88)}{0.4\, \Delta y_{t-3}} + \underset{(6.48)}{0.08\, \Delta oy_t} - \underset{(-5.79)}{0.1\, \Delta oy_{t-1}} + \underset{(4.03)}{0.06\, \Delta oy_{t-2}} - \underset{(-2.00)}{0.014\, CI(y)}$$

Here, there are some problems which should be considered :

* The unexpected opposite sign of lagged values of income is a matter of importance. It might have been possible to attribute this to some seasonal features of the data. However, as shown in section 5.4.2. HEGY test confirms that these time series have no seasonal characteristic. Nevertheless, seasonal dummies were included , so if there were any seasonal characteristics they would be removed, though theoretical conflict with finite samples can occur (Hylleberg et al, 1990:237). These unusual signs may occur due to the method of transforming annual data of income to quarterly figures, because the transfer has been carried out assuming a smooth trend (See 5.2.2). This peculiarity of lagged values has not been faced in the previous studies because they have used neither the quarterly data nor our estimation procedure.
* Concerning oil income, the odd signs might arise owing to some institutional limitations, in addition to the above discussion. Although contemporaneous oil income increases national income, this rate of increase can not continue permanently and after a while chronic bottlenecks might squeeze the growth rate. The analysis provided in chapter 3 supports this view, arguing that in an oil export-oriented economy like Iran, such a feature is likely. The performance of the government as well as mismatched production process has been tied to oil export earnings determined exogenously by volatile oil markets. In such a situation there probably are negative effects on growth.
* Much less expected is the sign of the government expenditure coefficients. The *a priori* expectation for the sign on the coefficients of government expenditure is positive, but lagged values of Dg have a negative sign. This erratic and strange feature is clearly inconsistent with a generally accepted view about positive impact of government expenditure on income , emphasized for Iran's case in

chapter 3, though insignificance of the individual t-ratios in the equation decreases the importance of the matter (Reestimation of the model excluding the second lag did not lead to significance of the other. Also separate estimation of the income equation shows the joint insignificance of the lagged values is not rejected). Makkian (1990) also obtained negative correlation between income and government expenditure with a significant but small coefficient.

Although the postulated theoretical relations are confirmed to a large extent, there are some results which contradict a large body of applied research. The unexpected sign of some estimates may stem from two reasons :

1. A part of the deficiency might be attributed to data features: firstly, quarterly data for income and oil sector income were not available, hence they were derived from annual figures based on some simple assumptions discussed in section 5.2.2. Secondly, cointegration considerations indicated that some of the time series have structural breaks. Finally, a common problem in developing countries is data inaccuracy, and the data used for the Iran economy are no exception.
2. A few large changes in income (see Figure 5) would influence results very much.

A separate problem is the mismatch between econometric and economic models. There may be two reasons :

- The problem may , at least partially, arise due to a deficiency in vector autoregressive modeling, VAR, used in this study. There is some criticism about the ability of the VAR approach to explain an economic mechanism, as well as about that of cointegration methodology. For instance, Pesaran (1988 : 337), discussing econometric modeling argues that :

  "... neither the VAR approach nor the cointegration approach can be taken seriously as representing or embodying any kind of theory. ... neither approach is satisfactory if the aim is to explain or understand how the economy functions."

Pesaran and Smith (1995: 65) propose a critical survey of recent studies on this subject and Pesaran (1996) introduces an alternative procedure. Hendry and Doornik (1994) who defend the approach, consider data and cognitive limitations as effective constraints (p. 30).

- Another alternative is to doubt the efficacy of the economic model being used. This sounds more reasonable because the model of Aghevli and Khan, in spite of having been applied to several developing countries including Iran, yielding satisfactory results, is for the first time being considered in a new cointegration context. The previous investigations (for example Aghevli and Khan, 1978, and Makkian, 1990 and Tabatabaee-Yazdi, 1991) have applied traditional econometrics based on the assumption of stationarity. However, as has already been mentioned stationarity was an issue which had to be examined and indeed has been rejected for the Iran case. Despite using new econometric techniques in this study, there remain some problems to be resolved in the future.

6 *Conclusion*

The objective of this study has been to explain price behaviour in the Iranian economy. The essential hypothesis was that the oil-orientated structure of the economy induced an increase in money supply via government expenditure, leading to higher prices. This inflation led to an increase in government expenditure while revenues were under pressure due to a sluggish tax system and negative shocks of oil prices. Since government expenditure failed to adjust decreasing revenues, there were widening budget deficits, again leading to an increase in money supply, and the process repeated itself. This process has been aggravated by a heavy dependence of government revenue and production on oil receipts.

In the light of theoretical analysis a simple dynamic model was constructed, nesting the main elements described above. This model was estimated using a vector autoregressive model (VAR) and cointegration. The following are the conclusions of each of the stages carried out in this study.

Chapter 2 provides a critical review of the monetarist and structuralist perspectives on inflation in the DCs. Monetarists emphasise that it is money supply increases which lead to higher level of prices and its reduction is the necessary and sufficient condition for curing inflation. Structuralists make emphasis that price rising is an inevitable outcome of structural imbalances during the developing process and cannot be primarily removed before structural reforms. This chapter discusses the strengths and weaknesses of the two views and concludes that inflation cannot be explained appropriately using either structuralism or monetarism exclusively. Reconciliation of the two views led to a model containing elements of both. With such a model, analysis of the causes of inflation seems more plausible.

A compromise may be obtained by paying attention to the interpretation of the role of money supply in the two camps. Monetarists emphasize that the money supply is translated into proportional changes in prices and is neutral with respect to output. However, they distinguish between the long-run and short-run effects of money supply changes. In other words they accept that in the short-run, which may even last for ten years, "*the changed rate of growth of nominal income typically shows up first in output and hardly at all in prices.*"(Freidman, 1992: 260), but through *decades* money growth primarily influences prices and output is determined by real factors. Moreover, they accept that in the short-run there is no theoretical agreement on the division of the effects of money growth between prices and output. They also believe in a two-way causality between money and inflation in the short-run. As a consequence tackling inflation by money reduction leads to unemployment which may be socially intolerable in DCs.

In contrast, structuralists admit that money increases lead to inflation, but they emphasize that development requirements oblige the monetary authorities to increase the money supply. In other words, they accept the proximateness of money supply but regard money reduction as an obstacle for sustained growth. However, increasing inflation may itself become an impediment for growth, as documented by much empirical evidence, leading to social unrest.

As a consequence, the alternative means of curing inflation seems to be a balanced option between money reduction and growth rate of the economy. For this objective an analytical model which combines the two kinds of elements seems appropriate. This has been documented by providing empirical evidence in the last part of chapter 2.

The general conclusions of the discussion of the Iranian economic outlook, provided in chapter 3, are as follows. The economy, in addition to traditional dualism, has suffered from oil/non-oil duality. The 1970s oil windfall has increased the role of the oil sector ever since. The salient importance of the oil sector can be clearly seen by the data presented in this chapter, where oil-induced revenue of the government reached 86.4% of total revenues and foreign exchange requirements were met nearly entirely by oil export receipts.

When the government acquired the 1973 windfall, it sharply increased the expenditure, even faster than the revenues obtained. In this process the absorptive capacity of the economy was completely neglected, leading to high rates of inflation and worsening structural imbalances. As a result, inflationary pressure and the dependency on the oil sector were aggravated. Such a situation, coupled with interventionist economic policies, prevented the post revolutionary government from tackling the problems successfully. When oil proceeds decreased as a result of the war and/or oil price reduction of the 1980s, the situation became more unsatisfactory. The nature of the budget was expansionary because the government acquired oil receipts exclusively. All the receipts were sold to the central bank and equivalently the government account was credited, leading to increases of high-powered money. The expansionary budget characteristics worsened due to increasing fiscal deficits. Also the foreign exchange constraint reduced production and investment which had already suffered from official control of resource distribution. This environment perpetuated inflation, reflecting the role of monetary elements in the presence of structural bottlenecks.

Chapter 4 considers the shortcomings of the single price equation of the monetarists, and shows that in empirical attempts proxies for non-monetarist elements are often included; a simultaneous equation approach is preferred because of its unbiased estimates. Six of the latest models used for Iranian inflation case are examined indicating their strengths and weaknesses. Of these, four researches used a single equation model, all but one, in a traditional econometric context. The two others applied a simultaneous equation model, the model of Aghevli and Khan (1978) which had been already conducted for four non-oil developing countries. They also used a traditional econometric procedure. Then, Aghevli and Khan's model is discussed in detail.

In the light of the discussion in chapter 3 this model is modified to be consistent with the particular characteristics of the oil-orientated economy. The selected model consists of three behavioural equations (price, government revenue and income) and two definitional ones (money supply and expected inflation). The overall conclusion of this chapter is that such a framework, which nests monetarist as well as structuralist factors, represents a more plausible analysis of inflation in the Iranian economy. Likewise, it would provide more reliable econometric results if it is estimated by a simultaneous equation approach in the cointegration context.

Chapter 5 conducts an empirical investigation to examine the above conclusions. All preliminary tests for stationarity, seasonality and cointegration are conducted. The findings illustrate that the all variables are I(1) without seasonal feature and there are three cointegrating vectors corresponding to each behavioural equation. Following on from this, a VAR procedure is used to estimate the model simultaneously. On the whole, the results support our predictions about the components of inflation and the direction of their impacts. The outcomes also confirm, more or less, the analysis of government revenue. In particular the role of oil-induced revenue is significant. Regarding income, although findings show a strong role for the oil sector, the alternating coefficient signs and some insignificant coefficients raised some doubts.

This limitation might arise due to different reasons:

1. The data features might partially be responsible for that deficiency. In addition to common problem of data inaccuracy in developing countries, quarterly data for income and oil income were not available and they were derived based on some simple assumptions from annual figures.
2. The problem may arise, to some extant, due to shortcomings of the simultaneous estimation method used in this study, using the vector autoregressive model, VAR. Although this procedure is applied by some researchers, it is criticised by some others (see for example Pessaran and Smith, 1995 for a survey in this field). In fact, there is some doubts about ability of VAR as well as cointegration to represent and embody economic theories. The difficulties of simultaneous equation estimation persuaded Aghevli and Sassanpour (1991) to estimate the equations of a simultaneous model of prices in the Iranian economy separately. The individual equations were relatively more robust and consistent with economic theory than the simultaneous equation estimates which convinces us that these results should be relied upon when econometric modelling is used to influence economic policymaking in Iran.
3. The economic model used is another alternative for our limitations. Aghevli and Khan's model is applied for several countries including Iran successfully. However, they estimated the model using conventional econometric methods based on stationarity assumption of variables. While the variables of our model are all nonstationary.

These are issues for the future debate.

Some policy implications may be derived from these findings :

- Prices seem sensitive to demand-side policies more than supply-side ones. This is consistent to our analysis about the important role of government budgetary performance in arising inflation. As mentioned in chapter 3, sharp increase in government expenditure by

5-fold after the 1970s windfall led to starting of high rate inflation era. Continuous over-spending of the government accompanied by budget deficit perpetuated inflation. Since government total expenditure accounted for about half of nominal GNP, the most important instrument to manage demand-side policies is government expenditure. Thus, price targeting depends on how the government tackles the over-spending problem. The large impact of previous price increases implies that the government may not be able to abandon a price control policy and not entirely rely on the market to achieve the desired level of prices.

- Expectation has an important role in determining prices. Intervention policies conducted in particular in the post-revolution era has had undesirable effects on expectation. The government has to avoid such measures, particularly unexpected arbitrary interventions which leads to more uncertainty and hence, higher rates of expected inflation.
- The sensitivity of government revenue to changes in oil-induced revenue is very high, while national income plays a relatively small role in obtaining revenues. This is consistent with the fact that the major part of the total revenue was accounted for by oil-induced revenue, reached even to 86 percent in some years of the period. As a result, adverse external shocks can damage the budget considerably leading to more increase in budget deficit. So the government ought to improve its budget structure, constructing an advanced tax system and diversifying its revenue sources. It is also important from the money reduction point of view because structural dependency of the budget on oil-induced revenue has been a primary source of money supply changes.

7 *Appendices*

7.1 Missing Data Estimation

Table 1 shows the estimates of 11 scattered gaps for expenditure, revenue and oil revenue of the government (discussed in 5.2.3, p. 125). Some actual figures are also presented for comparison.

Table 1: Estimates of the Missing figures

	Gov. Exp.		Gov. Rev.		Gov. Oil Rev.	
	Estimated	Actual	Estimated	Actual	Estimated	Actual
1971/Q2	62.3	65.3	63.3	56.5	37.4	34.5
Q3	85.3	73.1	67.3	59.3	37.5	35.4
Q4	56	---	57.9	---	38.6	---
1972/Q1	88.3	---	69.8	---	41.8	---
Q2	76.6	80.4	73.8	69.5	42.9	45.9
Q3	104.9	---	79.2	---	43	---
Q4	68.9	---	67.6	---	44.3	---
1973/Q1	108.6	---	81.5	---	47.9	---
Q2	102	---	111.7	---	74.9	---
Q3	139.7	---	119.8	---	75	---
Q4	91.7	131.4	102.2	113.6	77.3	72.3
1974/Q1	144.6	128.4	123.3	194.6	83.7	153.8
Q2	229.8	---	335.2	---	290	---
Q3	314.6	---	359.3	---	290.8	---
1979/Q2	475.6	---	415.6	---	293.5	---
Q3	651	---	445.5	---	294.3	---
Q4	427.4	546.1	380.2	449.5	303	371.1

7.2 Estimations for Proper βs in the adaptive Expectation

Cagan approach is used to determine the weight β, in a adaptive expectation procedure. The equations are estimated with different expected inflation series calculated by assessing β = 0.1 to 0.9. π_1, π_2 ... π_9 are the expected inflation series corresponding to β = 0.1, 0.2, ... 0.9. Then the β corresponding to the lowest RSS is chosen. The first equation estimated is EQ(1) and the others are similar. The results are summarised in Table 2.

EQ(1) Estimating the unrestricted reduced form by OLS
The present sample is: 1971 (2) to 1990 (1)

URF Equation 1 for p

Variable	Coefficient	Std.Error	t-value	t-prob
y	-0.080374	0.056237	-1.429	0.1573
m	0.99002	0.017561	56.376	0.0000
π_1	1.7858	1.0369	1.722	0.0894
m-p_1	-0.97211	0.036562	-26.588	0.0000
Constant	0.61874	0.50427	1.227	0.2239

σ = 0.05879 RSS = 0.2454

Table 2 : β s and Associated RSS

β	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RSS	0.245	0.232	0.219	0.210	0.204	0.200	0.198	0.197	0.196

7.3 Testing for Seasonality and Order of Integration : HGEY Test

This test, provided by Hylleberg et al (1990), examines the order of integration as well as the seasonal feature of time series. If the coefficients of Y_{i-1} and Y_{i-2} and either Y_{i-3} or Y_{i-4} are significantly negative, the null hypothesis of the nonstationarity of the variable i is rejected. If the coefficients of Y_{i-2} and either Y_{i-3} or Y_{i-4} are significantly negative, the null hypothesis of stochastic seasonality can be rejected. The significant cases are shadowed. These results confirm that all the variables are integrated of order 1 and there is no seasonal feature. L stands for logarithm. [...] showes probability, D_4 stands for seasonal difference and LM (for example) means logarithm of M (money).

EQ(1) Modelling D4LM by OLS

The present sample is: 1972 (1) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	$PartR^2$
Constant	0.088111	0.10204	0.864	0.3911	0.0115
Trend	-0.00095196	0.0015145	-0.629	0.5319	0.0061
Seasonal	0.063811	0.018810	3.392	0.0012	0.1524
Seasonal_1	-0.030637	0.018045	-1.698	0.0944	0.0431
Seasonal_2	0.010813	0.019718	0.548	0.5853	0.0047
Y1(M)_1	9.4287e-005	0.0056825	0.017	0.9868	0.0000
Y2(M)_1	-0.65639	0.10991	-5.972	0.0000	0.3578
Y3(M)_1	-0.33432	0.099540	-3.359	0.0013	0.1498
Y4(M)_1	-0.48619	0.099389	-4.892	0.0000	0.2721

$R^2 = 0.8472$ $F(8, 64) = 44.359$ [0.0000] $\sigma = 0.04384$ DW = 2.04
RSS = 0.1230 for 9 variables and 73 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 1.3977 [0.2371] and F-Form(1, 63) = 1.2298 [0.2717]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	-0.6386

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 3.5327 [0.1710] and F-Form(2, 62) = 1.5765 [0.2149]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	-0.8528	-0.6439

Testing for Error Autocorrelation from lags 1 to 3

Chi^2 (3) = 3.5821 [0.3103] and F-Form(3, 61) = 1.0492 [0.3773]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.8845	-0.6414	0.09102

Testing for Error Autocorrelation from lags 1 to 4

Chi^2 (4) = 3.5893 [0.4644] and F-Form(4, 60) = 0.77567 [0.5454]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	-0.9256	-0.6084	0.1038	-0.01829

EQ(1) Modelling D4Ly by OLS

The present sample is: 1972 (3) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.26757	0.091149	2.936	0.0047	0.1256
D4LY_1	-1.2324	0.35603	-3.461	0.0010	0.1665
D4LY_2	0.32700	0.11775	2.777	0.0073	0.1139
Y1(Y)_1	-0.007229	0.002468	-2.928	0.0048	0.1250
Y2(Y)_1	-3.9419	0.46996	-8.388	0.0000	0.5397
Y4(Y)_1	0.38132	0.11791	3.234	0.0020	0.1484
Y3(Y)_1	-0.18057	0.11720	-1.541	0.1287	0.0381
Trend	3.7514e-005	5.7260e-005	0.655	0.5149	0.0071
Seasonal	-0.0005641	0.0028714	-0.196	0.8449	0.0006
Seasonal_1	-0.0013882	0.0029121	-0.477	0.6353	0.0038
Seasonal_2	-0.0003938	0.0028710	-0.137	0.8913	0.0003

R^2 = 0.9929 F(10, 60) = 848.36 [0.0000] σ = 0.0085 DW = 1.91

RSS = 0.0044 for 11 variables and 71 observations

Testing for Error Autocorrelation from lags 1 to 1

Chi^2 (1) = 1.0831 [0.2980] and F-Form(1, 59) = 0.91398 [0.3430]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	0.3681

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 1.8675 [0.3931] and F-Form(2, 58) = 0.7834 [0.4616]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	0.1376	-0.3035

Testing for Error Autocorrelation from lags 1 to 3
Chi^2(3) = 3.7837 [0.2858] and F-Form(3, 57) = 1.0695 [0.3693]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.4531	-0.6229	-0.4676

Testing for Error Autocorrelation from lags 1 to 4
Chi^2 (4) = 3.8829 [0.4221] and F-Form(4, 56) = 0.80993 [0.5241]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.5733	-0.5517	-0.5441	-0.1079

EQ(1) Modelling D4LP by OLS
The present sample is: 1972 (1) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.22374	0.063206	3.540	0.0008	0.1637
Trend	0.0054823	0.0017540	3.126	0.0027	0.1324
Seasonal	0.0052620	0.013698	0.384	0.7021	0.0023
Seasonal_1	0.018269	0.015004	1.218	0.2278	0.0226
Seasonal_2	-0.059822	0.011251	-5.317	0.0000	0.3064
Y1(P)_1	-0.034945	0.011365	-3.075	0.0031	0.1287
Y2(P)_1	-0.92167	0.11483	-8.026	0.0000	0.5017
Y3(P)_1	-0.28338	0.092822	-3.053	0.0033	0.1271
Y4(P)_1	-0.47585	0.096023	-4.956	0.0000	0.2773

R^2 = 0.8672 F(8, 64) = 52.282 [0.0000] σ = 0.0262 DW = 2.12
RSS = 0.0441 for 9 variables and 73 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 2.1164 [0.1457] and F-Form(1, 63) = 1.8811 [0.1751]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	-0.4121

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 3.7947 [0.1500] and F-Form(2, 62) = 1.6998 [0.1911]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	-0.2981	0.3687

