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A Macroeconomic Model for a Developing Country:

**Estimation and Simulation of a Macroeconometric
Model for Iran (1959-1993)**

by

Mehdi Assali

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A thesis submitted to the University of Durham in

candidature for the degree of

Doctor of Philosophy

June 1996



3 0 OCT 1996

Abstract

Author: Mehdi Assali

Institution: University of Durham

Title of Ph.D. Thesis: A Macroeconomic Model for a Developing Country; Estimation and Simulation of a Macroeconometric Model for Iran (1959-1993)

Keywords: Iran; Flexible-Price Mundell-Flemming Model; Rational Expectations; Capital Control; Monetary Policy; Fiscal Policy; Budget Deficit; Crowding-out; Exchange Rate; Partial Equilibrium; Impact Multiplier; Dynamic Simulation

This is an empirical study of the economic structure and the impact of macroeconomic policy during the period 1959-1993 in the case of a particular developing economy-Iran.

The Iranian experience is of considerable importance not least because of the role this country plays in the Middle East and also its position as a founder member of the Economic Co-operation Organisation (ECO) which consists of Iran, Turkey, Pakistan, Afghanistan and six newly independent states of the former Soviet Union.

In this thesis an attempt is made to incorporate the major characteristics of the Iranian economy into a macroeconomic model. We have maintained a specification of the model as general as possible and used widely accepted developing country specifications. A unified data set provided by the IMF's IFS is used and we have relied on an appropriate econometric technique for the estimation of the model's parameters. For the purpose of dynamic simulation of the model we have utilised a computer program of ordinary substitution method.

The main aims of this study have been:

- (i) To generate a set of macroeconomic parameters for Iran that are recognised to be important for policy analysis and policy recommendation.
- (ii) To establish whether the economy has been structurally stable throughout the sample period of 1959-93.
- (iii) To use the estimated model for partial equilibrium and impact multiplier analysis of the economy in the short-run.
- (iv) To examine the effects of alternative policies on the performance of the economic system in the medium term by dynamic simulation of the estimated model.

Chapters III to VI of this thesis focus on these aims. As a result, this study provides considerable knowledge about the structure of the Iranian economy in the period 1959-93 and about the impact of macroeconomic policy both in the short-run and in the medium-term within the economy. Some of this knowledge might usefully be generalised to other developing countries, particularly to the oil exporting countries in which oil revenues constitute a substantial part of total government revenue.



**To my parents
and my family**

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ACKNOWLEDGEMENTS

I am sincerely grateful to Dr. J. L. Evans and Mr. A. C. Darnell for undertaking to be my supervisors during the course of my studies and for their advice and encouragement on the preparation of this thesis.

I wish to acknowledge my indebtedness to the Bureau of International Legal Services (B.I.L.S) for granting me a scholarship to read for a PhD degree in economics in the UK. I am very thankful to the head of the bureau Dr. G. Iftekhar Jahromi and to the managing director of the Bureau's London office Mr. M. Toloa for their support and encouragement during the course of my studies without which this thesis would not have completed.

I would like to express my heartfelt appreciation to my wife, Parvin, and to my family for their patience, support and encouragement during the course of my studies. My sincere thanks also go to my friends in the University of Durham and in the University of Newcastle upon Tyne for their helpful suggestions on the preparation of this thesis. I would particularly thank my friend A. Azizi, a Ph.D. student of mathematical science in the University, for his assistance with a computer program for preparing a flow-chart of the system dynamic model of Ch. VI of this thesis.

Chapter I

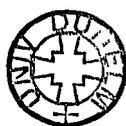
Introduction

1.1 Introduction

This is an empirical study of the economic structure and the impact of macroeconomic policy during the period 1950s-1993 in the case of a particular developing country-Iran. Chapter II provides historical and institutional perspective. Based on the economy's characteristics, as an oil exporting developing economy, and theoretical relationships a macroeconometric model is constructed in chapter III to accommodate a formal analysis of the economy. In chapter IV the behavioural equations of the model are estimated using an appropriate method and partial equilibrium implications of the estimated model are discussed. Structural stability of the model and impact multiplier analysis are examined in chapter V. Then the complete model is translated into a system dynamic model with which policy alternatives are simulated in chapter VI. An overview and summary of the thesis is provided in chapter VII, where suggestions are also made for further research.

1.2 Motivation for and Aims of the Study

As an Iranian student of economics, my incentive for such an investigation on Iran's economy could only seem natural. However, the Iranian experience is of considerable importance for many other observers-not least those who are



interested in the economic development of the oil exporting countries of the Middle East. There is little doubt that socio-economic development in Iran could have significant effects not only on the Middle-East but also on the central and south-west Asian countries many of which are now Iran's partners in the Economic Co-operation Organisation (ECO) which consists of Iran, Turkey, Pakistan, Afghanistan and 6 newly independent countries of the former Soviet Union. Also, Iran in the period under observation has experienced a wide range of changes in macroeconomic policy objectives and implementation of policy tools under governments with substantially varying political philosophies, most notably pre and post the 1979 revolution (see chapter II). A better understanding of that experience is valuable in itself.

The main framework for macroeconomic policy analysis and policy recommendation for developing countries in post-war era until 1970s has been derived from the Harrod-Domar aggregate growth model, Lewis-Fei-Rains labour-surplus models, Leontief fixed-coefficient model, static and dynamic linear programming models and Chenery two-gap models (see footnote 1 below). In general, assumptions that are made in these models include: (i) that the rate of inflation and the extent of aggregate demand are not important consideration; (ii) that the financial constraints on government and central bank behaviour can

(1) Alternative approaches towards economic policy analysis and recommendation also have developed since the 1940s. These approaches have been dominated mainly by structuralist economists' theories of development issues. Since our analysis in this thesis lies on the main stream economic thought of the Keynesian-Neoclassical synthesis we do not pay attention to these alternative approaches here. For a brief discussion of these theories see Tarp (1993, Ch. 6).

be safely ignored; and (iii) that short-run flexibility is extremely limited because short-run price responses are very low (see Behrman 1977, p.5). The resulting models usually included only real phenomena and were characterised by supply bottlenecks due to either limited foreign exchange or capital constraints.

However, short-run stabilisation issues have long been of substantial policy concern in a number of developing countries especially those with a history of inflation. Because of this growing interest in stabilisation and other short-run problems, a large number of Keynesian based national income determination models has been constructed since the 1970s. All too often, however, the structure of these models has been adopted from aggregate-demand models of developed economies with little or no adjustment for the special conditions in the developing countries. On the other, hand there has been no consensus on an analytical framework for the study of developing country macroeconomic issues. As Haque et al (1990, p. 538) argue “individual models suitable for different tasks have proliferated with different and often conflicting assumptions about a wide range of crucial aspects of these economies such as the nature of financial markets, the degree of capital mobility, the form and functioning of the exchange rate regime and so on”.

At the empirical level, the disagreement over the general specification of such models is even more pronounced. Also there is no general agreement over the order of magnitude of certain key parameters. These key parameters are for example; the interest responsiveness of saving and investment, the “offset coefficient” for monetary policy, the relative price elasticity of exports and imports and the importance of the “accelerator” mechanism in the determination

of investment (see Haque et al (1990 and 1993), Montiel (1990), Chhibber et al (1992), Khan and Knight(1982) Muscatelli et al (1994) Behrman (1977))

Although in this thesis an attempt is made to incorporate the major characteristics of the Iranian economy into a macroeconomic model, we have maintained a specification of the model as general as possible and used widely accepted developing country specifications wherever feasible. For this reason, the structure and the behavioural equations in our model are conventional in the sense that their specifications lie in the main stream economic thought. We have used a unified data set provided by the IMF's IFS and have relied on an appropriate econometric technique for the estimation of the model's parameters. For the purpose of dynamic simulation of the model we have utilised a computer program of ordinary substitution method.

However, our work differs in several important ways from most existing developing countries empirical work. (i) We assume that expectations are formed rationally by forward looking economic agents. (ii) allowance is made for the presence of capital controls. Capital controls are a common feature of most developing countries, but in most studies they have been neglected in empirical analysis. (iii) We have adopted a version of the buffer stock money concept to accommodate effects of short-run disequilibrium in the money market on the price level and on the real part of the economy. (iv) The degree of endogeneity of economic policy options is made explicit in our study. And (v) we have used the space-state approach and a version of the substitution method to simulate the complete model.

The main aims of this study have been:

- (i) To generate a set of macroeconomic parameters for Iran that are recognised to be important for policy analysis and policy recommendation.**
- (ii) To establish whether the economy has been structurally stable throughout the sample time period of 1959-1993.**
- (iii) To use the estimated model for partial equilibrium and impact multiplier analysis of the economy in the short-run.**
- (iv) To examine the effects of alternative policies on the performance of the economic system in the medium term by dynamic simulation of the estimated model.**

In the following chapters we first provide a survey of Iran's economic development in 1950s-1993 (chapter. II), and the specification of the macroeconomic model (chapter. III), then we move to the estimation of the model (chapter. IV) The short-run and medium term policy analyses are presented in chapters V and VI. Finally, chapter VII is devoted to the summary of the thesis where some suggestions are also made for further research.

Chapter II

Economic Development in Iran 1953-1993

2.1 Introduction

In this chapter a brief review of the economic development in Iran over the period 1953-1993 is presented. The main purpose of the survey is to provide some insight into the macroeconomic relationships in this economy to facilitate the specification of the structural model which is developed and estimated in the following chapters of this thesis. The chapter is organised around two sections. First, an attempt is made to capture the main characteristics of economic development since the early 1950s through an analysis of the macroeconomic variables. Second, the national economic policies, consisting of monetary, fiscal and foreign sector policies, are discussed.

2.2 Macroeconomic Trends 1953-1993

Iranian economic development in period 1953-93 is best understood if the time period is divided into two sub-periods- before and after 1979. The reason for this is that the 1979 revolution in this year changed the entire socio-political environment and had lasting impacts on the country's policy. However, in our survey of the economic development we have tried to maintain the continuity of the review.

2.2.1 Economic Growth and Aggregate Consumption

Following the overthrow of the government of Dr. Mosaddegh in 1953 (who had led nationalisation of the country's oil industry in his premiership) a new phase of economic development in Iran began in which state-owned oil revenue became the predominant source of financing the capital accumulation. Mobilisation of resources for investment from a mainly agrarian economy lent itself to distribution and allocation of the already centralised economic surplus in the form of oil revenue. This changed the nature of the state -economy interrelationship and inaugurated a period of rapid institutional transformation to a market economy (Karshenas ,1990, p.88).