Testing for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 3.8691 [0.2759] and F-Form(3, 61) = 1.138 [0.3409]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.2665	0.3457	-0.07864

Testing for Error Autocorrelation from lags 1 to 4
Chi^2 (4) = 6.1225 [0.1902] and F-Form(4, 60) = 1.3732 [0.2540]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	-0.8505	0.5545	-0.2021	-0.4388

EQ(1) Modelling D4LG by OLS
The present sample is: 1972 (1) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.62313	0.30821	2.022	0.0474	0.0600
Trend	0.001008	0.002273	0.443	0.6589	0.0031
Seasonal	0.27268	0.095433	2.857	0.0058	0.1131
Seasonal_1	0.050990	0.069098	0.738	0.4632	0.0084
Seasonal_2	0.19259	0.098803	1.949	0.0557	0.0560
Y1(G)_1	-0.029002	0.015249	-1.902	0.0617	0.0535
Y2(G)_1	-0.21712	0.069547	-3.122	0.0027	0.1322
Y3(G)_1	-0.21425	0.10230	-2.094	0.0402	0.0641
Y4(G)_1	-0.51784	0.10282	-5.036	0.0000	0.2838

R^2= 0.5539 F(8, 64) = 9.935 [0.0000] σ = 0.1952 DW = 1.90
RSS = 2.4401 for 9 variables and 73 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 1.4645 [0.2262] and F-Form(1, 63) = 1.2898 [0.2604]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	0.4677

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 1.638 [0.4409] and F-Form(2, 62) = 0.71154 [0.4949]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	0.5196	-0.1622

Testing for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 2.666 [0.4460] and F-Form(3, 61) = 0.77072 [0.5149]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.1688	-0.2876	0.3396

Testing for Error Autocorrelation from lags 1 to 4
Chi^2 (4) = 2.9865 [0.5601] and F-Form(4, 60) = 0.63985 [0.6361]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.08145	-0.4364	0.2169	0.1602

EQ(1) Modelling D4LOR by OLS
The present sample is: 1972 (1) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	$PartR^2$
Constant	0.91958	0.39039	2.356	0.0216	0.0798
Trend	-0.0020727	0.002379	-0.871	0.3870	0.0117
Seasonal	0.10664	0.13669	0.780	0.4382	0.0094
Seasonal_1	-0.037955	0.13118	-0.289	0.7733	0.0013
Seasonal_2	0.10890	0.13848	0.786	0.4345	0.0096
Y1(OR)_1	-0.039627	0.018696	-2.120	0.0379	0.0656
Y2(OR)_1	-0.20437	0.074194	-2.755	0.0076	0.1060
Y3(OR)_1	-0.42827	0.10161	-4.215	0.0001	0.2173
Y4(OR)_1	-0.45444	0.10112	-4.494	0.0000	0.2399

R^2= 0.6195 F(8, 64) = 13.029 [0.0000] σ = 0.3927 DW = 1.98
RSS = 9.8732 for 9 variables and 73 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 0.0186 [0.8913] and F-Form(1, 63) = 0.0161 [0.8994]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	0.05009

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 0.33626 [0.8452] and F-Form(2, 62) = 0.14346 [0.8666]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	0.02823	-0.1941

Testing for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 0.47504 [0.9243] and F-Form(3, 61) = 0.13318 [0.9399]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.1231	-0.2131	-0.128

Testing for Error Autocorrelation from lags 1 to 4
Chi (4) = 0.65152 [0.9572] and F-Form(4, 60) = 0.13508 [0.9688]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.4176	-0.1399	-0.1418	-0.1307

EQ(1) Modelling D4LR by OLS
The present sample is: 1972 (1) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	$PartR^2$
Constant	0.96198	0.39472	2.437	0.0176	0.0849
Trend	0.001865	0.002446	0.762	0.4486	0.0090
Seasonal	0.13814	0.10527	1.312	0.1941	0.0262
Seasonal_1	-0.054850	0.094945	-0.578	0.5655	0.0052
Seasonal_2	0.094780	0.10753	0.881	0.3814	0.0120
Y1(R)_1	-0.042906	0.019322	-2.221	0.0299	0.0715
Y2(R)_1	-0.21386	0.075297	-2.840	0.0060	0.1119
Y3(R)_1	-0.34861	0.097069	-3.591	0.0006	0.1677
Y4(R)_1	-0.41051	0.097567	-4.207	0.0001	0.2167

R^2 = 0.5495 F(8, 64) = 9.7587 [0.0000] σ = 0.2835 DW = 1.86
RSS = 5.1460 for 9 variables and 73 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 2.0458 [0.1526] and F-Form(1, 63) = 1.8165 [0.1826]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	0.4654

Testing for Error Autocorrelation from lags 1 to 2
Chi^2 (2) = 2.0871 [0.3522] and F-Form(2, 62) = 0.9124 [0.4069]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	0.4775	-0.06674

Testing for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 2.6899 [0.4419] and F-Form(3, 61) = 0.7779 [0.5108]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.6134	-0.03576	-0.2459

Testing for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 2.6899 [0.4419] and F-Form(3, 61) = 0.7779 [0.5108]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.6134	-0.03576	-0.2459

EQ(1) Modelling D4LOy by OLS

The present sample is: 1972 (4) to 1990 (1)

Variable	Coefficient	Std.Error	t-value	t-prob	$PartR^2$
Constant	0.37638	0.22877	1.645	0.1053	0.0446
D4LOY_1	-1.4540	0.44259	-3.285	0.0017	0.1569
D4LOY_2	0.80821	0.31822	2.540	0.0138	0.1001
D4LOY_3	-0.24886	0.12782	-1.947	0.0564	0.0614
Y1(OY)_1	-0.010928	0.006614	-1.652	0.1039	0.0449
Y2(OY)_1	-3.3455	0.50132	-6.673	0.0000	0.4343
Y3(OY)_1	-0.48059	0.10680	-4.500	0.0000	0.2588
Y4(OY)_1	0.20841	0.12100	1.722	0.0903	0.0487
Trend	-0.000704	0.000663	-1.061	0.2930	0.0190
Seasonal	0.0028717	0.022896	0.125	0.9006	0.0003
Seasonal_1	-0.030476	0.023775	-1.282	0.2050	0.0275
Seasonal_2	-0.015822	0.023153	-0.683	0.4971	0.0080

R^2= 0.9741 F(11, 58) = 199.06 [0.0000] σ = 0.0669 DW = 1.96
RSS = 0.2598 for 12 variables and 70 observations

Testing for Error Autocorrelation from lags 1 to 1
Chi^2 (1) = 0.3905 [0.5320] and F-Form(1, 57) = 0.3197 [0.5740]

Error Autocorrelation Coefficients:

	Lag 1
Coeff.	0.3012

Testing for Error Autocorrelation from lags 1 to 2

Chi^2 (2) = 0.43848 [0.8031] and F-Form(2, 56) = 0.1765 [0.8387]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2
Coeff.	0.3926	0.1046

Testing for Error Autocorrelation from lags 1 to 3

$Chi^2$3) = 3.5898 [0.3093] and F-Form(3, 55) = 0.99102 [0.4039]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.251	0.8562	0.8477

Testing for Error Autocorrelation from lags 1 to 4

Chi^2 (4) = 3.8325 [0.4291] and F-Form(4, 54) = 0.78194 [0.5419]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.1961	0.8841	0.6419	-0.234

7.4 Unit Root Tests on the Levels

DF or ADF tests are carried out on the level of the variables of the model. According to section 5.4.1 and following the general to specific approach proposed by Doornik and Hendry (1994a)[74] all tests commence with a general model :

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \sum_{i=1}^{k} \delta_i y_{t-i} + (\text{deteministic seasonals}) + \varepsilon_t$$

then tests proceed, if necessary, until the most specific model :

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t$$

First, by the computer programme (PcGive 8.0), k = 12 is selected to determine the significant lag at 5%. L refers to logarithm so LM (for example) stands for log of money. The criterion for test is DF or ADF statistic which tests the null hypothesis of nonstationarity. For instance, since none of these statistics reported for money (LM) does not exceed the corresponding critical value the null cannot be rejected. * and ** refer respectively to 5% and 1% confidence levels.

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LM	-0.49956	0.046470	12	-0.80933	0.4225
LM	-0.80836	0.046299	11	-0.16685	0.8682
LM	-0.90137	0.045828	10	0.13241	0.8952
LM	-0.90715	0.045366	9	-0.32906	0.7435
LM	-1.0230	0.044960	8	0.38353	0.7030
LM	-0.97319	0.044582	7	-0.90829	0.3680
LM	-1.1422	0.044507	6	-0.28132	0.7796
LM	-1.2324	0.044119	5	0.64829	0.5196
LM	-1.1429	0.043881	4	-0.37943	0.7059
LM	-1.2169	0.043539	3	0.46134	0.6464
LM	-1.1887	0.043231	2	-1.8098	0.0757

[74] *" The initial general model should contain all the effects likely to be relevant, including sufficient lags to ensure no residual autocorrelation, then be tested for its validity. Once that has been established, further testing can proceed in confidence that conflicts will not arise."* (p. 227)

LM	-1.3260	0.044086	1	-0.79897	0.4276
LM	-1.3739	0.043948	0		

Unit root tests for LM

The present sample is: 1971 (2) to 1990 (1)

Dickey-Fuller test for LM; DLM on

Variable	Coefficient	Std.Error	t-value
Constant	0.064435	0.097773	0.659
Trend	-0.0011363	0.0013465	-0.844
Seasonal	0.046787	0.014278	3.277
Seasonal_1	-0.047806	0.014335	-3.335
Seasonal_2	-0.0099154	0.014280	-0.694
LM_1	0.0059836	0.020950	0.286

σ = 0.0440019 DW = 2.03 DW(LM) = 0.003431 DF(LM) = 0.2856
Critical values used in DF test: 5%=-3.469 1%=-4.082
RSS = 0.1355319547 for 6 variables and 76 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LM	-0.82499	0.049275	12	0.44191	0.6605
LM	-0.73158	0.048877	11	-0.72124	0.4741
LM	-0.98899	0.048646	10	0.037603	0.9702
LM	-1.0244	0.048177	9	-0.66208	0.5108
LM	-1.2283	0.047921	8	2.0778	0.042
LM	-0.83623	0.049371	7	-2.2778	0.0267
LM	-1.2156	0.051216	6	-0.096181	0.9237
LM	-1.2712	0.050761	5	0.058571	0.9535
LM	-1.2943	0.050315	4	2.3218	0.0238
LM	-1.0138	0.052185	3	-1.5769	0.1203
LM	-1.1415	0.052838	2	-2.4974	0.0153
LM	-1.3342	0.055096	1	-1.3749	0.1743
LM	-1.4495	0.055497	0		

Unit root tests for LM

The present sample is: 1973 (2) to 1990 (1)

Augmented Dickey-Fuller test for LM; DLM on

Variable	Coefficient	Std.Error	t-value
Constant	0.21444	0.12589	1.703
Trend	0.00056106	0.0020787	0.270
LM_1	-0.025065	0.029746	-0.843

DLM_1	-0.11135	0.12888	-0.864
DLM_2	-0.19668	0.12587	-1.563
DLM_3	0.012171	0.13022	0.093
DLM_4	0.20929	0.12878	1.625
DLM_5	-0.019353	0.13064	-0.148
DLM_6	0.044887	0.12906	0.348
DLM_7	-0.17411	0.12555	-1.387
DLM_8	0.33531	0.12512	2.680

σ = 0.0482169 DW = 1.96 DW(LM) = 0.004856 ADF(LM) = -0.8426
Critical values used in ADF test: 5%=-3.476 1%=-4.097

RSS = 0.1325177641 for 11 variables and 68 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LM	-3.0914*	0.048780	12	0.45935	0.6480
LM	-3.1462*	0.048401	11	-0.73044	0.4685
LM	-3.1099*	0.048184	10	-0.0017037	0.9986
LM	-3.1643*	0.047727	9	-0.73471	0.4658
LM	-3.1142*	0.047523	8	2.0861	0.0417
LM	-3.7940**	0.048950	7	-2.3064	0.0249
LM	-3.2337*	0.050803	6	-0.19269	0.8479
LM	-3.3148*	0.050372	5	-0.040912	0.9675
LM	-3.4618*	0.049936	4	2.3183	0.0240
LM	-4.7453**	0.051754	3	-1.5876	0.1177
LM	-4.4555**	0.052406	2	-2.5884	0.0121
LM	-3.6122**	0.054800	1	-1.5026	0.1381
LM	-3.2576*	0.055353	0		

Unit root tests for LM

The present sample is: 1973 (2) to 1990 (1)

Augmented Dickey-Fuller test for LM; DLM on

Variable	Coefficient	Std.Error	t-value
Constant	0.18626	0.069779	2.669
LM_1	-0.017263	0.0069672	-2.478
DLM_1	-0.12221	0.12146	-1.006
DLM_2	-0.20539	0.12069	-1.702
DLM_3	0.0020323	0.12368	0.016
DLM_4	0.19980	0.12289	1.626
DLM_5	-0.032540	0.12019	-0.271
DLM_6	0.031613	0.11836	0.267

DLM_7	-0.18486	0.11811	-1.565
DLM_8	0.32532	0.11856	2.744

σ = 0.04783 DW = 1.95 DW(LM) = 0.004856 ADF(LM) = -2.478
Critical values used in ADF test: 5%=-2.904 1%=-3.528
RSS = 0.1326871366 for 10 variables and 68 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
LM	0.25627	0.053046	12	0.71310	0.4790
LM	0.40958	0.052795	11	-0.30009	0.7653
LM	0.36220	0.052340	10	0.49878	0.6200
LM	0.47108	0.051975	9	-0.20799	0.8360
LM	0.44237	0.051521	8	3.1464	0.0027
LM	1.1098	0.055464	7	-1.0881	0.2812
LM	0.89709	0.055553	6	0.77753	0.4401
LM	1.0874	0.055363	5	1.0662	0.2908
LM	1.3649	0.055427	4	4.4148	0.0000
LM	2.9165	0.063396	3	1.3612	0.1785
LM	4.0100	0.063837	2	-0.036775	0.9708
LM	4.7457	0.063321	1	0.71839	0.4752
LM	7.0272	0.063077	0		

Unit root tests for LM

The present sample is: 1973 (2) to 1990 (1)

Augmented Dickey-Fuller test for LM; DLM on

Variable	Coefficient	Std.Error	t-value
LM_1	0.00078960	0.0017575	0.449
DLM_1	-0.0078632	0.11941	-0.066
DLM_2	-0.087300	0.11798	-0.740
DLM_3	0.14512	0.11710	1.239
DLM_4	0.32750	0.11892	2.754
DLM_5	0.069233	0.11975	0.578
DLM_6	0.12035	0.11935	1.008
DLM_7	-0.11785	0.12125	-0.972
DLM_8	0.39429	0.12157	3.243

σ = 0.0502513 DW = 1.98 DW(LM) = 0.004856 ADF(LM) = 0.4493
Critical values used in ADF test: 5%=-1.945 1%=-2.597
RSS = 0.1489866247 for 9 variables and 68 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LP	-2.7371	0.025721	12	-0.50388	0.6168
LP	-2.9576	0.025516	11	1.2713	0.2099
LP	-2.7052	0.025680	10	-0.0096853	0.9923
LP	-2.8367	0.025416	9	1.0411	0.3029
LP	-2.6453	0.025438	8	-1.0738	0.2881
LP	-3.2367	0.025476	7	1.2931	0.2018
LP	-2.9483	0.025640	6	0.56465	0.5747
LP	-2.9515	0.025475	5	-0.63369	0.5290
LP	-3.6271*	0.025333	4	1.6114	0.1129
LP	-3.2039	0.025698	3	3.537	0.000
LP	-1.9170	0.028217	2	-0.65561	0.5148
LP	-2.2322	0.028075	1	2.2913	0.0257
LP	-1.7510	0.029086	0		

Unit root tests for LP

The present sample is: 1972 (1) to 1990 (1)

Augmented Dickey-Fuller test for LP; DLP on

Variable	Coefficient	Std.Error	t-value
Constant	0.22374	0.063206	3.540
Trend	0.0054823	0.0017540	3.126
Seasonal	0.0052620	0.013698	0.384
Seasonal_1	0.018269	0.015004	1.218
Seasonal_2	-0.059822	0.011251	-5.317
LP_1	-0.13978	0.045460	-3.075
DLP_1	0.30989	0.11105	2.790
DLP_2	-0.17087	0.11701	-1.460
DLP_3	0.43247	0.12050	3.589

σ = 0.0262762 DW = 2.12 DW(LP) = 0.004702 ADF(LP) = -3.075
Critical values used in ADF test: 5%=-3.471 1%=-4.087
RSS = 0.04418805832 for 9 variables and 73 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LP	-2.6855	0.030033	12	1.6643	0.1024
LP	-2.4089	0.030560	11	-0.86485	0.3912
LP	-2.6687	0.030484	10	-0.17830	0.8592

LP	-2.9399	0.030199	9	1.1216	0.2672
LP	-2.7116	0.030272	8	1.3908	0.1701
LP	-2.4253	0.030533	7	-1.5691	0.1225
LP	-3.2605	0.030936	6	0.57965	0.5649
LP	-3.3374	0.030752	5	-0.43726	0.6636
LP	-4.1525**	0.030533	4	6.126	0.00
LP	-1.8922	0.038980	3	0.92522	0.3587
LP	-1.6973	0.038933	2	-3.5229	0.0008
LP	-2.8790	0.042474	1	1.1383	0.2595
LP	-2.6514	0.042577	0		

Unit root tests for LP

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LP; DLP on

Variable	Coefficient	Std.Error	t-value
Constant	0.30887	0.076564	4.034
Trend	0.00814	0.0021270	3.830
LP_1	-0.20952	0.055127	-3.801
DLP_1	0.16408	0.10268	1.598
DLP_2	-0.10994	0.10594	-1.038
DLP_3	0.11890	0.10467	1.136
DLP_4	0.59455	0.10526	5.648

σ = 0.03055 DW = 1.88 DW(LP) = 0.00485 ADF(LP) = -3.80*
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 0.06070177547 for 7 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LG	-4.8703**	0.18100	12	0.10397	0.9176
LG	-4.9897**	0.17909	11	0.64255	0.5236
LG	-4.9794**	0.17799	10	0.26111	0.7951
LG	-5.0384**	0.17629	9	0.55351	0.5824
LG	-5.0573**	0.17506	8	-0.14267	0.8871
LG	-5.1327**	0.17337	7	0.14666	0.8840
LG	-5.1831**	0.17174	6	0.10541	0.9165
LG	-5.2313**	0.17013	5	-0.59724	0.5529
LG	-5.2770**	0.16911	4	1.5875	0.1182
LG	-5.3812**	0.17143	3	-1.8839	0.0649
LG	-5.4221**	0.17529	2	-0.39504	0.6943

LG	-5.5351**	0.17399	1	-3.009	0.003
LG	-6.4378**	0.18568	0		

Unit root tests for LG

The present sample is: 1971 (3) to 1990 (1)

Augmented Dickey-Fuller test for LG; DLG on

Variable	Coefficient	Std.Error	t-value
Constant	0.47458	0.29186	1.626
Trend	0.001855	0.0022128	0.839
Seasonal	0.36190	0.080847	4.476
Seasonal_1	0.10229	0.067267	1.521
Seasonal_2	0.25681	0.078778	3.260
LG_1	-0.10973	0.058638	-1.871
DLG_1	-0.42296	0.10820	-3.909