The growing predominance of the public sector was mainly the result of rising public expenditure financed by oil revenues. In this period effective measures were taken to encourage private capital and its entry into industry and agriculture in a major way.

In the period 1955-62 the economy witnessed a massive injection of external funds i.e. oil revenue and foreign capital. Government investment was largely confined to infrastructure while private sector investment was concentrated in construction, transportation and light industries. The uncoordinated growth of investment and the consequent economic boom increased the demand for foreign capital and intermediate goods and gave rise to a balance of payments crisis in the early 1960s.

During this boom period, the government showed little concern about the disequilibrating effects of its financial and monetary policies nor did it have the institutional framework for undertaking the necessary regulatory task at the

macro-economic level. For example, there was little appreciation of the role of fiscal policy in the level and composition of aggregate demand. During the period 1955-62 between 50 and 60 per cent of government expenditure was financed by oil revenues or borrowing from the domestic and foreign sectors. The budget deficit was about 40 per cent of the total government expenditure and close to 7 per cent of GDP(Karshenas,1990, p. 136).

A distinctive feature of the structural shift in government development expenditure in the post 1963 era was the increasing concentration of government investment in the industrial sector and related activities. Government investment was confined to heavy industries such as basic metals, petrochemical and mechanical engineering. In this period it was the availability of external finance, namely oil revenues and foreign credits, which determined the magnitude of government investment: and the availability of ample supplies of external funds over this period meant that capital formation could take place without the need to curtail the growth of consumption in the short run. The rapid acceleration of the rate of investment in the economy from 20 per cent of GDP in 1963 to about 47 per cent in 1977 went hand in hand with the very fast rate of growth of consumption both in the public and private sectors. Private sector consumption in real terms grew by about 11 per cent per annum over the 1963-1978 period while government consumption maintained a very high rate of growth close to 20 per cent a year in the same period(Bank Markazi Iran, various annual reports). This high rate of growth of consumption in the period gave rise to a rapid expansion of the domestic market which in turn provided the demand for

private industries. This reminds us of a Keynesian multiplier process which in the case of Iran was accelerated by the impact of oil revenue in this period.

By international standards, the growth performance of the Iranian economy during this period was very impressive. The rate of growth of GDP and investment in real terms ranked amongst the highest in the world economies for this period. It is argued that the real annual average rate of growth of investment in Iran was fairly close to the absorptive capacity of the economy. Other data published by the World Bank (1980) show that compared with other third world countries, Iran's annual real growth rate in 1959-78 was nearly 9 per cent. This was roughly double the average of countries in the middle-income category and higher than the average for any other group of countries in the world.

Over this period, the financial institutions also developed rapidly. By the early 1960s the banking system had acquired a much higher degree of differentiation than had existed a decade earlier. With the formation of the Central Bank (Bank Markazi Iran) in 1960 the government tightened its surveillance over the formal credit market; through a policy of different interest rates and different forms of credit control, Bank Markazi could exert its control over the total amount and distribution of funds within a regular credit market.

Thus, in summarising the economic development of Iran over the period 1953-78, it is fair to say that this period was a clear success for the Iranian economy. The achievement was beyond the most optimistic expectations of observers. During this period, Iran enjoyed a good measure of political stability and national confidence. The relationship between the public and private sector was mutually supportive and private investment was attractive to both domestic

and foreign investors. Rising demand for investment was spurred by Iran's substantial natural resources, a rich supply of human capital, extensive new physical infrastructure, a solid banking system and a large and expanding domestic market. The government policy of generous tax incentives, easy bank credit, bilateral trade agreements and liberal exchange facilities served as an unparalleled promoter of private enterprise and initiative. The economy, despite its imbalances and fragility, was a workable system capable of self correction and survival in the face of many economic challenges(see Amuzegar,1993, ch.3).

However, the economy was not without its own difficulties. One of the key weaknesses of the Iranian economy has been its heavy dependence upon imported capital and semi-processed goods. This has led to serious balance of payments problems on several occasions when the economy was growing fast and its demand for imports increased beyond its foreign reserves capacity. It is argued that, given the production structure of the economy, increasing reliance on external resources created a genuine shortage of foreign exchange which could not be removed without reducing the rate of growth of the economy much below its absorptive capacity. When in 1979 the country's foreign trade was disturbed, none of the large industrial firms was operating at more than 70 per cent of its capacity and some were below 11 per cent. On average 57 percent of the raw materials needed by industry were imported from abroad (see Amuzegar, 1993, p. 206).

In the year of revolution, 1979, the economy was in total disarray. The banking system was in imminent collapse due to massive withdrawals and nonfunctioning loans because of uncertainty and confusion caused by social

unrest. Unemployment, inflation and capital flight were on the rise while foreign trade and public confidence in the future were on the decline.

During 1979-1993 the Iranian economy has experienced periods of sharp declines in real output and by periods of respectable growth. There was a three year recession between 1979-81, a four year recovery of 1982-85, another economic slowdown between 1986 and 1989 and a new cycle of growth after 1989.

In the first period of struggle over economic restructuring the crisis caused by the revolution was particularly aggravated by the sudden exodus of experienced administrators, business managers, skilled workers, bankers and professionals. The loss of this vital human capital was exacerbated by an acute shortage of raw materials and semi-processed goods caused partly by the embargo imposed on the country in this period. Industrial plants were run by new and inexperienced managers. Construction activities that served as the mainstay of Iran's 1974-78 economic boom had come to a virtual standstill due to revolutionary turmoil. The difficulties were topped by a liquidity shortage caused by private currency hoarding outside the banks given a loss of confidence in the banking system. Under pressure from hard liners and socialist groups, the provisional government which was in favour of resuming pre revolutionary economic policy, nationalised the banking system. All banks and insurance companies and some 50 per cent of industrial corporations were nationalised by a decree of the Council of Revolution (see Amuzegar,1993, p.45).

Although the decision was essentially a political one, there were also economic reasons for the take-over. Several banks were on the brink of

insolvency and others had difficulties with excessive domestic and foreign exposure. Most major private insurance companies were in bad financial shape. Also large industries were heavily indebted to the banking system. They were unable to service their debts due to strikes and workers take-overs, and suffered from absentee owners who had left the country .

The outbreak of war with Iraq in 1980 following the Iraqi invasion of the country further affected economic activities. The oil industry and foreign trade were particularly heavily affected which caused more confusion and uncertainty about the future of the economy. However, by 1981, the government was in a position to resume the economy's normal operation albeit under war time conditions. The government increased its intervention in the economy by *rationing the basic necessities, allocating foreign exchange and imposing quantitative imports restrictions* as well as wages and price control.

The necessity of pursuing a year to year economic management dependent on oil revenues resulted in policy formulation based on what Amuzegar (1993,p.46) called expedient discrimination. This strategy manifested itself in establishing a dozen different exchange rates for different categories of imports, granting different types and amounts of subsidies to domestic producers, setting different foreign exchange quotas for various industries and so on. There were also frequent policy changes accompanied by arbitrary decisions on the part of government officials in economic policy implementation.

In 1981 real GDP fell to the same level as that of the early 1970s. An additional cause of this decline was growing uncertainty regarding private ownership and enterprise. In this period, investment fell drastically. The oil

sector experienced a 19.4 per cent decline because of damage to the industry caused by the war and its dependence on imports of raw materials and spare parts. Since the main source of the foreign exchange of the country was the oil sector the shortage of foreign exchange affected output negatively. As could be expected the most negatively affected sector after oil was manufacturing. Nearly 1.4 million workers -12 per cent of the work force - were officially out of work.

With partial restoration of political stability and a gradual return of confidence in the government's commitment to economic recovery, real output resumed its pre-revolution growth trend in 1982. The ensuing four year period was largely underwritten by the resumption of oil exports and its firm price in the international markets. Rising oil revenues enabled the country to finance the imports needed for further industrial production. For the four year period the average annual real growth rate was a respectable 6.9 per cent, although GDP in 1982 was still below its level of 1978.

The favourable growth rate was reversed in 1986 when the oil price dropped to its lowest level since 1974. The volume of exports was also affected because of military attacks on oil installations and tankers in the Persian Gulf by enemy forces. Soaring war expenditure, the fall in oil revenues and exhausted foreign exchange resources brought almost all foreign dependent activities to a stand still. Real GDP dropped by 8.8 per cent in 1986 when capacity utilisation in industry fell to a low of 30 per cent. Only the agricultural sector showed a small rate of growth.

After the cease-fire in war in 1988, a more pragmatic economic policy was adopted by the new administration. Substantial resources released from the war

effort and an improvement in oil production and export helped the industrial sector to recover; the budget deficit to decline; and inflation to recede. With the launching of a new five year plan in 1989 and a distinct shift in government priorities and policies, a broad-based expansion in the oil productive sector helped the 1989 GDP realise a 4.2 per cent rise in real terms. The momentum picked up speed in 1990 with the oil and industrial sectors taking the lead and pushing GDP up by 11.5 per cent. Enhanced public confidence in the new economic liberalisation measures and expectations of a better private investment climate helped the growth trend to continue through 1991 when GDP grew by 8.6 per cent in real terms. The unprecedented sharp increase in the import of machinery, spare parts and raw materials helped the industrial sector grow by over 18 per cent but this high growth rate slowed down when oil revenue projections did not materialise. As government revenues also fell by 17 per cent and the budget deficit doubled, the GDP growth rate for the year ending March 1993 was put at about 6-7 per cent(Amuzegar,1993,p.52).

Overall, the economic performance for the period 1978-1993 has been disappointing. At the end of the period real GDP was only about 2 per cent above that of 1978. Due to a very rapid population rise over the period real per capita income in 1993 was about 60 per cent of the level of per capita income in 1978. The economy needed a persistent increase in investment to restore its growth. But non-oil exports are still negligible relative to import requirements and there is no sign of a substantial and steady rise in the oil price. Foreign investment also faces institutional and structural difficulties in the country. Therefore there remains no easy way of obtaining sustained economic growth for

a country that in the last three decades has relied heavily on external resources- mainly oil revenues- adopting an import substitution strategy, but to mobilise its domestic resource for capital accumulation. On the other hand, due to the decline in per capita income the economy's saving capacity also has declined making investment and capital formation even more difficult. The next section is devoted to investment and capital formation in Iran since the early 1950s.