σ = 0.199673 DW = 2.07 DW(LG) = 0.182 ADF(LG) = -1.871

Critical values used in ADF test: 5%=-3.47 1%=-4.084

RSS = 2.7111146 for 7 variables and 75 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LG	-5.0081**	0.18159	12	0.68839	0.4945
LG	-4.9893**	0.18063	11	0.19460	0.8465
LG	-5.0681**	0.17892	10	0.35029	0.7276
LG	-5.1059**	0.17740	9	0.43807	0.6632
LG	-5.1300**	0.17604	8	0.34097	0.7345
LG	-5.1611**	0.17460	7	-0.30289	0.7631
LG	-5.2430**	0.17315	6	0.24152	0.8100
LG	-5.2844**	0.17169	5	-0.81378	0.4192
LG	-5.3316**	0.17118	4	2.429	0.0183
LG	-5.4485**	0.17827	3	-3.2910	0.0017
LG	-5.5038**	0.19255	2	0.73903	0.4628
LG	-5.4909**	0.19182	1	-5.9521	0.0000
LG	-7.9802**	0.23992	0		

Unit root tests for LG

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LG; DLG on

Variable	Coefficient	Std.Error	t-value
Constant	0.84930	0.30816	2.756

Trend	0.002261	0.002270	0.996
LG_1	-0.14270	0.061760	-2.311
DLG_1	-0.46570	0.11729	-3.970
DLG_2	-0.13154	0.12778	-1.029
DLG_3	-0.15470	0.12705	-1.218
DLG_4	0.34300	0.11091	3.093

σ = 0.191487 DW = 1.97 DW(LG) = 0.2269 ADF(LG) = -2.311
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 2.383361338 for 7 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LG	-4.0930**	0.19631	12	-0.10175	0.9194
LG	-4.1406**	0.19440	11	-0.53728	0.5934
LG	-4.1363**	0.19306	10	-0.33534	0.7387
LG	-4.1614**	0.19144	9	-0.088882	0.9295
LG	-4.2454**	0.18967	8	-0.23123	0.8180
LG	-4.3044**	0.18803	7	-0.83756	0.4059
LG	-4.2386**	0.18753	6	-0.19045	0.8496
LG	-4.3112**	0.18594	5	-1.2291	0.2241
LG	-4.1410**	0.18676	4	2.083	0.041
LG	-4.8891**	0.19197	3	-3.8000	0.0003
LG	-4.0715**	0.21238	2	0.14349	0.8864
LG	-4.1747**	0.21067	1	-8.1228	0.0000
LG	-4.1662**	0.30149	0		

Unit root tests for LG
The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LG; DLG on

Variable	Coefficient	Std.Error	t-value
Constant	0.62047	0.20536	3.021
LG_1	-0.090169	0.032126	-2.807
DLG_1	-0.51224	0.10758	-4.762
DLG_2	-0.16933	0.12201	-1.388
DLG_3	-0.18873	0.12236	-1.542
DLG_4	0.32487	0.10939	2.970

σ = 0.191475 DW = 1.95 DW(LG) = 0.2269 ADF(LG) = -2.807
Critical values used in ADF test: 5%=-2.902 1%=-3.522
RSS = 2.419736894 for 6 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
LG	0.68598	0.22557	12	0.28130	0.7796
LG	0.74979	0.22356	11	-0.068505	0.9456
LG	0.75590	0.22146	10	0.20858	0.8356
LG	0.81005	0.21949	9	0.60641	0.5468
LG	0.94846	0.21822	8	0.49259	0.6243
LG	1.0672	0.21674	7	-0.11324	0.9102
LG	1.0746	0.21485	6	0.58981	0.5576
LG	1.2394	0.21364	5	-0.33680	0.7375
LG	1.2049	0.21203	4	3.242	0.002
LG	2.0955	0.22822	3	-2.6920	0.0092
LG	1.5070	0.23962	2	0.76540	0.4470
LG	1.7458	0.23882	1	-8.0717	0.0000
LG	0.51500	0.33928	0		

Unit root tests for LG

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LG; DLG on

Variable	Coefficient	Std.Error	t-value
LG_1	0.0061186	0.0042953	1.424
DLG_1	-0.46706	0.11281	-4.140
DLG_2	-0.079901	0.12534	-0.637
DLG_3	-0.094656	0.12531	-0.755
DLG_4	0.41126	0.11181	3.678

σ = 0.202758 DW = 1.97 DW(LG) = 0.2269 ADF(LG) = 1.424
Critical values used in ADF test: 5%=-1.945 1%=-2.595
RSS = 2.754417095 for 5 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LR	-5.0699**	0.26201	12	1.3437	0.1856
LR	-4.8607**	0.26424	11	0.42745	0.6710
LR	-4.9646**	0.26198	10	1.2938	0.2019
LR	-4.7714**	0.26378	9	1.2036	0.2345
LR	-4.6312**	0.26496	8	0.19169	0.8488
LR	-4.6913**	0.26244	7	1.2730	0.2088

LR	-4.5998**	0.26401	6	-0.52445	0.6022
LR	-4.7210**	0.26219	5	0.38984	0.6982
LR	-4.7426**	0.26013	4	1.6701	0.1007
LR	-4.6374**	0.26432	3	-1.8294	0.0728
LR	-5.3112**	0.26981	2	0.98429	0.3292
LR	-5.2562**	0.26973	1	-0.62936	0.5316
LR	-6.2699**	0.26832	0		

Unit root tests for LR

The present sample is: 1971 (2) to 1990 (1)

Dickey-Fuller test for LR; DLR on

Variable	Coefficient	Std.Error	t-value
Constant	1.0658	0.36155	2.948
Trend	0.00487	0.002396	2.036
Seasonal	0.29960	0.098898	3.029
Seasonal_1	-0.03479	0.098531	-0.353
Seasonal_2	0.24011	0.099041	2.424
LR_1	-0.22956	0.070878	-3.239

σ = 0.303514 DW = 2.43 DW(LR) = 0.2386 DF(LR) = -3.239

Critical values used in DF test: 5%=-3.469 1%=-4.082

RSS = 6.44843321 for 6 variables and 76 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LR	-5.0439**	0.26409	12	1.6542	0.1045
LR	-4.7310**	0.26863	11	0.14302	0.8869
LR	-4.9167**	0.26604	10	1.6253	0.1103
LR	-4.6236**	0.27021	9	0.80718	0.4232
LR	-4.5704**	0.26932	8	0.56959	0.5714
LR	-4.5635**	0.26763	7	0.98526	0.3289
LR	-4.5151**	0.26756	6	-0.32617	0.7455
LR	-4.6147**	0.26541	5	0.16807	0.8671
LR	-4.6600**	0.26314	4	2.096	0.040
LR	-4.4878**	0.27073	3	-2.5619	0.0130
LR	-5.2971**	0.28321	2	1.7653	0.0827
LR	-4.9179**	0.28816	1	-1.8604	0.0677
LR	-6.7006**	0.29392	0		

Unit root tests for LR

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LR; DLR on			
Variable	Coefficient	Std.Error	t-value
Constant	1.1170	0.39911	2.799
Trend	0.0029406	0.00245	1.199
LR_1	-0.19979	0.078932	-2.531
DLR_1	-0.25604	0.12560	-2.038
DLR_2	-0.065955	0.12366	-0.533
DLR_3	-0.26250	0.12310	-2.132
DLR_4	0.25103	0.11787	2.130

σ = 0.279143 DW = 2.00 DW(LR) = 0.3471 ADF(LR) = -2.531
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 5.064851826 for 7 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LR	-3.6761**	0.28677	12	0.74860	0.4576
LR	-3.6944**	0.28553	11	-0.72400	0.4724
LR	-3.7667**	0.28422	10	0.82790	0.4115
LR	-3.7722**	0.28338	9	0.18973	0.8502
LR	-3.8141**	0.28084	8	-0.049115	0.9610
LR	-3.8523**	0.27828	7	0.44977	0.6546
LR	-3.9636**	0.27629	6	-0.84475	0.4018
LR	-3.9263**	0.27559	5	-0.38154	0.7042
LR	-3.9376**	0.27356	4	1.6561	0.1031
LR	-4.1007**	0.27757	3	-3.2180	0.0021
LR	-4.3391**	0.29842	2	1.0512	0.2974
LR	-4.2219**	0.29868	1	-2.7717	0.0074
LR	-5.5384**	0.31436	0		

Unit root tests for LR

The present sample is: 1972 (1) to 1990 (1)

Augmented Dickey-Fuller test for LR; DLR on			
Variable	Coefficient	Std.Error	t-value
Constant	0.85627	0.30222	2.833
LR_1	-0.13227	0.050793	-2.604
DLR_1	-0.40239	0.10820	-3.719
DLR_2	-0.15201	0.11766	-1.292
DLR_3	-0.41111	0.10697	-3.843

σ = 0.284212 DW = 1.80 DW(LR) = 0.3126 ADF(LR) = -2.604

Critical values used in ADF test: 5%=-2.901 1%=-3.521
RSS = 5.492803716 for 5 variables and 73 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
LR	0.67618	0.32097	12	0.70824	0.4820
LR	0.79446	0.31943	11	-0.84147	0.4039
LR	0.69177	0.31855	10	0.74357	0.4604
LR	0.81139	0.31723	9	0.30468	0.7618
LR	0.87446	0.31460	8	0.17585	0.8611
LR	0.91592	0.31187	7	0.86050	0.3932
LR	1.0629	0.31116	6	-0.48591	0.6289
LR	1.0096	0.30910	5	-0.034176	0.9729
LR	1.0240	0.30647	4	1.9522	0.0557
LR	1.3930	0.31357	3	-3.449	0.0010
LR	0.91291	0.34043	2	0.33804	0.7365
LR	0.97708	0.33799	1	-4.3107	0.0001
LR	0.45562	0.38225	0		

Unit root tests for LR

The present sample is: 1972 (1) to 1990 (1)

Augmented Dickey-Fuller test for LR; DLR on

Variable	Coefficient	Std.Error	t-value
LR_1	0.010717	0.0060296	1.777
DLR_1	-0.45690	0.11176	-4.088
DLR_2	-0.15954	0.12347	-1.292
DLR_3	-0.41115	0.11229	-3.662

σ = 0.298335 DW = 1.77 DW(LR) = 0.3126 ADF(LR) = 1.777
Critical values used in ADF test: 5%=-1.945 1%=-2.595
RSS = 6.141251751 for 4 variables and 73 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LOR	-3.8805*	0.40186	12	-0.97705	0.3337
LOR	-4.0509*	0.40167	11	0.27737	0.7827
LOR	-4.0989*	0.39779	10	0.56253	0.5764
LOR	-4.0892*	0.39500	9	0.29823	0.7668
LOR	-4.1190**	0.39139	8	0.32650	0.7454

LOR	-4.1431**	0.38794	7	-0.020539	0.9837
LOR	-4.2092**	0.38420	6	0.26447	0.7925
LOR	-4.2407**	0.38081	5	0.14870	0.8824
LOR	-4.2866**	0.37735	4	0.47003	0.6402
LOR	-4.2920**	0.37466	3	-1.5332	0.1310
LOR	-4.9949**	0.37916	2	1.4714	0.1468
LOR	-4.7260**	0.38301	1	-0.74499	0.4593
LOR	-5.6535**	0.38154	0		

Unit root tests for LOR

The present sample is: 1971 (2) to 1990 (1)

Dickey-Fuller test for LOR; DLOR on

Variable	Coefficient	Std.Error	t-value
Constant	0.95968	0.35225	2.724
Trend	0.000384	0.0023569	0.163
Seasonal	0.26128	0.13572	1.925
Seasonal_1	-0.026286	0.13551	-0.194
Seasonal_2	0.23564	0.13581	1.735
LOR_1	-0.20321	0.067903	-2.993

σ = 0.41745 DW = 2.47 DW(LOR) = 0.3789 DF(LOR) = -2.993
Critical values used in DF test: 5%=-3.469 1%=-4.082
RSS = 12.19848822 for 6 variables and 76 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LOR	-3.9082*	0.39889	12	-0.78170	0.4381
LOR	-4.0709*	0.39733	11	0.14420	0.8859
LOR	-4.1401**	0.39350	10	0.69215	0.4920
LOR	-4.1075**	0.39152	9	0.13969	0.8894
LOR	-4.1573**	0.38789	8	0.53855	0.5925
LOR	-4.1517**	0.38533	7	-0.19408	0.8468
LOR	-4.2315**	0.38194	6	0.41066	0.6829
LOR	-4.2431**	0.37910	5	-0.011835	0.9906
LOR	-4.3064**	0.37576	4	0.71646	0.4766
LOR	-4.2767**	0.37418	3	-1.9506	0.0559
LOR	-5.0775**	0.38297	2	1.9451	0.0565
LOR	-4.6231**	0.39175	1	-1.5279	0.1318
LOR	-5.9836**	0.39601	0		

Unit root tests for LOR

The present sample is: 1971 (2) to 1990 (1)

Dickey-Fuller test for LOR; DLOR on

Variable	Coefficient	Std.Error	t-value
Constant	1.1539	0.34661	3.329
Trend	0.00077289	0.0024221	0.319
LOR_1	-0.22065	0.069628	-3.169

σ = 0.430021 DW = 2.57 DW(LOR) = 0.3789 DF(LOR) = -3.169
Critical values used in DF test: 5%=-3.469 1%=-4.082
RSS = 13.49902182 for 3 variables and 76 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LOR	-3.7268**	0.40943	12	-0.36954	0.7133
LOR	-3.8597**	0.40595	11	0.48142	0.6323
LOR	-3.8638**	0.40294	10	1.0465	0.3002
LOR	-3.7493**	0.40330	9	0.52270	0.6034
LOR	-3.7380**	0.40058	8	1.0134	0.3154
LOR	-3.6308**	0.40067	7	0.26114	0.7950
LOR	-3.6623**	0.39733	6	0.83447	0.4076
LOR	-3.5899**	0.39627	5	0.41952	0.6764
LOR	-3.5937**	0.39344	4	1.0920	0.2794
LOR	-3.4691*	0.39408	3	-1.8523	0.0690
LOR	-4.2727**	0.40199	2	1.9252	0.0590
LOR	-3.7979**	0.41081	1	-1.6397	0.1062
LOR	-5.1209**	0.41636	0		

Unit root tests for LOR

The present sample is: 1971 (2) to 1990 (1)

Dickey-Fuller test for LOR; DLOR on

Variable	Coefficient	Std.Error	t-value
Constant	1.1409	0.34212	3.335
LOR_1	-0.21239	0.064246	-3.306

σ = 0.4274 DW = 2.59 DW(LOR) = 0.378 DF(LOR) = -3.306*
Critical values used in DF test: 5%=-2.9 1%=-3.517
RSS = 13.51785151 for 2 variables and 76 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

t-adf	σ	lag	t-lag	t-prob

LY	-3.0884	0.0090574	12	-0.47106	0.6398
LY	-3.2861	0.0089821	11	1.5090	0.1380
LY	-3.0027	0.0091008	10	-0.044816	0.9644
LY	-3.1453	0.0090077	9	0.30073	0.7649
LY	-3.2089	0.0089254	8	1.1992	0.2361
LY	-2.9935	0.0089636	7	0.84624	0.4014
LY	-2.8813	0.0089391	6	-0.49438	0.6231
LY	-3.2377	0.0088752	5	2.996	0.004
LY	-2.4652	0.0095081	4	-2.0213	0.0482
LY	-3.3082	0.0097712	3	5.7912	0.0000
LY	-1.9094	0.012286	2	-4.9095	0.0000
LY	-3.4848*	0.014565	1	12.308	0.0000
LY	-1.3560	0.027614	0		

Unit root tests for LY

The present sample is: 1972 (3) to 1990 (1)

Augmented Dickey-Fuller test for LY; DLY on

Variable	Coefficient	Std.Error	t-value
Constant	0.26757	0.091149	2.936
Trend	3.7514e-005	5.7260e-005	0.655
Seasonal	-0.0005641	0.0028714	-0.196
Seasonal_1	-0.0013882	0.0029121	-0.477
Seasonal_2	-0.0003938	0.0028710	-0.137
LY_1	-0.028916	0.0098746	-2.928
DLY_1	1.9117	0.11867	16.110
DLY_2	-2.0917	0.24779	-8.441
DLY_3	1.6624	0.29948	5.551
DLY_4	-0.90539	0.24730	-3.661
DLY_5	0.32700	0.11775	2.777

σ = 0.00859177 DW = 1.91 DW(LY) = 0.06247 ADF(LY) = -2.928
Critical values used in ADF test: 5%=-3.473 1%=-4.091
RSS = 0.004429106917 for 11 variables and 71 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LY	-3.1621	0.0088161	12	-0.50395	0.6166
LY	-3.3647	0.0087501	11	1.5474	0.1281
LY	-3.0720	0.0088689	10	-0.040896	0.9675
LY	-3.2151	0.0087833	9	0.30844	0.7590
LY	-3.2775	0.0087080	8	1.2227	0.2269

LY	-3.0572	0.0087478	7	0.86272	0.3921
LY	-2.9420	0.0087275	6	-0.52366	0.6026
LY	-3.3088	0.0086707	5	3.075	0.003
LY	-2.5180	0.0092918	4	-2.0954	0.0406
LY	-3.3817	0.0095595	3	5.9429	0.0000
LY	-1.9373	0.012022	2	-5.0332	0.0000
LY	-3.5447*	0.014253	1	12.574	0.0000
LY	-1.3821	0.026952	0		

Unit root tests for LY

The present sample is: 1972 (3) to 1990 (1)

Augmented Dickey-Fuller test for LY; DLY on

Variable	Coefficient	Std.Error	t-value
Constant	0.26868	0.088984	3.019
Trend	3.7816e-005	5.5978e-005	0.676
LY_1	-0.029099	0.0096398	-3.019
DLY_1	1.9124	0.11576	16.520
DLY_2	-2.0950	0.24181	-8.664
DLY_3	1.6683	0.29241	5.705
DLY_4	-0.90969	0.24154	-3.766
DLY_5	0.32859	0.11501	2.857

σ= 0.00840145 DW = 1.91 DW(LY) = 0.06247 ADF(LY) = -3.019
Critical values used in ADF test: 5%=-3.473 1%=-4.091
RSS = 0.004446817512 for 8 variables and 71 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LY	-3.1503*	0.0087489	12	-0.65641	0.5146
LY	-3.3242*	0.0087000	11	1.4543	0.1520
LY	-3.0802*	0.0087927	10	-0.10446	0.9172
LY	-3.2252*	0.0087103	9	0.25219	0.8019
LY	-3.2988*	0.0086345	8	1.2011	0.2350
LY	-3.0867*	0.0086691	7	0.86172	0.3926
LY	-2.9722*	0.0086492	6	-0.53214	0.5967
LY	-3.3581*	0.0085946	5	3.119	0.0028
LY	-2.5197	0.0092187	4	-2.0915	0.0409
LY	-3.4494*	0.0094786	3	6.0167	0.0000
LY	-1.9053	0.011940	2	-5.0569	0.0000
LY	-3.6131**	0.014141	1	12.762	0.0000
LY	-1.2369	0.026872	0		

Unit root tests for LY

The present sample is: 1972 (3) to 1990 (1)

Augmented Dickey-Fuller test for LY; DLY on

Variable	Coefficient	Std.Error	t-value
Constant	0.25811	0.087224	2.959
LY_1	-0.027779	0.009399	-2.955
DLY_1	1.9116	0.11526	16.585
DLY_2	-2.0945	0.24078	-8.699
DLY_3	1.6551	0.29052	5.697
DLY_4	-0.89448	0.23946	-3.735
DLY_5	0.31094	0.11153	2.788

σ = 0.00836 DW = 1.90 DW(LY) = 0.062 ADF(LY) = -2.955*

Critical values used in ADF test: 5%=-2.902 1%=-3.524

RSS = 0.004479031036 for 7 variables and 71 observations

Unit root tests 1974 (2) to 1990 (1)

Critical values: 5%=-3.48 1%=-4.106; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
LOY	-1.6480	0.071920	12	-0.29830	0.7668
LOY	-1.8273	0.071220	11	0.82273	0.4148
LOY	-1.6698	0.070979	10	-0.31422	0.7547
LOY	-1.8708	0.070324	9	1.6138	0.1130
LOY	-1.4576	0.071443	8	0.15715	0.8758
LOY	-1.4863	0.070757	7	0.44814	0.6560
LOY	-1.4292	0.070211	6	-1.9297	0.0591
LOY	-2.1503	0.071992	5	1.7324	0.0890
LOY	-1.6864	0.073314	4	-2.263	0.027
LOY	-2.6609	0.076014	3	3.5663	0.0008
LOY	-1.6135	0.083589	2	-2.9356	0.0048
LOY	-2.7450	0.089000	1	8.2656	0.0000
LOY	-0.84103	0.13082	0		

Unit root tests for LOY

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LOY; DLOY on

Variable	Coefficient	Std.Error	t-value
Constant	0.41332	0.21099	1.959
Trend	-0.000812	0.000614	-1.322

Seasonal	0.0028229	0.023415	0.121
Seasonal_1	-0.021286	0.023836	-0.893
Seasonal_2	-0.012557	0.023428	-0.536
LOY_1	-0.048217	0.024440	-1.973
DLOY_1	1.2813	0.11550	11.094
DLOY_2	-1.0222	0.17799	-5.743
DLOY_3	0.76342	0.17297	4.413
DLOY_4	-0.29025	0.12216	-2.376

σ = 0.068827 DW = 1.86 DW(LOY) = 0.04642 ADF(LOY) = -1.973
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 0.2937035291 for 10 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-3.48 1%=-4.106; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
LOY	-1.6418	0.071706	12	-0.43350	0.6666
LOY	-1.8625	0.071121	11	0.98042	0.3316
LOY	-1.6526	0.071094	10	-0.070946	0.9437
LOY	-1.7724	0.070410	9	1.3604	0.1796
LOY	-1.4460	0.070973	8	-0.019879	0.9842
LOY	-1.5266	0.070313	7	0.57906	0.5650
LOY	-1.4317	0.069887	6	-1.8144	0.0751
LOY	-2.1153	0.071303	5	1.5835	0.1189
LOY	-1.7073	0.072240	4	-2.482	0.016
LOY	-2.7705	0.075386	3	3.9455	0.0002
LOY	-1.5918	0.084180	2	-3.0105	0.0038
LOY	-2.7262	0.089658	1	8.1261	0.0000
LOY	-0.86712	0.12887	0		

Unit root tests for LOY

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for LOY; DLOY on

Variable	Coefficient	Std.Error	t-value
Constant	0.40018	0.20763	1.927
Trend	-0.000777	0.0006061	-1.283
LOY_1	-0.047714	0.024124	-1.978
DLOY_1	1.2860	0.11221	11.461
DLOY_2	-1.0543	0.17137	-6.152
DLOY_3	0.80372	0.16645	4.829
DLOY_4	-0.30744	0.11886	-2.587

σ= 0.067949 DW = 1.86 DW(LOY) = 0.04642 ADF(LOY) = -1.978
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 0.3001096165 for 7 variables and 72 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-2.907 1%=-3.534; Constant included

	t-adf	σ	lag	t-lag	t-prob
LOY	-1.5204	0.071696	12	-0.66522	0.5090
LOY	-1.7035	0.071303	11	0.74201	0.4615
LOY	-1.6048	0.070995	10	-0.30666	0.7603
LOY	-1.7031	0.070385	9	1.1638	0.2497
LOY	-1.5470	0.070616	8	-0.19140	0.8489
LOY	-1.6062	0.069995	7	0.42217	0.6745
LOY	-1.5757	0.069479	6	-2.0679	0.043
LOY	-1.9648	0.071448	5	1.3449	0.1840
LOY	-1.7628	0.071944	4	-2.8420	0.0062
LOY	-2.4345	0.076137	3	3.6639	0.0005
LOY	-1.7545	0.083649	2	-3.3029	0.0016
LOY	-2.4717	0.090188	1	7.9896	0.0000
LOY	-1.4786	0.12797	0		

Unit root tests for LOY

The present sample is: 1972 (4) to 1990 (1)

Augmented Dickey-Fuller test for LOY; DLOY on

Variable	Coefficient	Std.Error	t-value
Constant	0.16504	0.12282	1.344
LOY_1	-0.021719	0.01578	-1.376
DLOY_1	1.4042	0.12009	11.693
DLOY_2	-1.3971	0.20509	-6.812
DLOY_3	1.2814	0.24424	5.247
DLOY_4	-0.90672	0.24584	-3.688
DLOY_5	0.52631	0.20342	2.587
DLOY_6	-0.26002	0.12214	-2.129

σ = 0.0667789 DW = 1.97 DW(LOY) = 0.04745 ADF(LOY) = -1.376
Critical values used in ADF test: 5%=-2.903 1%=-3.525
RSS = 0.276484202 for 8 variables and 70 observations

Unit root tests 1974 (2) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
LOY	-0.67937	0.072530	12	-0.98747	0.3281

LOY	-0.62253	0.072513	11	0.44136	0.6608
LOY	-0.65646	0.071960	10	-0.59976	0.5512
LOY	-0.62598	0.071532	9	0.91142	0.3661
LOY	-0.69737	0.071422	8	-0.41879	0.6770
LOY	-0.67445	0.070894	7	0.20594	0.8376
LOY	-0.69784	0.070296	6	-2.394	0.0200
LOY	-0.56488	0.073108	5	1.0227	0.3107
LOY	-0.62405	0.073136	4	-3.3475	0.0014
LOY	-0.49490	0.079112	3	3.2186	0.0021
LOY	-0.63875	0.084965	2	-3.8017	0.0003
LOY	-0.46789	0.093731	1	7.5694	0.0000
LOY	-0.95032	0.12898	0		

Unit root tests for LOY

The present sample is: 1972 (4) to 1990 (1)

Augmented Dickey-Fuller test for LOY; DLOY on

Variable	Coefficient	Std.Error	t-value
LOY_1	-0.00055983	0.0010397	-0.538
DLOY_1	1.4184	0.12039	11.782
DLOY_2	-1.4373	0.20420	-7.038
DLOY_3	1.3070	0.24505	5.334
DLOY_4	-0.95287	0.24499	-3.890
DLOY_5	0.54523	0.20422	2.670
DLOY_6	-0.29471	0.12014	-2.453

σ = 0.0672045 DW = 1.98 DW(LOY) = 0.04745 ADF(LOY) = -0.5385
Critical values used in ADF test: 5%=-1.945 1%=-2.596
RSS = 0.2845357474 for 7 variables and 70 observations

7.5 Unit Root Tests on the Differences

DF or ADF tests are carried out for the differences of the variables similar to the previous section. The results show that the first differences of all the variables are stationary. D and L respectively refer to difference and logarithm so DLM (for example) stands for first difference of log of money. The criterion for test is DF or ADF statistic which tests the null hypothesis of nonstationarity. For example, since the statistics reported for money (DLM) exceeds the critical value [ADF(DLM) = -6.913**] the null is rejected at 1% confidence level, the first difference of log of money is stationary.

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-3.481 1%=-4.108; Constant and Trend and Seasonals included

	t-adf	σ	lag	t-lag	t-prob
DLM	-3.4802	0.046490	12	0.51236	0.6109
DLM	-3.4914*	0.046116	11	1.1558	0.2537
DLM	-3.2959	0.046280	10	0.48132	0.6325
DLM	-3.3082	0.045908	9	0.23787	0.8130
DLM	-3.4358	0.045464	8	0.70171	0.4862
DLM	-3.4224	0.045233	7	-0.11646	0.9078
DLM	-3.8462*	0.044793	6	1.0766	0.2867
DLM	-3.7045*	0.044862	5	0.58880	0.5585
DLM	-3.8063*	0.044584	4	-0.37529	0.7089
DLM	-4.6264**	0.044228	3	0.59571	0.5539
DLM	-5.1268**	0.043968	2	-0.29739	0.7673
DLM	-7.2898**	0.043609	1	2.0076	0.0495
DLM	-8.4614**	0.044753	0		

Unit root tests for DLM
The present sample is: 1971 (4) to 1990 (1)

Augmented Dickey-Fuller test for DLM: DDLM on

Variable	Coefficient	Std.Error	t-value
Constant	0.10403	0.018131	5.737
Trend	-0.00096256	0.00027306	-3.525
Seasonal	0.053043	0.015007	3.534
Seasonal_1	-0.035737	0.017061	-2.095
Seasonal_2	0.0052553	0.018779	0.280
DLM_1	-1.1819	0.17096	-6.913
DDLM_1	0.15875	0.11974	1.326

σ = 0.0439534 DW = 1.95 DW(DLM) = 2.088 ADF(DLM) = -6.913**
Critical values used in ADF test: 5%=-3.47 1%=-4.085
RSS = 0.1294372742 for 7 variables and 74 observations

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-2.908 1%=-3.536; Constant included

	t-adf	σ	lag	t-lag	t-prob
DLP	-2.6197	0.031926	12	1.3543	0.1819
DLP	-2.3276	0.032191	11	-1.4309	0.1587
DLP	-3.0494*	0.032520	10	1.1501	0.2555
DLP	-2.8156	0.032621	9	0.92656	0.3584
DLP	-2.6624	0.032578	8	-0.26667	0.7908
DLP	-2.9632*	0.032296	7	-0.92411	0.3595
DLP	-3.7274**	0.032253	6	2.2932	0.0257
DLP	-2.9804*	0.033457	5	0.76178	0.4494
DLP	-2.9108*	0.033334	4	2.1942	0.0323
DLP	-2.2863	0.034412	3	-4.7255	0.0000
DLP	-5.2214**	0.040154	2	-0.60348	0.5485
DLP	-9.0005**	0.039941	1	4.1970	0.0001
DLP	-7.4872**	0.045053	0		

Unit root tests for DLP

The present sample is: 1973 (1) to 1990 (1)

Augmented Dickey-Fuller test for DLP; DDLP on

Variable	Coefficient	Std.Error	t-value
Constant	0.040320	0.011054	3.648
DLP_1	-1.0485	0.26884	-3.900
DDLP_1	0.18287	0.25102	0.729
DDLP_2	-0.08408	0.23618	-0.356
DDLP_3	0.08753	0.23362	0.375
DDLP_4	0.63316	0.20541	3.082
DDLP_5	0.34837	0.16689	2.087
DDLP_6	0.33898	0.13070	2.594

σ = 0.0318397 DW = 1.90 DW(DLP) = 1.915 ADF(DLP) = -3.9**
Critical values used in ADF test: 5%=-2.904 1%=-3.527
RSS = 0.06183960197 for 8 variables and 69 observations

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-3.481 1%=-4.108; Constant and Trend included

	t-adf	σ	lag	t-lag	t-prob
DLG	-2.2467	0.20584	12	0.75642	0.4531
DLG	-2.1250	0.20494	11	-0.11743	0.9070
DLG	-2.3234	0.20291	10	0.25961	0.7962

DLG	-2.3992	0.20104	9	-0.05576	0.9557
DLG	-2.6119	0.19911	8	-0.08712	0.9309
DLG	-2.8755	0.19723	7	-0.16491	0.8696
DLG	-3.2539	0.19545	6	0.37866	0.7064
DLG	-3.4261	0.19392	5	-0.39810	0.6921
DLG	-4.0798*	0.19246	4	1.0916	0.2797
DLG	-4.0193*	0.19278	3	-2.6850	0.0095
DLG	-7.9767**	0.20284	2	3.3025	0.0016
DLG	-7.1776**	0.21921	1	-0.76395	0.4479
DLG	-21.581**	0.21845	0		

Unit root tests for DLG

The present sample is: 1972 (2) to 1990 (1)

Augmented Dickey-Fuller test for DLG; DDLG on

Variable	Coefficient	Std.Error	t-value
Constant	0.15104	0.062286	2.425
Trend	-0.0022193	0.001219	-1.820
DLG_1	-1.5783	0.37620	-4.195
DDLG_1	0.032727	0.30258	0.108
DDLG_2	-0.14476	0.21940	-0.660
DDLG_3	-0.33608	0.11445	-2.936

σ = 0.197681 DW = 1.94 DW(DLG) = 3.464 ADF(DLG) = -4.195**
Critical values used in ADF test: 5%=-3.472 1%=-4.089
RSS = 2.579129113 for 6 variables and 72 observations

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-2.908 1%=-3.536; Constant included

	t-adf	σ	lag	t-lag	t-prob
DLR	-2.3304	0.29608	12	0.58896	0.5586
DLR	-2.2697	0.29414	11	-0.59225	0.5563
DLR	-2.5490	0.29226	10	0.85059	0.3990
DLR	-2.4184	0.29148	9	-0.88990	0.3776
DLR	-2.7987	0.29091	8	-0.18285	0.8556
DLR	-3.0390*	0.28829	7	-0.19754	0.8442
DLR	-3.3494*	0.28576	6	-0.77254	0.4431
DLR	-4.0810**	0.28473	5	0.51691	0.6073
DLR	-4.3142**	0.28290	4	0.33047	0.7423
DLR	-4.8123**	0.28072	3	-1.5766	0.1203
DLR	-8.2199**	0.28423	2	3.7538	0.0004
DLR	-6.8853**	0.31371	1	-0.48903	0.6266
DLR	-14.491**	0.31174	0		

Unit root tests for DLR

The present sample is: 1972 (1) to 1990 (1)

Augmented Dickey-Fuller test for DLR; DDLR on

Variable	Coefficient	Std.Error	t-value
Constant	0.074306	0.035580	2.088
DLR_1	-2.0393	0.25014	-8.153
DDLR_1	0.58167	0.19774	2.942
DDLR_2	0.41569	0.11135	3.733

σ = 0.29588 DW = 1.77 DW(DLR) = 2.925 ADF(DLR) = -8.153**
Critical values used in ADF test: 5%=-2.901 1%=-3.521
RSS = 6.040597648 for 4 variables and 73 observations

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
DLOR	-2.5585*	0.42450	12	-0.73433	0.4662
DLOR	-2.9287**	0.42258	11	1.0284	0.3086
DLOR	-2.7506**	0.42281	10	0.18418	0.8546
DLOR	-2.8371**	0.41894	9	-0.48433	0.6301
DLOR	-3.1702**	0.41596	8	0.05354	0.9575
DLOR	-3.3738**	0.41217	7	-0.48481	0.6297
DLOR	-3.8700**	0.40935	6	0.37177	0.7115
DLOR	-4.0924**	0.40624	5	-0.27686	0.7829
DLOR	-4.7885**	0.40300	4	0.31892	0.7509
DLOR	-5.4449**	0.39992	3	-0.16063	0.8729
DLOR	-7.4713**	0.39666	2	3.1910	0.0023
DLOR	-6.5085**	0.42546	1	-0.63761	0.5261
DLOR	-13.074**	0.42342	0		

Unit root tests for DLOR

The present sample is: 1972 (1) to 1990 (1)

Augmented Dickey-Fuller test for DLOR; DDLOR on

Variable	Coefficient	Std.Error	t-value
DLOR_1	-1.7164	0.23712	-7.239
DDLOR_1	0.38143	0.19117	1.995
DDLOR_2	0.34470	0.11313	3.047

σ = 0.403902 DW = 1.94 DW(DLOR) = 2.805 ADF(DLOR) = -7.239**
Critical values used in ADF test: 5%=-1.945 1%=-2.595
RSS = 11.41955048 for 3 variables and 73 observation

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

t-adf	σ	lag	t-lag	t-prob

DLY	-2.5438*	0.0094615	12	0.64905	0.5193
DLY	-2.4802*	0.0094076	11	1.2183	0.2287
DLY	-2.2796*	0.0094514	10	-0.79254	0.4316
DLY	-2.5390*	0.0094181	9	0.77737	0.4404
DLY	-2.4407*	0.0093836	8	0.56692	0.5731
DLY	-2.3904*	0.0093255	7	-0.32345	0.7476
DLY	-2.5564*	0.0092506	6	-0.0330	0.9738
DLY	-2.6845**	0.0091692	5	1.5732	0.1212
DLY	-2.3552*	0.0092851	4	-2.1562	0.0352
DLY	-3.2607**	0.0095679	3	3.1565	0.0025
DLY	-2.3353*	0.010258	2	-5.0079	0.0000
DLY	-4.8055**	0.012114	1	6.2815	0.0000
DLY	-2.4427*	0.015420	0		

Unit root tests for DLY

The present sample is: 1972 (3) to 1990 (1)

Augmented Dickey-Fuller test for DLY; DDLY on

Variable	Coefficient	Std.Error	t-value
DLY_1	-0.11053	0.047271	-2.338
DDLY_1	1.1128	0.11017	10.100
DDLY_2	-1.1079	0.16266	-6.811
DDLY_3	0.63873	0.15462	4.131
DDLY_4	-0.30261	0.11642	-2.599

σ = 0.00878893 DW = 1.90 DW(DLY) = 0.3171 ADF(DLY) = -2.338*
Critical values used in ADF test: 5%=-1.945 1%=-2.595
RSS = 0.005098187784 for 5 variables and 71 observations

Unit root tests 1974 (3) to 1990 (1)
Critical values: 5%=-1.946 1%=-2.599

	t-adf	σ	lag	t-lag	t-prob
DLOY	-2.2598*	0.073517	12	0.051245	0.9593
DLOY	-2.3873*	0.072795	11	0.95936	0.3419
DLOY	-2.2044*	0.072739	10	-0.46878	0.6412
DLOY	-2.5111*	0.072202	9	0.57163	0.5700
DLOY	-2.4728*	0.071750	8	-0.95143	0.3456
DLOY	-3.0766**	0.071688	7	0.37561	0.7086
DLOY	-3.2126**	0.071136	6	-0.25544	0.7993
DLOY	-3.7446**	0.070551	5	2.3597	0.0217
DLOY	-2.9821**	0.073276	4	-1.0506	0.2978
DLOY	-3.8629**	0.073341	3	3.3283	0.0015
DLOY	-2.7080**	0.079261	2	-3.2398	0.0020
DLOY	-4.8316**	0.085207	1	3.7782	0.0004
DLOY	-3.3096**	0.093887	0		

Unit root tests for DLOY

The present sample is: 1972 (4) to 1990 (1)

Augmented Dickey-Fuller test for DLOY: DDLOY on

Variable	Coefficient	Std.Error	t-value
DLOY_1	-0.40902	0.10442	-3.917
DDLOY_1	0.83069	0.12704	6.539
DDLOY_2	-0.60824	0.14179	-4.290
DDLOY_3	0.70100	0.15654	4.478
DDLOY_4	-0.25217	0.12682	-1.988
DDLOY_5	0.29325	0.11944	2.455

σ = 0.0668306 DW = 1.98 DW(DLOY) = 0.6049 ADF(DLOY) = -3.917**

Critical values used in ADF test: 5%=-1.945 1%=-2.596

RSS = 0.2858452264 for 6 variables and 70 observations

7.6 Cointegration Tests for Income Equation

These tests are conducted to seek long-run relationships among real income (y), real government expenditure (g-p) and oil sector income (oy). The first equation with a constant restricted into cointegration space and 5 lags leads to a well-behaved residual (with 4 lags there is autocorrelation problem, EQ(2)) but does not confirm the presence of any cointegration vector. Adding dummies for a structural break around 1976 introduces EQ(3). With this model the existence of one cointegration vector is not rejected. Uniqueness tests show that oy and (g-p) are weakly exogenous, hence the unique cointegration relationship is :

$$y = 6.95 + 0.3\,(g\text{-}p) + 0.17\,oy$$

s1976p2 and ts1976p2 respectively refer to step dummy for the second quarter 1976 and trends multipied by that dummy.