2.2.2 Investment and Capital formation

Given the steady increase in oil revenues in the second half of the 1950s, government was able to expand its development expenditure without crowding-out private sector investment. The concentration of government investment on activities not favoured by the private sector created a highly complementary relationship between public and private capital. The data on public and private investment in this period reveals that public investment and credit advanced by the banking system to the private sector have enhanced private investment (see Karshenas, 1990, ch.5). The state policy on industrial finance played a decisive role in encouraging the private sector to participate in economic development. The ratio of “government investment plus credit advanced by the banking system” to “total gross fixed capital” in both manufacturing and mining was 44.1 percent on average between 1963 and 1967. This ratio increased to 64.9 percent over the period 1973-77 and in agriculture it grew from over 160 per cent to more than 178 per cent over the same period. The inflow of total government managed funds, into the manufacturing sector, grew from 10.3 per cent of quasi rents in 1963-67 period to 33.1 percent in 1973-77 and in agriculture they grew

from 61.3 per cent to 87.2 per cent of net agricultural surplus over the same period.

Between 1955 and 1960 the share of the private sector's fixed investment in GDP more than doubled and by 1956 it had already overtaken public investment. Such an acceleration in the rate of growth of investment was not possible without the availability of abundant bank credit in this period (Karshenas, 1990, p. 108). There were various factors underlying the growth of the supply of bank credit in this period. Apart from the expansion of the banking system itself (which was evident from the declining share of currency in total money supply from 60.7 per cent in 1953 to 51.1 per cent in 1959 and 38.6 per cent in 1961) a lack of tight monetary control and the revaluation of the rial in 1957 led to a rapid expansion of bank credit between 1954-60.

The period 1955-59 was one of rapid growth of real investment following the massive injection of external funds into the economy. Government investment in this period was largely confined to infrastructure and manufacturing whilst private investment concentrated on construction, transportation and light manufacturing. Public sector investment in this period, witnessed an annual rate of growth of 25 per cent in real terms. According to development expenditure data, more than 68 per cent of government investment in this period went into economic infrastructure. The only field in which government investment directly contributed to expanding productive capacities in a significant way was the manufacturing sector.

The recession that developed in 1959 continued until 1963. Political uncertainty in the early 1960s was also responsible for the slow down in economic activity. The economy emerged from the early 1960s' recession to witness the longest period of sustained capital accumulation in the recorded economic history of Iran. Real gross fixed investment by the public sector grew by an average annual rate of 22 per cent over the 1963-77 period and by 1967 it had surpassed the level of private investment. The fact that government investment was mainly financed by external resources substantially increased its multiplier impact. The average annual rate of growth for gross fixed investment in the period 1963-78 was the impressive rate of 18.9 per cent. The share of gross fixed investment in non-oil GDP rose from 16.9 per cent in 1962 to 30.9 per cent in 1971 and reached its phenomenal rate of 50.7 per cent in the post 1973 oil boom years(see Karshenas ,1990, ch.7). Such rates of growth of course could only be sustained with increasing oil revenues accrued by government.

It is important to note that even when public sector expenditure is financed by external funds as in the case of Iran, the crowding out effect would still be present. This is because the private sector has to accommodate greater public absorption of domestic resources by curtailing its own expenditure. On the other hand, in the case of Iran (with an undeveloped capital market) deficit spending, financed by domestic borrowing, could produce direct crowding out under the assumption of a non-accommodating monetary policy. Also, a shortage of foreign exchange has been one of the key factors curbing investment and economic growth. Therefore, government development expenditure and the government deficit may have caused a crowding-out effect on private sector investment.

To summarise the main features of investment in the Iranian economy in the period 1955-1978, one may refer to: the remarkable high rate of capital accumulation; the dominant role of the State in the process and the absence of a serious crowding-out effect of public sector investment within the economy. Also important were oil resources, external funds to capital formation and the banking systems credit expansion impact on private investment. Although some of these features were still in place after 1979 there have been some substantial changes in this regard.

The general picture portrayed for investment and capital formation in the Iranian economy in the period 1953-78 was no longer the same post 1979. Aggregate demand during the entire 1979-93 period reflected an overall decline in economic activities. The ratio of total investment in GDP fell from 24 per cent in 1978 to 12 per cent in 1992. Total gross capital formation in 1992 was about 50 per cent of the real outlay in 1978. During 1979-89 there was a slight increase in the share of agricultural investment in the total gross fixed capital formation. The casualty of the socio-political events of 1978-1993 in the country was clearly the level of investment. A large share of private and public sector expenditure shifted in favour of consumption. Private investment was negatively affected by the erosion of public confidence in the future of the economy and the financial crowding out effect of the government budget deficit (see Amuzegar, 1993, p.116).

The public share of total capital formation fell below that of the private sector for most of the 1978-93 period. Regarding the decline of total investment (in real terms) it is evident that the dominant role the government exercised in

Iranian economic growth pre 1979 was reduced post 1979. However it is worth noting that the government still exerted considerable influence upon investment and capital formation within the economy. Not only because of its considerable share in total investment but also through fiscal and monetary instruments by which it could affect private investment. It is argued that due to the undeveloped capital and securities markets, credits advanced to the private sector by the banking system (which in post 1979 were controlled by the state) played a significant role in private investment. For this reason it is a strong possibility that the public sector's budget deficit and the policy of financing it through the domestic banking system had a crowding out effect on private sector investment between 1979 and 1993.