EQ(1) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (2) to 1990 (1)

URF Equation 1 for y

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	2.9808	0.15813	18.851	0.0000
y_2	-3.8509	0.43441	-8.865	0.0000
y_3	2.7284	0.57332	4.759	0.0000
y_4	-1.0067	0.44125	-2.281	0.0263
y_5	0.12469	0.15785	0.790	0.4329
g _1	0.001105	0.005266	0.210	0.8345
g _2	-0.002459	0.004865	-0.506	0.6152
g _3	-0.001456	0.005236	-0.278	0.7819
g _4	0.0037706	0.004892	0.771	0.4441
g _5	-7.7444e-005	0.005311	-0.015	0.9884
oy_1	-0.041468	0.019960	-2.078	0.0423
oy_2	0.075975	0.045131	1.683	0.0979
oy_3	-0.007334	0.055513	-0.132	0.8954
oy_4	-0.061951	0.046773	-1.325	0.1907
oy_5	0.034083	0.019988	1.705	0.0937
Constant	0.22272	0.10261	2.170	0.0342

$\sigma = 0.00841141$ RSS = 0.003962097849

URF Equation 2 for g-p

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	1.4751	3.8791	0.380	0.7052
y_2	-3.7157	10.657	-0.349	0.7286
y_3	5.3590	14.065	0.381	0.7046
y_4	-4.9600	10.825	-0.458	0.6486
y_5	1.5708	3.8724	0.406	0.6866
g _1	0.37052	0.12919	2.868	0.0058
g _2	0.36918	0.11936	3.093	0.0031
g _3	-0.054117	0.12846	-0.421	0.6752
g _4	0.51425	0.12001	4.285	0.0001
g _5	-0.24770	0.13030	-1.901	0.0624
oy_1	0.14115	0.48966	0.288	0.7742
oy_2	-0.40419	1.1072	-0.365	0.7164
oy_3	0.63449	1.3618	0.466	0.6431
oy_4	-0.44305	1.1474	-0.386	0.7009
oy_5	0.17514	0.49036	0.357	0.7223
Constant	1.8510	2.5173	0.735	0.4652

$\sigma = 0.206348$ RSS = 2.384457895

URF Equation 3 for oy

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	2.7826	1.2038	2.312	0.0245
y_2	-4.4620	3.3071	-1.349	0.1827
y_3	0.59179	4.3646	0.136	0.8926
y_4	2.6237	3.3592	0.781	0.4380
y_5	-1.5181	1.2017	-1.263	0.2117
g _1	-0.005236	0.04009	-0.131	0.8966
g _2	0.00034752	0.03704	0.009	0.9925
g _3	-0.031355	0.03986	-0.787	0.4349
g _4	0.0076117	0.03724	0.204	0.8388
g _5	0.018702	0.04043	0.463	0.6455
oy_1	1.9649	0.15195	12.931	0.0000
oy_2	-1.9174	0.34358	-5.581	0.0000
oy_3	1.8412	0.42261	4.357	0.0001
oy_4	-1.4860	0.35607	-4.173	0.0001
oy_5	0.56163	0.15217	3.691	0.0005
Constant	0.12811	0.78119	0.164	0.8703

$\sigma = 0.0640347$ RSS = 0.2296248116

correlation of URF residuals

	y	g	oy
y	1.000		
g	0.04832	1.000	
oy	0.5869	0.1096	1.000

standard deviations of URF residuals

y	g	oy
0.008411	0.2063	0.06403

loglik = 698.33392 log|ê| = -19.3982 |ê| = 3.76257e-009 T = 72
log|Y'Y/T| = 1.58902
R^2(LR) = 1 R^2(LM) = 0.940877

F-test against unrestricted regressors, F(48, 161) = 3897.7 [0.0000] **
No variables entered unrestricted.
F-tests on retained regressors, F(3, 54)

y_1	151.887 [0.0000] **	y_2	32.5931 [0.0000] **
y_3	10.8184 [0.0000] **	y_4	3.99879 [0.0121] *
y_5	1.77305 [0.1633]	g_1	2.76283 [0.0508]
g_2	3.21436 [0.0299] *	g_3	0.250915 [0.8603]
g_4	6.17890 [0.0011] **	g_5	1.35763 [0.2655]
oy_1	100.179 [0.0000] **	oy_2	22.1126 [0.0000] **
oy_3	9.64938 [0.0000] **	oy_4	6.22146 [0.0010] **
oy_5	4.48406 [0.0070] **	Constant	2.31027 [0.0866]

correlation of actual and fitted

y	g	oy
0.9978	0.9226	0.9950

Vector portmanteau statistic for 8 lags and 72 observations: 61.3

Testing for vector error autocorrelation from lags 1 to 5
Chi^2(45) = 63.363 [0.0368] * and F-Form(45, 116) = 1.1369 [0.2891]

Vector normality test for residuals
The present sample is: 1972 (2) to 1990 (1)
Skewness
1.870 -0.8197 -1.785

Excess kurtosis
-0.04904 2.419 7.810

Vector normality Chi^2 (6)= 74.202 [0.0000] **

Testing for vector heteroscedasticity using squares
Chi^2(180) = 196.37 [0.1914] and F-Form(180, 126) = 0.71547 [0.9803]

EQ(2) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (1) to 1990 (1)

URF Equation 1 for y

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	2.8076	0.13659	20.555	0.0000
y_2	-3.3411	0.32641	-10.236	0.0000
y_3	2.0648	0.33172	6.224	0.0000
y_4	-0.55899	0.13736	-4.069	0.0001
g _1	0.0019374	0.0048506	0.399	0.6910
g _2	-0.0028559	0.0049843	-0.573	0.5688
g _3	-0.00064353	0.0049646	-0.130	0.8973
g _4	0.0042001	0.0049529	0.848	0.3998
oy_1	-0.047020	0.019694	-2.388	0.0201
oy_2	0.092367	0.041174	2.243	0.0286
oy_3	-0.042431	0.042015	-1.010	0.3166
oy_4	-0.0053281	0.019508	-0.273	0.7857
Constant	0.26769	0.097606	2.743	0.0080

$\sigma = 0.00883993$ RSS = 0.004688658905

URF Equation 2 for g-p

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	-0.38274	3.2192	-0.119	0.9058
y_2	1.8483	7.6930	0.240	0.8110
y_3	-1.8490	7.8180	-0.237	0.8138
y_4	0.0079627	3.2374	0.002	0.9980
g _1	0.28032	0.11432	2.452	0.0171
g _2	0.40996	0.11747	3.490	0.0009
g _3	-0.15353	0.1170	-1.312	0.1945
g _4	0.45575	0.11673	3.904	0.0002
oy_1	0.16625	0.46416	0.358	0.7215
oy_2	-0.44509	0.97039	-0.459	0.6481
oy_3	0.62380	0.99022	0.630	0.5311
oy_4	-0.23213	0.45977	-0.505	0.6155
Constant	2.6182	2.3004	1.138	0.2596

$\sigma = 0.208341$ RSS = 2.604365268

URF Equation 3 for oy

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	2.5755	1.0863	2.371	0.0210
y_2	-4.7110	2.5960	-1.815	0.0746
y_3	2.4749	2.6382	0.938	0.3520
y_4	-0.37132	1.0925	-0.340	0.7351
g _1	0.0010825	0.03857	0.028	0.9777
g _2	-0.0019930	0.03964	-0.050	0.9601
g _3	-0.0062009	0.03948	-0.157	0.8757
g _4	0.011409	0.03939	0.290	0.7731
oy_1	1.8067	0.15663	11.535	0.0000
oy_2	-1.4104	0.32745	-4.307	0.0001

oy_3	0.92516	0.33415	2.769	0.0075
oy_4	-0.36283	0.15515	-2.339	0.0227
Constant	0.59622	0.77626	0.768	0.4455

σ = 0.0703042 RSS = 0.2965610956

correlation of URF residuals

	y	g	oy
y	1.000		
g	0.09694	1.000	
oy	0.6290	0.1286	1.000

standard deviations of URF residuals

y	g	oy
0.008840	0.2083	0.07030

loglik = 693.97092 log|ê| = -19.0129 |ê| = 5.53097e-009 T = 73
log|Y'Y/T| = 1.60916
R^2 (LR) = 1 R^2 (LM) = 0.936473

F-test against unrestricted regressors, F(39, 172) = 4674.8 [0.0000] **
No variables entered unrestricted.
F-tests on retained regressors, F(3, 58)

y_1	195.846 [0.0000] **	y_2	45.3214 [0.0000] **
y_3	17.2928 [0.0000] **	y_4	7.96980 [0.0002] **
g _1	2.02661 [0.1201]	g _2	4.19708 [0.0093] **
g _3	0.554859 [0.6470]	g _4	5.12026 [0.0033] **
oy_1	92.6871 [0.0000] **	oy_2	19.0536 [0.0000] **
oy_3	6.54528 [0.0007] **	oy_4	2.54530 [0.0648]
Constant	3.22621 [0.0289] *		

correlation of actual and fitted

y	g	oy
0.9976	0.9167	0.9936

Vector portmanteau statistic for 8 lags and 73 observations: 74.3

Testing for vector error autocorrelation from lags 1 to 4
$Chi^2(36)$ = 60.02 [0.0072] ** and F-Form(36, 136) = 1.519 [0.0460] *

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness
1.043 -0.2715 -1.025

Excess kurtosis
1.732 2.451 8.300

Vector normality Chi^2(6)= 80.103 [0.0000] **

Testing for vector heteroscedasticity using squares
Chi^2(144) = 166.99 [0.0922] and F-Form(144, 183) = 0.93677 [0.6581]

Cointegration analysis 1972 (2) to 1990 (1)

eigenvalue μi	loglik for rank	
	686.976	0
0.16184	693.332	1
0.0859211	696.566	2
0.0479303	698.334	3
-5.91183e-016	---	

Ho:rank=p	-Tlog(1-μ)	using T-nm	95%	-TΣlg(1-μ)	using T-nm	95%
p == 0	12.71	10.06	22.0	22.72	17.98	34.9
p <= 1	6.468	5.121	15.7	10	7.92	20.0
p <= 2	3.536	2.8	9.2	3.536	2.8	9.2

standardized β' eigenvectors

y	g	oy	Constant
1.000	-0.03648	-0.1858	-7.769
136.9	1.000	54.00	-1681.
1.952	-1.731	1.000	-21.17

standardized α coefficients

y	-0.01501	-6.028e-005	-0.0002279
g	-0.3487	6.913e-005	0.03503
oy	0.07513	-0.0004724	0.003880

long-run matrix Po=αβ', rank 3

	y	g	oy	Constant
y	-0.02370	0.0008818	-0.0006958	0.2227
g	-0.2708	-0.04787	0.1035	1.851
oy	0.01802	-0.009930	-0.03559	0.1281

Number of lags used in the analysis: 5
Variables entered restricted:
Constant

EQ(3) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (2) to 1990 (1)

URF Equation 1 for y
Variable Coefficient Std.Error t-value t-prob

y_1	2.8883	0.16045	18.000	0.0000
y_2	-3.6418	0.43060	-8.458	0.0000
y_3	2.5063	0.56527	4.434	0.0000
y_4	-0.89493	0.43535	-2.056	0.0447
y_5	0.093228	0.15981	0.583	0.5621
g _1	3.2537e-005	0.0055571	0.006	0.9953
g _2	-2.4423e-005	0.0051110	-0.005	0.9962
g _3	0.00055990	0.0051688	0.108	0.9141
g _4	0.0091759	0.0052904	1.734	0.0885
g _5	0.0072181	0.0059626	1.211	0.2313
oy_1	-0.030875	0.021297	-1.450	0.1529
oy_2	0.056932	0.045732	1.245	0.2185
oy_3	0.013142	0.055987	0.235	0.8153
oy_4	-0.075570	0.047822	-1.580	0.1199
oy_5	0.040349	0.022101	1.826	0.0734
Constant	0.37066	0.20156	1.839	0.0714
s1976p2	-0.024484	0.010182	-2.405	0.0196
ts1976p2	0.0004705	0.00027496	1.711	0.0927

$\sigma = 0.00813616$ RSS = 0.003574641168

URF Equation 2 for g-p

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	3.6220	3.6539	0.991	0.3260
y_2	-5.8927	9.8056	-0.601	0.5504
y_3	9.4589	12.872	0.735	0.4656
y_4	-10.773	9.9139	-1.087	0.2820
y_5	5.4200	3.6391	1.489	0.1422
g _1	0.17197	0.12654	1.359	0.1798
g _2	0.22976	0.11639	1.974	0.0535
g _3	-0.096978	0.11770	-0.824	0.4136
g _4	0.47424	0.12047	3.937	0.0002
g _5	-0.18633	0.13578	-1.372	0.1756
oy_1	-0.49788	0.48497	-1.027	0.3092
oy_2	0.47980	1.0414	0.461	0.6468
oy_3	-0.44362	1.2749	-0.348	0.7292
oy_4	0.76327	1.0890	0.701	0.4864
oy_5	-0.71200	0.50329	-1.415	0.1629
Constant	-11.928	4.5899	-2.599	0.0120
s1976p2	-0.03179	0.23185	-0.137	0.8914
ts1976p2	-0.01470	0.00626	-2.349	0.0225

$\sigma = 0.185276$ RSS = 1.853668647

URF Equation 3 for oy

Variable	Coefficient	Std.Error	t-value	t-prob
y_1	3.0613	1.2604	2.429	0.0185

y_2	-4.7423	3.3823	-1.402	0.1666
y_3	1.1231	4.4401	0.253	0.8013
y_4	1.8665	3.4197	0.546	0.5875
y_5	-1.0158	1.2553	-0.809	0.4219
g_1	-0.031201	0.043650	-0.715	0.4778
g_2	-0.017820	0.040146	-0.444	0.6589
g_3	-0.036916	0.040601	-0.909	0.3673
g_4	0.0024911	0.041555	0.060	0.9524
g_5	0.026866	0.046835	0.574	0.5686
oy_1	1.8816	0.16728	11.24	0.0000
oy_2	-1.8022	0.35922	-5.017	0.0000
oy_3	1.7008	0.43977	3.867	0.0003
oy_4	-1.3286	0.37563	-3.537	0.0008
oy_5	0.44584	0.17360	2.568	0.0130
Constant	-1.6694	1.5832	-1.054	0.2964
s1976p2	-0.004639	0.079975	-0.058	0.9540
ts1976p2	-0.001912	0.002159	-0.885	0.3799

σ = 0.0639085 RSS = 0.2205523048

correlation of URF residuals

	y	g	oy
y	1.000		
g	0.03228	1.000	
oy	0.6206	0.01836	1.000

standard deviations of URF residuals

y	g	oy
0.008136	0.1853	0.06391

loglik = 714.44801 log|ê| = -19.8458 |ê| = 2.40485e-009 T = 72
log|Y'Y/T| = -1.72441
R^2 (LR) = 1 R^2 (LM) = 0.894308

F-test against unrestricted regressors, F(48, 155) = 1430.3 [0.0000] **
variables entered unrestricted:
s1976p2 ts1976p2

F-tests on retained regressors, F(3, 52)

y_1	143.954 [0.0000] **	y_2	30.7180 [0.0000] **
y_3	9.67924 [0.0000] **	y_4	3.41988 [0.0239] *
y_5	1.51734 [0.2209]	g_1	0.860994 [0.4672]
g_2	1.35244 [0.2676]	g_3	0.722939 [0.5429]
g_4	6.33681 [0.0010] **	g_5	1.12741 [0.3465]
oy_1	78.0012 [0.0000] **	oy_2	18.0501 [0.0000] **
oy_3	7.28708 [0.0004] **	oy_4	4.39130 [0.0079] **
oy_5	2.83920 [0.0468] *	Constant	5.88297 [0.0016] **

correlation of actual and fitted

y	g	oy
0.9980	0.9404	0.9952

Vector portmanteau statistic for 8 lags and 72 observations: 57.23

Testing for vector error autocorrelation from lags 1 to 5
$Chi^2(45)$ = 73.139 [0.0050] ** and F-Form(45, 110) = 1.3043 [0.1331]

Vector normality test for residuals
The present sample is: 1972 (2) to 1990 (1)
Skewness
2.834 -1.405 -1.781

Excess kurtosis
0.1452 0.4088 7.635

Vector normality Chi^2(6)= 71.663 [0.0000] **

Testing for vector heteroscedasticity using squares
$Chi^2(180)$ = 190.91 [0.2747] and F-Form(180, 114) = 0.62098 [0.9979]

Single Equation Diagnostic Tests

Testing y for Error Autocorrelation from lags 1 to 5
$Chi^2(5)$ = 14.361 [0.0135] * and F-Form(5, 49) = 2.4417 [0.0471] *

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Coeff.	-0.5026	-0.6749	0.02142	0.211	-0.0467

Testing g for Error Autocorrelation from lags 1 to 5
$Chi^2(5)$ = 8.7002 [0.1216] and F-Form(5, 49) = 1.347 [0.2606]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Coeff.	0.005056	0.1896	0.2333	-0.5071	-0.3343

Testing oy for Error Autocorrelation from lags 1 to 5
$Chi^2(5)$ = 7.3483 [0.1960] and F-Form(5, 49) = 1.1139 [0.3653]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Coeff.	-0.05242	-0.4355	0.2987	0.08593	0.03157

Normality test for y

The present sample is: 1972 (2) to 1990 (1)
Sample Size 72
Mean 0.000000
Std.Devn. 0.007046
Skewness 0.650153
Excess Kurtosis 1.043605
Minimum -0.013969
Maximum 0.023939
Normality $Chi^2(2)$= 5.778 [0.0556]

Normality test for g
The present sample is: 1972 (2) to 1990 (1)
Sample Size 72
Mean 0.000000
Std.Devn. 0.160454
Skewness -0.395253
Excess Kurtosis 0.224157
Minimum -0.454019
Maximum 0.389056
Normality $Chi^2(2)$= 2.2146 [0.3305]

Normality test for oy
The present sample is: 1972 (2) to 1990 (1)
Sample Size 72
Mean 0.000000
Std.Devn. 0.055346
Skewness -0.446176
Excess Kurtosis 4.753846
Minimum -0.198255
Maximum 0.199962
Normality $Chi^2(2)$= 42.349 [0.0000] **

Testing y for ARCH from lags 1 to 4
$Chi^2(4)$ = 4.9733 [0.2900] and F-Form(4, 46) = 0.90744 [0.4676]

Testing g for ARCH from lags 1 to 4
$Chi^2(4)$ = 9.2189 [0.0559] and F-Form(4, 46) = 1.8036 [0.1444]

Testing oy for ARCH from lags 1 to 4
$Chi^2(4)$ = 15.905 [0.0031] ** and F-Form(4, 46) = 3.511 [0.0139] *

Testing y for Heteroscedastic errors
Chi^2 (30) = 36.117 [0.2043] and F-Form(30, 23) = 0.77165 [0.7503]

Testing g-p for Heteroscedastic errors
Chi^2 (30) = 35.085 [0.2396] and F-Form(30, 23) = 0.72865 [0.7943]

Testing oy for Heteroscedastic errors
Chi^2 (30) = 51.27 [0.0091] ** and F-Form(30, 23) = 1.8962 [0.0588]

Cointegration analysis 1972 (2) to 1990 (1)

eigenvalue μi	loglik for rank	
	691.002	0
0.265436	702.107	1
0.239262	711.952	2
0.0669962	714.448	3
8.15358e-017	---	

Ho:rank=p	-Tlog(1-μ)	using T-nm	95%	-TΣlg(1-μ)	using T-nm	95%
p == 0	22.21*	17.58	22.0	46.89**	37.12*	34.9
p <= 1	19.69*	15.59	15.7	24.68*	19.54	20.0
p <= 2	4.993	3.953	9.2	4.993	3.953	9.2

standardized β' eigenvectors

y	g-p	oy	Constant
1.000	-0.2776	-0.1908	-6.794
-5.099	1.000	1.272	32.13
-0.1797	-0.3937	1.000	-5.245

standardized α coefficients

y	-0.06608	-0.003185	-0.004580
g-p	0.4738	-0.2678	0.02051
oy	0.2264	-0.01142	-0.04493

long-run matrix Po=αβ', rank 3

	y	g-p	oy	Constant
y	-0.04902	0.01696	0.003978	0.3707
g-p	1.835	-0.4073	-0.4104	-11.93
oy	0.2927	-0.05658	-0.1026	-1.669

Number of lags used in the analysis: 5
Variables entered unrestricted:
s1976p2 ts1976p2
Variables entered restricted:
Constant

General cointegration test 1972 (2) to 1990 (1)

β'

y	g-p	oy	Constant
0.8620	-0.2546	-0.1455	-5.996

α

y	-0.08563
g-p	0.0000
oy	0.0000

standardized β' eigenvectors

y	g-p	oy	Constant
1.000	-0.2954	-0.1688	-6.955

standardized à coefficients

y	-0.07382
g-p	0.0000
oy	0.0000

Restricted long-run matrix Po=αβ', rank 1

	y	g-p	oy	Constant
y	-0.07382	0.02180	0.01246	0.5134
g-p	0.0000	0.0000	0.0000	0.0000
oy	0.0000	0.0000	0.0000	0.0000

Reduced form β'

	g-p	oy	Constant
y	0.2954	0.1688	6.955

loglik = 701.559 unrloglik = 702.107
LR-test, rank=1: Chi^2 (÷2) = 1.0954 [0.5783]

7.7 Cointegration Tests for Government Revenue Equation

EQ(1) is built to examine the presence of long-run relationship between real government revenue (rr), real income (y) and real oil-induced revenue of the government (ror). The equation contains the structural dummies and a constant imposed onto cointegration space. The lag length is selected at 4 because decreasing the number of lag to 3 leads to the autocorrelation problem (EQ(2)). The test for cointegration confirms that there is a long-run relationship. The joint restriction test (General coint. ... 1) for weak exogeneity of y and ror is rejected. The test for y being weak exogenous is not rejected (General coint. ... 3) but that of ror is rejected (General coint. ... 2). The acceptable cointegration vector is the first standardized β eigenvector (shadowed)(See page 164):

$$rr = -4.5 + 0.3\ ror + 0.7\ y$$

s1974p2 and ts1974p2 respectively refer to step dummy for the second quarter 1974 and trends multipied by that dummy.

EQ(1) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (1) to 1990 (1)

URF Equation 1 for rr

Variable	Coefficient	Std.Error	t-value	t-prob
rr_1	-0.10043	0.19536	-0.514	0.6092
rr_2	-0.27149	0.20178	-1.345	0.1837
rr_3	-0.39344	0.19903	-1.977	0.0528
rr_4	0.32576	0.21256	1.533	0.1308
ror_1	0.085644	0.14465	0.592	0.5561
ror_2	0.28140	0.15743	1.787	0.0791
ror_3	0.075812	0.15649	0.484	0.6299
ror_4	0.021770	0.15808	0.138	0.8909
y_1	3.2984	2.5522	1.292	0.2014
y_2	-1.5083	6.2107	-0.243	0.8090
y_3	1.7285	6.2573	0.276	0.7833
y_4	-2.4676	2.5836	-0.955	0.3435
Constant	-6.9181	3.4724	-1.992	0.0511
s1974p2	1.1854	0.21865	5.421	0.0000
ts1974p2	-0.020080	0.00409	-4.906	0.0000

σ = 0.213927 RSS = 2.654354888

URF Equation 2 for ror

Variable	Coefficient	Std.Error	t-value	t-prob
rr_1	-0.58179	0.27908	-2.085	0.0415
rr_2	-0.53384	0.28825	-1.852	0.0691
rr_3	-0.14289	0.28431	-0.503	0.6172
rr_4	0.29632	0.30365	0.976	0.3332
ror_1	0.52840	0.20664	2.557	0.0132
ror_2	0.54553	0.22490	2.426	0.0184
ror_3	-0.12451	0.22355	-0.557	0.5797
ror_4	0.059243	0.22582	0.262	0.7940
y_1	2.7992	3.6459	0.768	0.4457
y_2	4.8758	8.8720	0.550	0.5847
y_3	-8.9817	8.9386	-1.005	0.3192
y_4	2.4745	3.6908	0.670	0.5052
Constant	-8.2357	4.9603	-1.660	0.1023
s1974p2	1.4891	0.31235	4.76	0.0000
ts1974p2	-0.02970	0.00584	-5.079	0.0000

$\sigma = 0.305597$ RSS = 5.416588187

URF Equation 3 for y

Variable	Coefficient	Std.Error	t-value	t-prob
rr_1	0.0014371	0.0086845	0.165	0.8691
rr_2	0.0026944	0.0089699	0.300	0.7650
rr_3	0.0097420	0.0088475	1.101	0.2754
rr_4	0.0014321	0.0094490	0.152	0.8801
ror_1	-0.0001114	0.0064302	-0.017	0.9862
ror_2	-0.0005910	0.0069984	-0.084	0.9330
ror_3	-0.007349	0.0069567	-1.056	0.2952
ror_4	-0.002392	0.0070273	-0.340	0.7348
y_1	2.5941	0.11345	22.86	0.0000
y_2	-2.9784	0.27609	-10.78	0.0000
y_3	1.9358	0.27816	6.960	0.0000
y_4	-0.59851	0.11485	-5.211	0.0000
Constant	0.41019	0.15436	2.657	0.0102
s1974p2	0.008805	0.0097198	0.906	0.3687
ts1974p2	-4.8543e-005	0.0001819	-0.267	0.7906

$\sigma = 0.00950974$ RSS = 0.005245239125

correlation of URF residuals

	rr	ror	y
rr	1.000		
ror	0.7322	1.000	
y	0.04698	-0.1525	1.000

standard deviations of URF residuals

rr	ror	y
0.2139	0.3056	0.009510

loglik = 595.13515 log|ê| = -16.3051 |ê| = 8.29463e-008 T = 73
log|Y'Y/T| = -3.23332
R^2(LR) = 0.999998 R^2(LM) = 0.611157

F-test against unrestricted regressors, F(39, 166) = 348.64 [0.0000] **
variables entered unrestricted:
s1974p2 ts1974p2

F-tests on retained regressors, F(3, 56)

rr_1	2.19670 [0.0985]	rr_2	1.10406 [0.3552]
rr_3	2.74229 [0.0516]	rr_4	0.770930 [0.5151]
ror_1	3.47126 [0.0219] *	ror_2	1.92146 [0.1366]
ror_3	1.38228 [0.2576]	ror_4	0.0519085 [0.9842]
y_1	180.840 [0.0000] **	y_2	38.7298 [0.0000] **
y_3	15.5958 [0.0000] **	y_4	9.02397 [0.0001] **
Constant	3.79244 [0.0151] *		

correlation of actual and fitted

rr	ror	y
0.9506	0.9597	0.9974

Testing rr for Error Autocorrelation from lags 1 to 4
$Chi^2(4)$ = 4.3135 [0.3652] and F-Form(4, 54) = 0.84781 [0.5012]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.298	0.01007	-0.2747	-0.1076

Testing ror for Error Autocorrelation from lags 1 to 4
$Chi^2(4)$ = 1.4948 [0.8276] and F-Form(4, 54) = 0.28221 [0.8883]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.0763	0.0449	-0.03899	-0.192

Testing y for Error Autocorrelation from lags 1 to 4
$Chi^2(4)$ = 15.847 [0.0032] ** and F-Form(4, 54) = 3.7431 [0.0093] **

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4
Coeff.	0.4572	-0.5638	-0.02148	-0.3014

Normality test for rr

The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean 0.000000
Std.Devn. 0.190686
Skewness -0.755165
Excess Kurtosis 0.421943
Minimum -0.615781
Maximum 0.334896
Normality $Chi^2(2)$= 8.2748 [0.0160] *

Normality test for ror
The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean 0.000000
Std.Devn. 0.272396
Skewness -0.425428
Excess Kurtosis 0.766690
Minimum -0.847720
Maximum 0.533253
Normality $Chi^2(2)$= 4.0752 [0.1303]

Normality test for y
The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean 0.000000
Std.Devn. 0.008477
Skewness 0.118929
Excess Kurtosis 0.391707
Minimum -0.022570
Maximum 0.025249
Normality $Chi^2(2)$= 1.9916 [0.3694]

Testing rr for ARCH from lags 1 to 4
$Chi^2(4)$ = 0.67579 [0.9543] and F-Form(4, 50) = 0.12364 [0.9733]

Testing ror for ARCH from lags 1 to 4
$Chi^2(4)$ = 2.536 [0.6382] and F-Form(4, 50) = 0.47696 [0.7524]

Testing y for ARCH from lags 1 to 4
$Chi^2(4)$ = 11.261 [0.0238] * and F-Form(4, 50) = 2.4378 [0.0591]

Testing rr for Heteroscedastic errors
$Chi^2(24)$ = 25.51 [0.3785] and F-Form(24, 33) = 0.7386 [0.7775]

Testing ror for Heteroscedastic errors
$Chi^2(24)$ = 38.632 [0.0298] * and F-Form(24, 33) = 1.5456 [0.1218]

Testing y for Heteroscedastic errors
$Chi^2(24) = 23.153$ [0.5108] and F-Form(24, 33) = 0.63867 [0.8714]

Testing for vector error autocorrelation from lags 1 to 4
$Chi^2(36) = 53.537$ [0.0301] * and F-Form(36, 130) = 1.2666 [0.1700]

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness

-1.883 -0.9656 0.1245

Excess kurtosis

-0.5881 0.9137 1.107

Vector normality $Chi^2(6)$= 6.9001 [0.3302]

Testing for vector heteroscedasticity using squares
$Chi^2(144) = 162.75$ [0.1358] and F-Form(144, 171) = 0.84316 [0.8548]

Cointegration analysis 1972 (1) to 1990 (1)

eigenvalue μi	loglik for rank	
	565.827	0
0.388049	583.753	1
0.195155	591.677	2
0.0903972	595.135	3
1.64803e-015	---	

Ho:rank=p	-Tlog(1-μ)	using T-nm	95%	-TΣlg(1-μ)	using T-nm	95%
p == 0	35.85**	29.96**	22.0	58.62**	48.98**	34.9
p <= 1	15.85*	13.24	15.7	22.77*	19.02	20.0
p <= 2	6.917	5.78	9.2	6.917	5.78	9.2

standardized β' eigenvectors

rr	ror	y	Constant
1.000	-0.3001	-0.6967	4.456
-1.466	1.000	1.791	-14.67
0.4992	-0.5274	1.000	-9.250

standardized α coefficients

rr	-1.353	0.05948	0.001699
ror	-1.464	-0.1814	0.4726
y	-0.007419	-0.02066	-0.01516

long-run matrix Po=αβ', rank 3

	rr	ror	y	Constant
rr	-1.440	0.4646	1.051	-6.918

ror	-0.9622	0.008659	1.168	-8.236
y	0.01531	-0.01044	-0.04699	0.4102

Number of lags used in the analysis: 4
Variables entered unrestricted:
s1974p2 ts1974p2
Variables entered restricted:
Constant

General cointegration test 1972 (1) to 1990 (1) [1]

β'

rr	ror	y	Constant
1.629	-0.8235	-0.9981	6.699

α

rr	-0.6050
ror	0.0000
y	0.0000

standardized β' eigenvectors

rr	ror	y	Constant
1.000	-0.5055	-0.6127	4.112

standardized α coefficients

rr	-0.9856
ror	0.0000
y	0.0000

Restricted long-run matrix Po=αβ', rank 1

	rr	ror	y	Constant
rr	-0.9856	0.4982	0.6039	-4.053
ror	0.0000	0.0000	0.0000	0.0000
y	0.0000	0.0000	0.0000	0.0000

Reduced form β'

	ror	y	Constant
rr	0.5055	0.6127	-4.112

loglik = 575.629 unrloglik = 583.753
LR-test, rank=1: $Chi^2(\div 2)$ = 16.248 [0.0003] **

General cointegration test 1972 (1) to 1990 (1) [2]

β'

rr	ror	y	Constant
1.558	-0.7941	-1.000	6.836

α

rr	-0.6278
ror	0.0000
y	0.002357

standardized β' eigenvectors

rr	ror	y	Constant
1.000	-0.5097	-0.6421	4.388

standardized α coefficients

rr	-0.9781
ror	0.0000
y	0.003673

Restricted long-run matrix Po=αβ', rank 1

	rr	ror	y	Constant
rr	-0.9781	0.4985	0.6281	-4.292
ror	0.0000	0.0000	0.0000	0.0000
y	0.003673	-0.001872	-0.002358	0.01611

Reduced form β'

	ror	y	Constant
rr	0.5097	0.6421	-4.388

loglik = 575.639 unrloglik = 583.753
LR-test, rank=1: Chi(÷1) = 16.227 [0.0001] **

General cointegration test 1972 (1) to 1990 (1) **[3]**

β'

rr	ror	y	Constant
1.058	-0.3366	-0.8077	5.394

α

rr	-1.350
ror	-1.474
y	0.0000

standardized β' eigenvectors

rr	ror	y	Constant
1.000	-0.3180	-0.7631	5.096

standardized α coefficients

rr	-1.429
ror	-1.560
y	0.0000

Restricted long-run matrix Po=αβ', rank 1

	rr	ror	y	Constant
rr	-1.429	0.4545	1.091	-7.284
ror	-1.560	0.4962	1.191	-7.951
y	0.0000	0.0000	0.0000	0.0000

Reduced form β'

	ror	y	Constant
rr	0.3180	0.7631	-5.096

loglik = 583.55 unrloglik = 583.753
LR-test, rank=1: $Chi^2(\div 1)$ = 0.40543 [0.5243]

7.8 Cointegration for Price Equation

Seeking a long-run relationship between real money (m-p), real income (y) and the expected rate of inflation (π = p*) the following tests are conducted. Trend and structural dummies are imposed onto cointegration space. The cointegration test shows the existence of a cointegrated vector among the variables. The assumption that y is weak exogenous is not rejected. So, the unique long-run relationship is :

$$(m\text{-}p) = 0.106\ y - 5.679\ \pi + 0.05\ t + 2.06\ DU - 0.056\ DT$$

s1980p2 and ts1980p2 respectively refer to step dummy for the second quarter 1980 and trends multipied by that dummy.

EQ(1) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (3) to 1990 (1)

URF Equation 1 for m-p

Variable	Coefficient	Std.Error	t-value	t-prob
m-p_1	0.76988	0.12447	6.185	0.0000
m-p_2	0.099089	0.13925	0.712	0.4798
m-p_3	-0.13193	0.13800	-0.956	0.3433
m-p_4	0.34729	0.13967	2.487	0.0160
m-p_5	-0.33402	0.15818	-2.112	0.0394
m-p_6	0.089913	0.14234	0.632	0.5303
y_1	-0.27185	0.72332	-0.376	0.7085
y_2	1.2290	2.1236	0.579	0.5652
y_3	-2.4262	3.2066	-0.757	0.4526
y_4	2.5433	3.2332	0.787	0.4350
y_5	-1.4330	2.1861	-0.656	0.5149
y_6	0.35116	0.76419	0.460	0.6477
p*	-0.93662	0.25499	-3.673	0.0006
Trend	0.0080471	0.00449	1.790	0.0790
s1980p2	0.32420	0.19638	1.651	0.1046
ts1980p2	-0.0088149	0.00442	-1.990	0.0517
Constant	0.57396	0.88225	0.651	0.5181

$\sigma = 0.047809$ RSS = 0.1234279614

URF Equation 2 for y

Variable	Coefficient	Std.Error	t-value	t-prob
m-p_1	0.010457	0.022897	0.457	0.6497
m-p_2	-0.015257	0.025615	-0.596	0.5539
m-p_3	0.013778	0.025386	0.543	0.5896

m-p_4	0.010322	0.025692	0.402	0.6894
m-p_5	-0.019292	0.029097	-0.663	0.5101
m-p_6	-0.0021457	0.026184	-0.082	0.9350
y_1	2.8624	0.13306	21.513	0.0000
y_2	-3.9180	0.39065	-10.030	0.0000
y_3	3.5721	0.58986	6.056	0.0000
y_4	-2.3366	0.59476	-3.929	0.0002
y_5	1.0679	0.40213	2.655	0.0104
y_6	-0.27314	0.14057	-1.943	0.0572
p*	-0.042253	0.046906	-0.901	0.3717
Trend	4.2330e-005	0.00082689	0.051	0.9594
s1980p2	-0.0011592	0.036125	-0.032	0.9745
ts1980p2	8.7131e-005	0.00081488	0.107	0.9152
Constant	0.24219	0.16229	1.492	0.1414

σ = 0.00879458 RSS = 0.004176608176

correlation of URF residuals

	m-p	y
m-p	1.000	
y	0.1757	1.000

standard deviations of URF residuals

m-p	y
0.04781	0.008795

loglik = 572.51138 log|ê| = -16.1271 |ê| = 9.91055e-008 T = 71
log|Y'Y/T| = -5.80654
R^2 (LR) = 0.999967 R^2 (LM) = 0.994207

F-test against unrestricted regressors, F(32, 106) = 573.76 [0.0000] **
variables entered unrestricted:
Constant

F-tests on retained regressors, F(2, 53)

m-p_1	18.9750 [0.0000] **	m-p_2	0.511497 [0.6025]
m-p_3	0.704298 [0.4990]	m-p_4	3.03486 [0.0565]
m-p_5	2.23154 [0.1174]	m-p_6	0.214664 [0.8075]
y_1	235.857 [0.0000] **	y_2	52.1407 [0.0000] **
y_3	19.6754 [0.0000] **	y_4	8.67864 [0.0005] **
y_5	4.09809 [0.0221] *	y_6	2.17756 [0.1234]
p*	6.65421 [0.0026] **	Trend	1.60783 [0.2099]
s1980p2	1.39002 [0.2580]	ts1980p2	2.04876 [0.1390]

correlation of actual and fitted

m-p	y
0.9967	0.9974

Testing for vector error autocorrelation from lags 1 to 1
Chi^2 (4) = 8.1308 [0.0869] and F-Form(4, 102) = 1.5845 [0.1841]

Testing for vector error autocorrelation from lags 1 to 2
Chi^2 (8) = 18.327 [0.0189] * and F-Form(8, 98) = 1.9137 [0.0663]

Testing for vector error autocorrelation from lags 1 to 3
Chi^2 (12) = 23.246 [0.0257] * and F-Form(12, 94) = 1.6278 [0.0969]

Testing for vector error autocorrelation from lags 1 to 4
Chi^2 (16) = 28.507 [0.0275] * and F-Form(16, 90) = 1.5202 [0.1099]

Testing for vector error autocorrelation from lags 1 to 5
Chi^2 (20) = 29.514 [0.0781] and F-Form(20, 86) = 1.2164 [0.2614]

Testing for vector error autocorrelation from lags 1 to 6
Chi^2(24) = 42.682 [0.0108] * and F-Form(24, 82) = 1.6298 [0.0545]

Vector normality test for residuals
The present sample is: 1972 (3) to 1990 (1)
Skewness
4.689 1.304

Excess kurtosis
1.437 1.732

Vector normality Chi^2(4)= 28.755 [0.0000] **

Testing for vector heteroscedasticity using squares
1 squares removed
Chi^2(93) = 94.575 [0.4350] and F-Form(93, 60) = 0.54192 [0.9961]

Testing m-p for Error Autocorrelation from lags 1 to 6
Chi^2(6) = 23.755 [0.0006] ** and F-Form(6, 48) = 4.0225 [0.0024] **

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6
Coeff.	-0.2612	-0.6934	0.3683	-0.5641	0.2543	-0.3396

Testing y for Error Autocorrelation from lags 1 to 6
Chi^2(6) = 5.1032 [0.5307] and F-Form(6, 48) = 0.61953 [0.7136]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6
Coeff.	0.2235	0.02543	0.5296	0.1295	-0.5013	-0.476

Normality test for m-p
The present sample is: 1972 (3) to 1990 (1)
Sample Size 71
Mean 0.000000
Std.Devn. 0.041694
Skewness 1.616783
Excess Kurtosis 6.638667
Minimum -0.077493
Maximum 0.205594
Normality Chi^2 (2)= 23.326 [0.0000] **

Normality test for y
The present sample is: 1972 (3) to 1990 (1)
Sample Size 71
Mean -0.000000
Std.Devn. 0.007670
Skewness 0.226549
Excess Kurtosis 0.840207
Minimum -0.022932
Maximum 0.020409
Normality Chi^2 (2)= 4.5721 [0.1017]