For most of the 1980s the principal investment policy instruments employed by the monetary authorities to control the overall expansion of credit were quantitative quotas assigned to each bank and the administrative guidelines regarding the composition of credit to the various sectors. Within the aggregate credit limits for the year commercial banks were given a credit ceiling based on their source and use of funds (see Amuzegar, 1993, ch. 8). In 1979-93 because of the current account deficit and the decline of the country's net foreign exchange reserves and later (in 1990-93) the accumulation of foreign debts, and the dependency of the economy on imported capital and semi-processed imported goods, any effort to promote economic growth has led to balance of payments problems. Although the economy had faced balance of payments crises in the early 1960s and early 1970s before the oil boom era, the size and magnitude of

the balance of payments problem in the 1990s was in excess of the earlier Iranian experiences.

2.2.3 Foreign Trade and the Balance of Payments

The 1955-59 boom was followed by an economic recession which continued up to 1963. The recession was triggered by the 1960-61 balance of payments crisis, but the deflationary measures taken by the government to stabilise the foreign exchange reserves had recessionary consequences. The crisis was caused by over expansion of commodity imports during the late 1950s' economic boom. The period witnessed a continuous decline in the significance of non-oil exports in financing commodity imports. The stagnation of non-oil exports was partly due to the rapid expansion of the domestic market and also to the removal of export subsidies which the abolition of the dual exchange system implied.

Despite the rapid growth of foreign exchange proceeds from the oil sector, the economy faced chronic balance of payments crises again in the late 1960s. This phase of the balance of payments crisis began with the acceleration of economic growth after 1963, which led to a widening current account deficit. By the late 1960s , the central bank, had to take action in order to control imports and credit expansion. This created a minor recession in (1967-69), (Karshenas,1990, p.216). According to the Bank Markazi's report in 1969, the pressures on foreign exchange became quite clear by mid 1968. Towards the end of this year, the first set of restrictive measures were introduced to prevent the depletion of foreign exchange reserves.

The burden of restrictions imposed on credit and foreign trade was borne by private sector investment. A decline in the rate of growth of investment did not curtail absorption of the economy as a whole in a noticeable manner. This was due to the fact that government fiscal policy was highly expansionary throughout these years.

The oil price hikes of 1973-74 temporarily pushed aside the preoccupation with balance of payments problems, yet it only postponed the problem. From the principal components of the balance of payments records, one can see that the non-oil trade formed the main component of the current account deficit though the services account also showed a perpetual deficit of increasing magnitude, it constituted a relatively small item in the overall non-oil current account deficit. A major part of the services deficit was composed of interest payments on long-run foreign debts which arose out of the need to finance the commodity trade deficit in the first place. The primary cause of balance of payments problems during this period therefore should be sought in the underlying factors of the trade balance deficit.

While the performance of commodity exports and in particular manufacturing exports is very important in an economy like Iran from a long-run perspective, the medium-term balance of payment problems were mainly related to the rise in commodity imports. This is due to the fact that the value of imports was far higher than non-oil exports and they could not exert an important influence on the overall trade balance of payments in the medium-term.

Despite a 10 per cent average annual rate of growth of private consumption the rate of growth of imports of consumer goods was no more than 1.7 per cent per annum. At the same time, there was rapid growth in the imports of intermediate and capital goods. The cyclical fluctuation in the overall trade balance during the crisis of the early 1960s was a perfect mirror image of the fluctuation in the manufacturing deficit. While the minor recession of the late 1960s began to bring down the manufacturing deficit, the sudden rise in the oil price prevented the repetition of the pattern of the earlier period.

For most of the years since 1978 the country has experienced a deficit in its external accounts. These deficits were mainly caused by: reduced volumes of crude oil exports; the fall in the oil price; additional import requirements because of the war; a flight of capital; and the government policy of paying back external debts. In 1978-79, oil export earnings were down to \$18.1 bn from \$21 bn in the previous year, but due to a slow down in economic activity and reduced total imports the balance of payments produced only a small deficit. In 1979, there was a decline in foreign payments, while foreign receipts remained high because of high oil prices therefore there was a surplus of \$ 5.9 bn. In 1980 foreign receipts decreased as a result of the oil export reduction as well as the break out of the war with Iraq, while foreign payments increased. The year ended with a current account deficit of \$ 2.4 bn and an overall balance of \$ -9.7 bn. From 1979 up to 1993, the overall balance of payments registered a total deficit of about \$ 5.7 bn. A not insignificant portion of the negative overall balance of payments was due to a relentless flight of capital from the country.

Despite heavy penalties for unauthorised foreign exchange transactions, the government was unable to stop capital transfers through the decade.

The services account of the balance of payments was affected in a number of different ways during the decade. On the receipts side, there was a decline in investment return due to reduced net foreign assets and the freezing of some foreign exchange holdings abroad. On the payments side, there was also a substantial reduction in debt servicing up to 1991 when foreign debt began to accumulate again. On the whole the services account remained in large deficit, thus despite a surplus in the trade account the balance of the current account was in deficit for the most of the period 1978-93.

Trade liberalisation, exchange reforms and the shifting source of GDP growth (from services to the commodity producing sectors) greatly increased foreign trade. Total imports of goods and services rose from just over \$ 13 bn in 1988 to a record high of more than \$30 bn (in current US dollars) in 1991. As a result, the current account deteriorated to a record deficit of nearly \$ 8 bn. The deficit was financed mainly through borrowing and a draw down on official reserves and foreign assets (see Amuzegar, 1993).