Testing m-p for ARCH from lags 1 to 4
Chi^2(4) = 2.0227 [0.7316] and F-Form(4, 46) = 0.35798 [0.8372]

Testing y for ARCH from lags 1 to 4
Chi^2(4) = 8.9113 [0.0634] and F-Form(4, 46) = 1.7642 [0.1523]

Testing m-p for Heteroscedastic errors
Chi^2(31) = 30.56 [0.4885] and F-Form(31, 22) = 0.53631 [0.9455]

Testing y for Heteroscedastic errors
Chi^2(31) = 32.911 [0.3736] and F-Form(31, 22) = 0.61319 [0.8966]

Cointegration analysis 1972 (3) to 1990 (1)

eigenvalue μi	loglik for rank	
	550.754	0
0.364622	566.854	1
0.147312	572.511	2
4.75653e-016	---	
7.98469e-017	---	
-1.28252e-017	---	
-2.16577e-016	---	

Ho:rank=p	$-T\log(1-\mu)$	using T-nm	95%	$-T\sum\lg(1-\mu)$	using T-nm	95%
p == 0	32.2**	26.76**	19.0	43.52**	36.16**	25.3
p <= 1	11.31	9.402	12.3	11.31	9.402	12.3

standardized β' eigenvectors

m-p	y	p*	Trend	s1980p2	ts1980p2
1.000	-0.06161	5.734	-0.05064	-2.053	0.05605
0.02458	1.000	1.316	0.001339	0.1669	-0.006731

standardized α coefficients

m-p	-0.1594	-0.01739
y	-0.001511	-0.02552

long-run matrix Po=αβ', rank 2

	m-p	y	p*	Trend	s1980p2	ts1980p2
m-p	-0.1598	-0.007571	-0.9366	0.008047	0.3242	-0.008815
y	-0.002138	-0.02543	-0.04225	4.233e-005	-0.001159	8.713e-005

Number of lags used in the analysis: 6
Variables entered unrestricted:
Constant
Variables entered restricted:
p* Trend s1980p2 ts1980p2

General cointegration test 1972 (3) to 1990 (1)

β'

m-p	y	p*	Trend	s1980p2	ts1980p2
0.9991	-0.1062	5.673	-0.05070	-2.060	0.05635

α

m-p	-0.1580
y	0.0000

standardized β' eigenvectors

m-p	y	p*	Trend	s1980p2	ts1980p2
1.000	-0.1063	5.679	-0.05075	-2.062	0.05640

standardized α coefficients

m-p	-0.1578
y	0.0000

Restricted long-run matrix Po=αβ', rank 1

	m-p	y	p*	Trend	s1980p2	ts1980p2
m-p	-0.1578	0.01678	-0.8963	0.008010	0.3255	-0.008902
y	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Reduced form β'

	y	p*	Trend	s1980p2	ts1980p2
m-p	0.1063	-5.679	0.05075	2.062	-0.05640

loglik = 566.822 unrloglik = 566.854
LR-test, rank=1: Chi^2 (÷1) = 0.063444 [0.8011]

7.9 Model Estimation

EQ(1) is an unrestricted statistical system consisting of all the dependent and independent variables of the model. All relevant tests show an acceptable result. Regarding parsimonious principle the variables Dp_1, Dp_2, Dp_3, Dm_3, Dg_3, Doy_3, Dor_3 and Dor_1 are omitted to build system 2. This system which has reasonable features is used as a base for an econometric model. Then this model is estimated by 3SLS (Model 1) and 2SLS (Model 2).

System 1

EQ(1) Estimating the unrestricted reduced form by OLS
The present sample is: 1972 (1) to 1990 (1)

URF Equation 1 for Dp

Variable	Coefficient	Std.Error	t-value	t-prob
Dp_1	0.23466	3.3801	0.069	0.9450
Dp_2	-1.0865	3.5331	-0.308	0.7601
Dp_3	1.0590	3.4491	0.307	0.7605
Dy_1	-0.14267	0.50456	-0.283	0.7789
Dy_2	0.26190	0.77251	0.339	0.7365
Dy_3	-0.24695	0.51091	-0.483	0.6316
Dr_1	0.021511	0.035949	0.598	0.5531
Dr_2	-0.074236	0.041714	-1.780	0.0831
Dr_3	-0.069731	0.036324	-1.920	0.0624
Dm	0.25966	0.10876	2.387	0.0220
Dm_1	-0.13047	0.10387	-1.256	0.2168
Dm_2	0.085375	0.10475	0.815	0.4201
Dm_3	-0.17763	0.09627	-1.845	0.0728
Dg	-0.026929	0.02437	-1.105	0.2761
Dg_1	-0.0041964	0.03863	-0.109	0.9141
Dg_2	0.058813	0.038380	1.532	0.1337
Dg_3	0.030779	0.029042	1.060	0.2959
Dor	0.0064805	0.012922	0.502	0.6189
Dor_1	-0.021394	0.022657	-0.944	0.3510
Dor_2	0.034193	0.025714	1.330	0.1915
Dor_3	0.028528	0.023849	1.196	0.2390
Doy	0.024337	0.062987	0.386	0.7014
Doy_1	-0.014539	0.097699	-0.149	0.8825
Doy_2	-0.043520	0.10779	-0.404	0.6887
Doy_3	0.077877	0.075796	1.027	0.3107
Dp*_1	0.076375	5.5870	0.014	0.9892
Dp*_2	1.5206	5.0161	0.303	0.7634
Dp*_3	-0.091588	2.3176	-0.040	0.9687

CI(p)_1	0.042838	0.05199	0.824	0.4151
CI(y)_1	0.0073293	0.082414	0.089	0.9296
CI(r)_1	0.017277	0.023060	0.749	0.4583
Seasonal	-0.061582	0.10124	-0.608	0.5466
Seasonal_1	-0.016042	0.099524	-0.161	0.8728
Seasonal_2	-0.13704	0.096005	-1.427	0.1616
Seasonal_3	-0.039781	0.099554	-0.400	0.6917

σ = 0.0283004 RSS = 0.0304346376

URF Equation 2 for Dy

Variable	Coefficient	Std.Error	t-value	t-prob
Dp_1	0.43386	0.89005	0.487	0.6287
Dp_2	-0.32763	0.93035	-0.352	0.7267
Dp_3	-0.23788	0.90823	-0.262	0.7948
Dy_1	1.4937	0.13286	11.243	0.0000
Dy_2	-1.2277	0.20342	-6.035	0.0000
Dy_3	0.46013	0.13453	3.420	0.0015
Dr_1	0.020471	0.00946	2.163	0.0369
Dr_2	0.016375	0.01098	1.491	0.1443
Dr_3	0.0013669	0.00956	0.143	0.8871
Dm	0.014212	0.02863	0.496	0.6226
Dm_1	-0.0017206	0.02735	-0.063	0.9502
Dm_2	-0.0026929	0.02758	-0.098	0.9227
Dm_3	0.011357	0.02535	0.448	0.6567
Dg	-0.0017542	0.00641	-0.273	0.7861
Dg_1	-0.022539	0.01017	-2.215	0.0328
Dg_2	-0.015242	0.01010	-1.508	0.1398
Dg_3	-0.0021435	0.00764	-0.280	0.7808
Dor	0.00045989	0.00340	0.135	0.8932
Dor_1	-0.0034876	0.00596	-0.585	0.5623
Dor_2	-0.0029982	0.00677	-0.443	0.6604
Dor_3	0.0013570	0.00628	0.216	0.8301
Doy	0.083836	0.01658	5.055	0.0000
Doy_1	-0.097088	0.02572	-3.774	0.0005
Doy_2	0.062185	0.02838	2.191	0.0347
Doy_3	-0.016110	0.01995	-0.807	0.4246
Dp*_1	-0.98619	1.4712	-0.670	0.5067
Dp*_2	-0.014648	1.3208	-0.011	0.9912
Dp*_3	0.16058	0.6102	0.263	0.7939
CI(p)_1	0.038131	0.01369	2.785	0.0083
CI(y)_1	-0.066283	0.0217	-3.054	0.0041
CI(r)_1	-0.016385	0.00607	-2.698	0.0103
Seasonal	-0.063011	0.0266	-2.364	0.0233
Seasonal_1	-0.062296	0.0262	-2.377	0.0226
Seasonal_2	-0.063371	0.0252	-2.507	0.0166
Seasonal_3	-0.070612	0.0262	-2.694	0.0105

σ = 0.0074521 RSS = 0.002110285534

URF Equation 3 for Dr

Variable	Coefficient	Std.Error	t-value	t-prob
Dp_1	-28.425	17.311	-1.642	0.1088
Dp_2	35.325	18.095	1.952	0.0583
Dp_3	-8.0636	17.665	-0.456	0.6506
Dy_1	0.83407	2.5842	0.323	0.7486
Dy_2	-2.6042	3.9565	-0.658	0.5144
Dy_3	3.3071	2.6167	1.264	0.2140
Dr_1	-0.40304	0.18412	-2.189	0.0348
Dr_2	-0.33858	0.21364	-1.585	0.1213
Dr_3	-0.22015	0.18604	-1.183	0.2440
Dm	0.35979	0.55704	0.646	0.5222
Dm_1	0.28884	0.53200	0.543	0.5903
Dm_2	0.40353	0.53647	0.752	0.4566
Dm_3	0.12712	0.49309	0.258	0.7980
Dg	0.34818	0.12482	2.789	0.0082
Dg_1	0.34336	0.19789	1.735	0.0908
Dg_2	0.019698	0.19657	0.100	0.9207
Dg_3	0.14289	0.14874	0.961	0.3428
Dor	0.46768	0.066181	7.067	0.0000
Dor_1	0.12766	0.11604	1.100	0.2782
Dor_2	0.23634	0.13169	1.795	0.0807
Dor_3	0.070074	0.12215	0.574	0.5696
Doy	0.026173	0.32260	0.081	0.9358
Doy_1	0.043519	0.50038	0.087	0.9312
Doy_2	0.51650	0.55206	0.936	0.3554
Doy_3	-0.62822	0.38820	-1.618	0.1139
Dp*_1	45.871	28.614	1.603	0.1172
Dp*_2	-32.590	25.690	-1.269	0.2123
Dp*_3	7.7152	11.870	0.650	0.5196
CI(p)_1	-0.17515	0.26628	-0.658	0.5147
CI(y)_1	0.43541	0.42209	1.032	0.3088
CI(r)_1	-0.090026	0.11810	-0.762	0.4506
Seasonal	0.36390	0.51852	0.702	0.4871
Seasonal_1	0.35069	0.50973	0.688	0.4956
Seasonal_2	0.38912	0.49170	0.791	0.4336
Seasonal_3	0.22350	0.50988	0.438	0.6636

σ = 0.144944 RSS = 0.7983315751

correlation of URF residuals

	Dp	Dy	Dr
Dp	1.000		
Dy	-0.3302	1.000	
Dr	-0.06665	0.2389	1.000

standard deviations of URF residuals

Dp	Dy	Dr
0.02830	0.007452	0.1449

loglik = 836.73024 log|ê| = -22.9241 |ê| = 1.10709e-010 T = 73
log|Y'Y/T| = -14.9692
R^2(LR) = 0.999649 R^2(LM) = 0.915649

F-test against unrestricted regressors, F(105, 108) = 13.713 [0.0000] **
No variables entered unrestricted.
F-tests on retained regressors, F(3, 36)

Dp_1	1.13339 [0.3486]	Dp_2	1.49976 [0.2311]
Dp_3	0.0916791 [0.9642]	Dy_1	46.0303 [0.0000] **
Dy_2	12.6895 [0.0000] **	Dy_3	3.90603 [0.0163] *
Dr_1	4.57255 [0.0082] **	Dr_2	2.52836 [0.0727]
Dr_3	1.72492 [0.1792]	Dm	2.46595 [0.0779]
Dm_1	0.690031 [0.5641]	Dm_2	0.416124 [0.7425]
Dm_3	1.09428 [0.3640]	Dg	3.29123 [0.0315] *
Dg_1	3.53510 [0.0242] *	Dg_2	1.16428 [0.3368]
Dg_3	0.701076 [0.5576]	Dor	16.6517 [0.0000] **
Dor_1	1.09423 [0.3641]	Dor_2	1.74759 [0.1747]
Dor_3	0.669483 [0.5763]	Doy	10.0123 [0.0001] **
Doy_1	5.52734 [0.0032] **	Doy_2	1.60766 [0.2046]
Doy_3	1.10158 [0.3611]	Dp*_1	1.20202 [0.3229]
Dp*_2	0.572120 [0.6370]	Dp*_3	0.137868 [0.9367]
CI(p)_1	4.13512 [0.0128] *	CI(y)_1	4.29982 [0.0108] *
CI(r)_1	2.31081 [0.0926]	Seasonal	3.00131 [0.0431] *
Seasonal_1	2.64098 [0.0641]	Seasonal_2	4.46356 [0.0092] **
Seasonal_3	3.28516 [0.0317] *		

correlation of actual and fitted

Dp	Dy	Dr
0.8776	0.9804	0.9565

Testing for vector error autocorrelation from lags 1 to 1
Chi^2 (9) = 17.731 [0.0384] * and F-Form(9, 80) = 1.0145 [0.4357]

Testing for vector error autocorrelation from lags 1 to 2
Chi^2 (18) = 41.86 [0.0012] ** and F-Form(18, 85) = 1.2762 [0.2243]

Testing for vector error autocorrelation from lags 1 to 3
Chi^2 (27) = 46.112 [0.0124] * and F-Form(27, 79) = 0.87676 [0.6401]

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness
0.4813 1.410 -1.111

Excess kurtosis
1.761 0.7194 0.3605

Vector normality Chi^2 (6)= 7.2014 [0.3026]

Testing Dp for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 13.305 [0.0040] ** and F-Form(3, 35) = 2.6004 [0.0676]

Testing Dy for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 10.097 [0.0178] * and F-Form(3, 35) = 1.8727 [0.1522]

Testing Dr for Error Autocorrelation from lags 1 to 3
Chi^2 (3) = 0.50919 [0.9169] and F-Form(3, 35) = 0.08195 [0.9694]

Normality test for Dp
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	-0.000000
Std.Devn.	0.020418
Skewness	0.079056
Excess Kurtosis	0.695572
Minimum	-0.050007
Maximum	0.063592
Normality Chi^2(2)=	3.7673 [0.1520]

Normality test for Dy
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	0.000000
Std.Devn.	0.005377
Skewness	0.417101
Excess Kurtosis	0.152685
Minimum	-0.012992
Maximum	0.014288
Normality Chi^2 (2)=	2.3525 [0.3084]

Normality test for Dr
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	0.000000
Std.Devn.	0.104576
Skewness	-0.304930
Excess Kurtosis	0.006996
Minimum	-0.273606
Maximum	0.208428
Normality Chi^2 (2)=	1.3218 [0.5164]

Testing Dp for ARCH from lags 1 to 4
Chi^2 (4) = 2.1556 [0.7072] and F-Form(4, 30) = 0.24186 [0.9123]

Testing Dy for ARCH from lags 1 to 4
Chi^2 (4) = 7.0871 [0.1314] and F-Form(4, 30) = 0.85852 [0.5000]

Testing Dr for ARCH from lags 1 to 4
Chi^2 (4) = 0.36091 [0.9856] and F-Form(4, 30) = 0.039435 [0.9969]

System 2

Dp_1, Dp_2, Dp_3, Dm_3, Dg_3, Doy_3, Dor_3 and Dor_1 are omitted.

EQ(2) Estimating the unrestricted reduced form by RLS
The present sample is: 1972 (1) to 1990 (1)

URF Equation 1 for Dp

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	-0.030243	0.43374	-0.070	0.9447
Dy_2	-0.43205	0.60084	-0.719	0.4757
Dy_3	0.37713	0.34365	1.097	0.2782
Dr_1	0.0048941	0.022752	0.215	0.8306
Dr_2	-0.041409	0.031391	-1.319	0.1937
Dr_3	-0.012658	0.015649	-0.809	0.4227
Dm	0.20076	0.099123	2.025	0.0487
Dm_1	-0.05908	0.096906	-0.610	0.5451
Dm_2	0.10435	0.094711	1.102	0.2763
Dg	-0.023402	0.023428	-0.999	0.3231
Dg_1	-0.0074633	0.035967	-0.208	0.8365
Dg_2	0.039123	0.027999	1.397	0.1690
Dor	0.016333	0.011663	1.400	0.1681
Dor_2	0.021341	0.019409	1.100	0.2772
Doy	0.021605	0.057658	0.375	0.7096
Doy_1	-0.012820	0.079683	-0.161	0.8729
Doy_2	0.0077125	0.067081	0.115	0.9090
Dp*_1	0.25877	0.30283	0.855	0.3973
Dp*_2	-0.35128	0.23774	-1.478	0.1463
Dp*_3	0.37052	0.24897	1.488	0.1435
Seasonal	-0.10693	0.090040	-1.188	0.2411
Seasonal_1	-0.07100	0.088712	-0.800	0.4276
Seasonal_2	-0.17813	0.086937	-2.049	0.0462
Seasonal_3	-0.084972	0.090693	-0.937	0.3537
CI(p)_1	0.063923	0.044531	1.435	0.1579
CI(y)_1	0.011710	0.069648	0.168	0.8672
CI(r)_1	0.0073579	0.019762	0.372	0.7114

σ = 0.0287458 RSS = 0.03801069831

URF Equation 2 for Dy

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	1.5560	0.10889	14.290	0.0000
Dy_2	-1.2224	0.15084	-8.104	0.0000
Dy_3	0.42963	0.086271	4.980	0.0000
Dr_1	0.015072	0.0057117	2.639	0.0113
Dr_2	0.011401	0.0078805	1.447	0.1547
Dr_3	0.00055415	0.0039287	0.141	0.8884
Dm	0.0037662	0.024884	0.151	0.8804
Dm_1	-0.015481	0.024328	-0.636	0.5277
Dm_2	-0.0023664	0.023777	-0.100	0.9212
Dg	-0.0048798	0.0058816	-0.830	0.4110
Dg_1	-0.023585	0.0090294	-2.612	0.0121
Dg_2	-0.014204	0.0070290	-2.021	0.0491
Dor	-0.00033342	0.0029279	-0.114	0.9098
Dor_2	-0.00065536	0.0048725	-0.135	0.8936
Doy	0.082298	0.014475	5.686	0.0000
Doy_1	-0.097371	0.020004	-4.868	0.0000
Doy_2	0.049412	0.016840	2.934	0.0052
Dp*_1	-0.18049	0.076025	-2.374	0.0218
Dp*_2	-0.024975	0.059683	-0.418	0.6776
Dp*_3	0.011459	0.062502	0.183	0.8553
Seasonal	-0.038653	0.022604	-1.710	0.0940
Seasonal_1	-0.037880	0.022271	-1.701	0.0957
Seasonal_2	-0.040510	0.021825	-1.856	0.0699
Seasonal_3	-0.048255	0.022768	-2.119	0.0395
CI(p)_1	0.024565	0.011179	2.197	0.0331
CI(y)_1	-0.055728	0.017485	-3.187	0.0026
CI(r)_1	-0.011713	0.0049611	-2.361	0.0225

σ = 0.00721648 RSS = 0.002395568778

URF Equation 3 for Dr

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	-1.9963	2.2343	-0.893	0.3762
Dy_2	3.3997	3.0951	1.098	0.2777
Dy_3	0.17432	1.7702	0.098	0.9220
Dr_1	-0.24212	0.11720	-2.066	0.0445
Dr_2	-0.064758	0.16170	-0.400	0.6907
Dr_3	-0.13438	0.080612	-1.667	0.1023
Dm	0.61050	0.51060	1.196	0.2380
Dm_1	0.46276	0.49918	0.927	0.3587
Dm_2	0.40266	0.48787	0.825	0.4134
Dg	0.34404	0.12068	2.851	0.0065

Dg_1	0.20304	0.18527	1.096	0.2788
Dg_2	-0.13017	0.14423	-0.903	0.3715
Dor	0.42615	0.060078	7.093	0.0000
Dor_2	0.037359	0.099979	0.374	0.7104
Doy	-0.13779	0.29700	-0.464	0.6449
Doy_1	0.50999	0.41046	1.242	0.2204
Doy_2	-0.35428	0.34555	-1.025	0.3106
Dp*_1	-0.93857	1.5599	-0.602	0.5503
Dp*_2	-2.4702	1.2246	-2.017	0.0495
Dp*_3	1.5842	1.2825	1.235	0.2230
Seasonal	0.061177	0.46381	0.132	0.8956
Seasonal_1	0.19991	0.45697	0.437	0.6638
Seasonal_2	0.18829	0.44783	0.420	0.6761
Seasonal_3	0.085246	0.46717	0.182	0.8560
CI(p)_1	-0.083818	0.22939	-0.365	0.7165
CI(y)_1	0.12338	0.35877	0.344	0.7325
CI(r)_1	-0.18093	0.10180	-1.777	0.0821

$\sigma = 0.148075$ RSS = 1.008600537

correlation of URF residuals

	Dp	Dy	Dr
Dp	1.000		
Dy	-0.3219	1.000	
Dr	-0.09977	0.1911	1.000

standard deviations of URF residuals

Dp	Dy	Dr
0.02875	0.007216	0.1481

loglik = 814.5023 log|ê| = -22.3151 |ê| = 2.03546e-010 T = 73
log|Y'Y/T| = -14.9692
R^2(LR) = 0.999355 R^2(LM) = 0.895174

F-test against unrestricted regressors, F(81, 132) = 17.433 [0.0000] **
No variables entered unrestricted.
F-tests on retained regressors, F(3, 44)

Dy_1	76.3125 [0.0000] **	Dy_2	26.9586 [0.0000] **
Dy_3	10.6819 [0.0000] **	Dr_1	4.73643 [0.0060] **
Dr_2	1.09520 [0.3612]	Dr_3	1.20182 [0.3202]
Dm	2.05973 [0.1193]	Dm_1	0.705901 [0.5536]
Dm_2	0.672729 [0.5734]	Dg	3.68470 [0.0188] *
Dg_1	3.36309 [0.0269] *	Dg_2	1.57823 [0.2081]
Dor	17.7231 [0.0000] **	Dor_2	0.468103 [0.7060]
Doy	12.7395 [0.0000] **	Doy_1	10.0770 [0.0000] **
Doy_2	3.93134 [0.0143] *	Dp*_1	1.80682 [0.1599]
Dp*_2	2.31427 [0.0889]	Dp*_3	1.39376 [0.2573]

Seasonal 2.05579 [0.1199] Seasonal_1 1.73348 [0.1740]
Seasonal_2 3.73495 [0.0178] * Seasonal_3 2.45385 [0.0757]
CI(p)_1 3.33228 [0.0279] * CI(y)_1 3.77912 [0.0170] *
CI(r)_1 2.42831 [0.0780]

correlation of actual and fitted

Dp	Dy	Dr
0.8444	0.9777	0.9447

Testing for vector error autocorrelation from lags 1 to 1
$Chi^2(9)$ = 20.372 [0.0158] * and F-Form(9, 99) = 1.4943 [0.1605]

Testing for vector error autocorrelation from lags 1 to 2
$Chi^2(18)$ = 40.027 [0.0021] ** and F-Form(18, 107) = 1.4681 [0.1162]

Testing for vector error autocorrelation from lags 1 to 3
$Chi^2(27)$ = 52.845 [0.0021] ** and F-Form(27, 102) = 1.2828 [0.1871]

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness
1.093 0.2234 -1.489

Excess kurtosis
0.4328 1.187 0.7137

Vector normality $Chi^2(6)$= 5.5672 [0.4734]

Testing Dp for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 4.4924 [0.2130] and F-Form(3, 43) = 0.9399 [0.4297]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.2361	0.4016	0.2061

Testing Dy for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 9.0912 [0.0281] * and F-Form(3, 43) = 2.0389 [0.1226]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.1737	-0.3803	0.2043

Testing Dr for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 1.7861 [0.6180] and F-Form(3, 43) = 0.35948 [0.7825]

Error Autocorrelation Coefficients:
Lag 1 Lag 2 Lag 3

Coeff. -0.2294 -0.1577 -0.09364

Normality test for Dp
The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean -0.000000
Std.Devn. 0.022819
Skewness 0.198109
Excess Kurtosis 0.070058
Minimum -0.055947
Maximum 0.059491
Normality $Chi^2(2)=$ 0.8969 [0.6386]

Normality test for Dy
The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean -0.000000
Std.Devn. 0.005729
Skewness 0.110117
Excess Kurtosis 0.296669
Minimum -0.016042
Maximum 0.014545
Normality $Chi^2(2)=$ 1.5352 [0.4641]

Normality test for Dr
The present sample is: 1972 (1) to 1990 (1)
Sample Size 73
Mean -0.000000
Std.Devn. 0.117543
Skewness -0.443793
Excess Kurtosis 0.320037
Minimum -0.322852
Maximum 0.283839
Normality $Chi^2(2)=$ 2.754 [0.2523]

Testing Dp for ARCH from lags 1 to 4
Chi^2 (4) = 3.3094 [0.5075] and F-Form(4, 38) = 0.47859 [0.7512]

Testing Dy for ARCH from lags 1 to 4
$Chi^2(4)$ = 7.5044 [0.1115] and F-Form(4, 38) = 1.1593 [0.3440]

Testing Dr for ARCH from lags 1 to 4
$Chi^2(4)$ = 3.0988 [0.5414] and F-Form(4, 38) = 0.44671 [0.7741]

Progress to date

system T p log-likelihood Schwarz Hannan-Quinn

2	73	81	RLS	814.50230	-17.55	-19.08
1	73	93	RLS	825.50540	-17.15	-18.91

Tests of model reduction
System 1 --> System 2: F(12, 106) = 1.0673 [0.3950]

Model 1

EQ(3) Estimating the model by 3SLS
The present sample is: 1972 (1) to 1990 (1)

Equation 1 for Dp

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_2	-0.41913	0.28254	-1.483	0.1437
Dy_3	0.38195	0.25866	1.477	0.1455
Dr_2	-0.031508	0.020842	-1.512	0.1363
Dr_3	-0.014501	0.012366	-1.173	0.2460
Dm	0.22919	0.082144	2.790	0.0072
Dm_2	0.080894	0.073306	1.104	0.2746
Dg_2	0.036649	0.016400	2.235	0.0295
Dor	0.011515	0.0082991	1.388	0.1709
Dor_2	0.013669	0.014717	0.929	0.3571
Dp*_2	-0.39380	0.17088	-2.305	0.0250
Dp*_3	0.26578	0.17436	1.524	0.1332
Seasonal	-0.15607	0.052485	-2.974	0.0044
Seasonal_1	-0.11599	0.04747	-2.443	0.0178
Seasonal_2	-0.22283	0.05083	-4.383	0.0001
Seasonal_3	-0.13205	0.04442	-2.973	0.0044
CI(p)_1	0.085206	0.020807	4.095	0.0001
Dy	0.0049031	0.15466	0.032	0.9748

$\sigma = 0.026994$

Equation 2 for Dy

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	1.6022	0.10323	15.521	0.0000
Dy_2	-1.2319	0.14864	-8.287	0.0000
Dy_3	0.40973	0.084009	4.877	0.0000
Dr_1	0.0067397	0.003828	1.760	0.0839
Dr_2	0.0072544	0.004476	1.621	0.1108
Dg_1	-0.010498	0.006448	-1.628	0.1092
Dg_2	-0.0093632	0.006352	-1.474	0.1462
Doy	0.082359	0.012711	6.479	0.0000
Doy_1	-0.10012	0.017298	-5.788	0.0000
Doy_2	0.060684	0.015074	4.026	0.0002
Dp*_1	-0.091259	0.050105	-1.821	0.0740

Seasonal	0.00013301	0.0043657	0.030	0.9758
Seasonal_1	0.0037713	0.0037748	0.999	0.3221
Seasonal_2	0.0046167	0.0029376	1.572	0.1218
Seasonal_3	-0.0041170	0.0046045	-0.894	0.3751
CI(y)_1	-0.013722	0.0068612	-2.000	0.0504
Dp	0.040448	0.060524	0.668	0.5067

$\sigma = 0.00768371$

Equation 3 for Dr

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	-2.5339	3.7849	-0.669	0.5060
Dy_2	3.6995	2.3935	1.546	0.1279
Dr_1	-0.20308	0.078291	-2.594	0.0121
Dr_3	-0.11850	0.063155	-1.876	0.0659
Dm	0.65252	0.41481	1.573	0.1214
Dg	0.33062	0.10964	3.016	0.0039
Dg_1	0.12752	0.11948	1.067	0.2905
Dg_2	-0.13439	0.098159	-1.369	0.1765
Dor	0.47227	0.055233	8.550	0.0000
Doy_1	0.39629	0.31077	1.275	0.2076
Doy_2	-0.37257	0.29759	-1.252	0.2159
Dp*_2	-2.6047	0.99584	-2.616	0.0115
Dp*_3	2.1385	1.0658	2.006	0.0497
Seasonal	-0.0060141	0.099950	-0.060	0.9522
Seasonal_1	0.18382	0.11489	1.600	0.1153
Seasonal_2	0.035285	0.066757	0.529	0.5992
Seasonal_3	0.046840	0.080758	0.580	0.5643
CI(r)_1	-0.15768	0.066551	-2.369	0.0214
Dp	-1.2885	1.3020	-0.990	0.3267
Dy	-0.098334	2.0471	-0.048	0.9619

$\sigma = 0.140627$

loglik = 802.17952 log|ê| = -21.9775 |ê| = 2.85288e-010 T = 73
LR test of over-identifying restrictions: $Chi^2(27) = 24.6456$ [0.5943]

correlation of residuals

	Dp	Dy	Dr
Dp	1.000		
Dy	-0.4292	1.000	
Dr	0.1328	0.07601	1.000

Testing for vector error autocorrelation from lags 1 to 1
$Chi^2(9) = 16.567$ [0.0559] and F-Form(9, 121) = 1.4365 [0.1799]

Testing for vector error autocorrelation from lags 1 to 2

$Chi^2(18)$ = 27.311 [0.0733] and F-Form(18, 133) = 1.171 [0.2941]

Testing for vector error autocorrelation from lags 1 to 3
$Chi^2(27)$ = 36.972 [0.0956] and F-Form(27, 129) = 1.013 [0.4568]

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness
1.116 -1.244 -1.164

Excess kurtosis
0.08652 0.7420 0.5482

Vector normality $Chi^2(6)$= 5.0068 [0.5429]

Testing Dp for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 9.5292 [0.0230] * and F-Form(3, 43) = 2.1519 [0.1076]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.2934	0.5266	0.1832

Testing Dy for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 20.812 [0.0001] ** and F-Form(3, 43) = 5.7161 [0.0022] **

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.2653	-0.2537	0.2795

Testing Dr for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 6.8395 [0.0772] and F-Form(3, 43) = 1.4817 [0.2329]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.2349	-0.206	-0.1403

Normality test for Dp
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	-0.000000
Std.Devn.	0.023421
Skewness	0.167688
Excess Kurtosis	0.006133
Minimum	-0.053205
Maximum	0.059019

Normality $Chi^2(2)$= 0.65411 [0.7210]

Normality test for Dy
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	-0.000000
Std.Devn.	0.006322
Skewness	-0.298126
Excess Kurtosis	0.333474
Minimum	-0.020729
Maximum	0.014689
Normality $Chi^2(2)$=	2.0111 [0.3658]

Normality test for Dr
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	0.000000
Std.Devn.	0.121674
Skewness	-0.309128
Excess Kurtosis	0.100765
Minimum	-0.320748
Maximum	0.287646
Normality $Chi^2(2)$=	1.4635 [0.4811]

Testing Dp for ARCH from lags 1 to 4
$Chi^2(4)$ = 3.0091 [0.5563] and F-Form(4, 38) = 0.43318 [0.7838]

Testing Dy for ARCH from lags 1 to 4
$Chi^2(4)$ = 6.1887 [0.1855] and F-Form(4, 38) = 0.93601 [0.4535]

Testing Dr for ARCH from lags 1 to 4
$Chi^2(4)$ = 4.502 [0.3423] and F-Form(4, 38) = 0.6631 [0.6215]

Progress to date

model	T	p		log-likelihood	Schwarz	Hannan-Quinn
1	73	54	3SLS	802.17952	-18.80	-19.82

system	T	p		log-likelihood	Schwarz	Hannan-Quinn
2	73	81	RLS	814.50230	-17.55	-19.08

Tests of model reduction
System 2 --> Model 1: $Chi^2(27)$ = 24.646 [0.5943]

<u>**Model 2**</u>

EQ(4) Estimating the model by 2SLS

The present sample is: 1972 (1) to 1990 (1)

Equation 1 for Dp

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_2	-0.40313	0.28596	-1.410	0.1642
Dy_3	0.37753	0.26270	1.437	0.1563
Dr_2	-0.033063	0.022080	-1.497	0.1400
Dr_3	-0.013681	0.013185	-1.038	0.3040
Dm	0.23068	0.086095	2.679	0.0097
Dm_2	0.091060	0.078663	1.158	0.2520
Dg_2	0.036873	0.016660	2.213	0.0310
Dor	0.013265	0.0087816	1.511	0.1366
Dor_2	0.015194	0.015847	0.959	0.3419
Dp*_2	-0.46464	0.18046	-2.575	0.0128
Dp*_3	0.21990	0.18276	1.203	0.2340
Seasonal	-0.15165	0.053908	-2.813	0.0068
Seasonal_1	-0.10797	0.049232	-2.193	0.0325
Seasonal_2	-0.21338	0.052562	-4.060	0.0002
Seasonal_3	-0.12384	0.045792	-2.704	0.0091
CI(p)_1	0.081299	0.021403	3.798	0.0004
Dy	-0.035532	0.15587	-0.228	0.8205

$\sigma = 0.0268082$

Equation 2 for Dy

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	1.6100	0.10804	14.902	0.0000
Dy_2	-1.2405	0.15372	-8.070	0.0000
Dy_3	0.41497	0.085472	4.855	0.0000
Dr_1	0.0070271	0.0040654	1.729	0.0895
Dr_2	0.0075012	0.004652	1.612	0.1126
Dg_1	-0.011077	0.006915	-1.602	0.1149
Dg_2	-0.0096185	0.006573	-1.463	0.1491
Doy	0.082343	0.013635	6.039	0.0000
Doy_1	-0.10074	0.018403	-5.474	0.0000
Doy_2	0.060419	0.016123	3.747	0.0004
Dp*_1	-0.10298	0.052501	-1.962	0.0549
Seasonal	0.00067654	0.004413	0.153	0.8787
Seasonal_1	0.0045082	0.0038289	1.177	0.2441
Seasonal_2	0.0042946	0.0029691	1.446	0.1537
Seasonal_3	-0.0042082	0.0046916	-0.897	0.3737
CI(y)_1	-0.012495	0.0070884	-1.763	0.0835
Dp	0.032019	0.061060	0.524	0.6021

$\sigma = 0.0075835$

Equation 3 for Dr

Variable	Coefficient	Std.Error	t-value	t-prob
Dy_1	-2.9088	3.8061	-0.764	0.4480
Dy_2	3.9347	2.4060	1.635	0.1077
Dr_1	-0.19205	0.078925	-2.433	0.0182
Dr_3	-0.11820	0.063314	-1.867	0.0672
Dm	0.63927	0.41632	1.536	0.1304
Dg	0.30467	0.11108	2.743	0.0082
Dg_1	0.11520	0.12051	0.956	0.3433
Dg_2	-0.13678	0.098348	-1.391	0.1699
Dor	0.47418	0.055481	8.547	0.0000
Doy_1	0.40706	0.31304	1.300	0.1989
Doy_2	-0.39435	0.29966	-1.316	0.1936
Dp*_2	-2.5004	0.99872	-2.504	0.0153
Dp*_3	2.1878	1.0683	2.048	0.0453
Seasonal	0.0030545	0.10025	0.030	0.9758
Seasonal_1	0.17797	0.11526	1.544	0.1283
Seasonal_2	0.039249	0.066857	0.587	0.5596
Seasonal_3	0.039644	0.081039	0.489	0.6266
CI(r)_1	-0.16163	0.067287	-2.402	0.0197
Dp	-1.2366	1.3056	-0.947	0.3477
Dy	0.14540	2.0566	0.071	0.9439

$\sigma = 0.140151$

loglik = 801.73754 log|ê| = -21.9654 |ê| = 2.88764e-010 T = 73
LR test of over-identifying restrictions: $Chi^2(27) = 25.5295$ [0.5448]

correlation of residuals

	Dp	Dy	Dr
Dp	1.000		
Dy	-0.3766	1.000	
Dr	0.1210	0.06424	1.000

Testing for vector error autocorrelation from lags 1 to 1
$Chi^2(9) = 16.819$ [0.0516] and F-Form(9, 121) = 1.4617 [0.1698]

Testing for vector error autocorrelation from lags 1 to 2
$Chi^2(18) = 27.153$ [0.0762] and F-Form(18, 133) = 1.1643 [0.2998]

Testing for vector error autocorrelation from lags 1 to 3
$Chi^2(27) = 36.688$ [0.1010] and F-Form(27, 129) = 1.0037 [0.4691]

Vector normality test for residuals
The present sample is: 1972 (1) to 1990 (1)
Skewness
1.244 -1.285 -1.261

Excess kurtosis
0.1684 0.6154 0.4864

Vector normality $Chi^2(6)$= 5.4343 [0.4894]

Testing Dp for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 8.6076 [0.0350] * and F-Form(3, 43) = 1.916 [0.1413]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.232	0.4999	0.142

Testing Dy for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 20.677 [0.0001] ** and F-Form(3, 43) = 5.6644 [0.0023] **

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	0.2526	-0.2657	0.251

Testing Dr for Error Autocorrelation from lags 1 to 3
$Chi^2(3)$ = 6.6978 [0.0822] and F-Form(3, 43) = 1.4479 [0.2421]

Error Autocorrelation Coefficients:

	Lag 1	Lag 2	Lag 3
Coeff.	-0.2143	-0.1867	-0.1383

Normality test for Dp
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	-0.000000
Std.Devn.	0.023332
Skewness	0.207433
Excess Kurtosis	0.073457
Minimum	-0.054774
Maximum	0.060073
Normality $Chi^2(2)$=	0.93637 [0.6261]

Normality test for Dy
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	-0.000000
Std.Devn.	0.006332
Skewness	-0.318256
Excess Kurtosis	0.265638
Minimum	-0.020730
Maximum	0.013698
Normality $Chi^2(2)$=	1.8739 [0.3918]

Normality test for Dr
The present sample is: 1972 (1) to 1990 (1)

Sample Size	73
Mean	0.000000
Std.Devn.	0.121754
Skewness	-0.342055
Excess Kurtosis	0.136644
Minimum	-0.320450
Maximum	0.287977
Normality $Chi^2(2)$=	1.7275 [0.4216]

Testing Dp for ARCH from lags 1 to 4
$Chi^2(4)$ = 2.4518 [0.6533] and F-Form(4, 38) = 0.35 [0.8424]

Testing Dy for ARCH from lags 1 to 4
$Chi^2(4)$ = 6.0719 [0.1938] and F-Form(4, 38) = 0.91664 [0.4642]

Testing Dr for ARCH from lags 1 to 4
$Chi^2(4)$ = 4.3371 [0.3623] and F-Form(4, 38) = 0.63719 [0.6392]

Progress to date

model	T	p		log-likelihood	Schwarz	Hannan-Quinn
2	73	54	2SLS	801.73754	-18.79	-19.81

system	T	p		log-likelihood	Schwarz	Hannan-Quinn
2	73	81	RLS	814.50230	-17.55	-19.08

Tests of model reduction
System 2 --> Model 2: $Chi^2(27)$ = 25.530 [0.5448]

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