The break down of the balance of payments into its main components leads to four broad observations. First, the trade balance was determined essentially by the value of oil exports and the consequent value of merchandise imports. Second, the services sector which was perennially in deficit, was largely in the freight and insurance account and long-run investment income from Iran's pre-revolution loans and investment. Third, principal activities in the capital account related to the freezing and the release of Iranian assets as well as the use of short-

term credit. And, finally, non-oil exports played a relatively insignificant role in the overall balance of payments.

2.2.4 Price Level and Inflation

The balance of payments problem of the early 1960s was caused by a monetary-induced boom. Loans extended to the private sector increased by 46.1 per cent in 1957, 60.5 per cent in 1958 and 32.4 per cent in 1959. Rising government expenditure together with the unprecedented expansion in private sector credit produced Iran's first major boom during this period. In addition to the government's fiscal actions the expansion was aided by a major liberalisation of restrictions on importation of capital equipment. Prices rose by only 1 per cent in 1959, partially because imports increased by about one-third during that year. A year later the price level had risen by 10 per cent while imports had expanded by only 10 per cent. By the end of the 1950s the monetary -induced boom had come to its inevitable end with the country facing both excessively rising prices and a large and growing current account deficit. The government was forced to embark on an economic stabilisation programme initiated by the IMF, with its standard measures such as exerting direct control over private sector credit, raising interest rates, restriction of imports and reduction of government expenditure.

As a result the economy turned into recession until 1963. In the early years of the 1960s and indeed until 1970, the rise in the price index was relatively low and caused little concern and the economy enjoyed a prolonged period of price

stability through the 1960s. Beginning in 1972 however, growing inflation pressures developed and were present throughout the 1970s.

A comparison of the rate of increase in the money supply and that of inflation confirms that in the post oil boom of 1973, the Iranian economy had advanced beyond its absorptive capacity in that the complementary factors of production were put to work alongside the rapid increase in financial resources. Apparently an injection of oil revenues beyond a certain level -the annual absorptive capacity of the economy- only led to higher inflationary pressures with little or no corresponding increase in output resulting from this expenditure. The evidence for Iran during the post 1972 period suggests a tendency of trying to do too much in too short a time(Looney,1982, ch. 8).

Most domestic sources of the inflationary pressures that built up in the mid 1970s can be traced to the decision to revise the fifth five-year Plan investments and expenditure. The projection of total investment was doubled and significant resources were allocated to social welfare and subsidies. From the total government budget of 1974 (which was tripled from the previous year) only 28 per cent went into fixed capital formation whereas 58 per cent was spent on current expenditures.

To sum up, the inflationary cause and effects in the period 1960-77, one can observe that the impact of an increase in government current expenditure on the one hand and the economy's absorptive capacity on the other hand were key factors. In the fourth economic development plan(1968-73) government current spending increased annually by an average rate of 22 per cent per year. In 1971 the current account increased by about 31 per cent. In the fifth economic

development plan, 1973-1978, current budgetary spending accelerated greatly . The increase was equal to 300 per cent. Part of the increased current expenditure went into government subsidies of basic necessities but the major part contributed to rises in salary and wages in the public sector, further feeding a soaring demand.

The economic crisis of 1978 had its monetary origins in the economic boom of the years following the sharp increase in oil prices. In 1978 it was hard to call the Central Bank's action part of a rational stabilisation policy. However, a Bank Markazi's survey (Bank Markazi Iran 1991) of the early 1978-93 period shows that a series of measures adopted in 1978 to combat inflation in the housing sector resulted in a decline in the housing price index and affected the overall consumer price rise due to the heavy weight given to the dwelling price index in the overall consumer price index. Other factors, such as a reduction in public expenditure, the outflow of a considerable volume of bank notes from the banking system and a decline in the velocity of money also affected the price level negatively.

In 1980 inflation once again became one of the authorities, major concerns. With the outbreak of the Iran-Iraq war, a devastating decline in oil production and revenues together with significantly reduced imports of consumer goods and industrial inputs affected aggregate supply considerably while aggregate demand (mainly because of soaring government expenditure) rose sharply. The central bank reported a 35 per cent rise in money supply as the chief cause of the 1980 inflation. Due to the war-time conditions the government established a price control centre, rationed main foods and other basic necessities and adopted a

plan to subsidise other important consumption goods. Despite these efforts the CPI in 1981 still rose by 22.8 per cent. The central bank estimate of inflation for the whole three year period, 1978-1981, was about 50 per cent.

In 1982 consumer prices rose by 19.2 per cent. Due to the recovery in the industrial sector, greater availability of foreign exchange and increased imports of basic goods and raw materials, the rise in the CPI was reduced from the previous year's level. In 1983 some other goods were added to the rationing system. The CPI in 1983 rose about 15 per cent. In 1984 consumer prices rose by just 10.4 per cent due to an extension of subsidies as well as stabilisation policy.

A reduction in public sector expenditure accompanied by a slower rate of increase in private liquidity resulted in a fall in aggregate demand. On the supply side, increased output in agriculture and manufacturing helped the balance. 1985 witnessed a recession and the rise in the CPI was reduced to 6.9 per cent.

In 1986 oil prices fell markedly. On the other hand, the government expenditure soared due to the intensification of hostilities in war. The money supply increased due to a huge budget deficit and fuelled the inflationary pressures once again. The CPI rose by 23.7 per cent. The most direct cause was the unprecedented budget deficit due to the fall in oil revenues. The inflation continued in 1987 and the CPI rose by 27.7 percent. The main cause again was the budget deficit, more or less for the same reason as the previous year. An 18.1 per cent rise in the nominal money supply was reported by the central bank (Bank Markazi Iran).

The fall in the global price of oil in 1987 negatively affected government revenue and foreign exchange reserves. With a budget deficit of 50 per cent of total government expenditure and a 25 per cent rise in private liquidity an upsurge in inflation was inevitable and the CPI rose by nearly 29 per cent. Then came the cease-fire. This eased the war and military related expenditure and redirected some part of these resources toward production which lowered the budget deficit. On the other hand private sector investment increased as a result of stronger expectations of economic recovery in the post-war era. The rise in the CPI for 1989 was however still high-17.4 per cent, but in 1990 it fell to a lower level of 9 per cent. Growing demand for construction materials, basic commodities, industrial parts, skilled labour and so on put new pressures on prices in 1991. The CPI rose by 19.6 per cent in this year. The rise in the cost of living was reported to be 23 per cent in 1992.

Apart from different internal and external factors such as: population growth; supply bottlenecks; the devastating eight year war with Iraq; and a decline in oil price and revenues, the root cause of Iran's high inflation can be explained in two related phenomena, namely (i) the government budget deficit and (ii) the debt financing policy of borrowing from the domestic banking system, which created high powered money which in turn fed private liquidity and increased the money supply in the 1978-93 period (see Amuzegar, 1993).

The correlation between the nominal money supply, private sector liquidity and the price level was quite evident from the data. During 1981-83 when liquidity increased by an annual average of nearly 20 per cent, the CPI rose by 21 per cent. When the expansion of private liquidity was reduced to an annual 12

per cent in the 1984-86 period so annual inflation fell to about 10 per cent. After 1986, both indices rose in tandem until 1990.

The link between inflation and foreign exchange reserves has also been plainly evident. The clearest linkage between the fall in foreign exchange earnings and inflation was apparent in the increase in liquidity resulting from the budget deficit. Since oil revenues normally constituted a substantial part of total government revenues, any drastic decline in oil income was bound to result in a correspondingly larger budget deficit. Since the budget deficit was ordinarily financed by borrowing from the central bank more outside money was created and inflation was inevitably linked to the government oil revenue and foreign exchange holdings. The other linkage between foreign exchange reserves and inflation was through inputs of imported raw materials and semi-processed goods to output. Due to the heavy dependence of the country's industries on imported goods, the availability of foreign exchange was linked to import increases and economic growth.

2.3 National Economic Policies

2.3.1 Monetary System and Monetary and Credit Policies

Modern banking in Iran started late but, protected and stimulated by the state and expanding economic activities, it developed and became one of the fastest growing parts of the economy particularly after the mid 1960s. In the 1950s, the Iranian banking system was composed of six banks, four of which were owned by the government, one was a Russian-owned bank which specialised in trade between the two countries and the remaining one was the only private

commercial bank (formed in 1950). By 1960 the number of banks had increased to twenty-six including four specialised banks. Seven banks were private, nine were operated with foreign participation. The share of the private banks rose to 39 per cent of the total assets of the banking system by the end of 1962. By 1976 the number of banks had increased to thirty-five which included ten specialised banks. Despite the proliferation of private banks, in 1976 the government banks still owned more than 50 per cent of the assets of commercial and specialised banks. While during the 1950s the government exerted no effective control over the activities of the private banks, the formation of the central bank (Bank Markazi Iran) in 1960 changed this. The Currency and Credit Council of the central bank gave the government tightened surveillance over the formal credit market. Through a policy of differential interest rates and different forms of credit controls, the Bank Markazi exerted its control over the total amount and distribution of funds within the regulated credit market (see Karshenas, 1990).

The rapid development of the banking system in the 1950s led to a large expansion of uncontrolled credit which was one of the causes of inflationary pressures between 1957 and 1960. In an attempt to expand government control over the country's financial system the state owned Bank Markazi took over the central bank's functions in 1960. The principal instruments of monetary policy available to the Bank Markazi were interest rates and selective credit controls, reserve requirements, credit ceilings, refinancing facilities and exchange rate policies.

Changes in the money supply came about in three ways, (i) external transactions of the government sector, (ii) change in the supply of credit to the

non government sectors by banks and (iii) changes in the government domestic budget. The Bank Markazi had to manipulate those factors in the monetary base or multiplier in the light of the expected effect on money of those factors it did not control (Looney,1982, p.183).

Each of these sources of change in money supply and liquidity showed a steady growth during the period 1960-1970. As a result, the growth in the money supply and liquidity was also relatively steady in the 1960s. Thus, the money supply (defined by the monetary authorities as notes and coins in circulation plus private sector sight deposits) increased from about Rls 40 bn in 1961 to Rls 97 bn in 1970. Monetary liquidity rose by an average rate of 15.5 per cent a year in the period 1961-1970. The rate of growth for the period 1970-77 was 31.4 per cent. The drastic upward movement was mainly due to the jump in oil revenue which accrued to the government budget in the form of foreign reserves. In the wake of the rise of oil revenues budgetary expenditure expanded sharply, the inflationary effects of which caused concern to the monetary authorities and prompted a stabilisation policy.

The lagged impact of the growth of money supply changes indicates that the Bank Markazi's liberal financing of government deficits in the late 1960s and early 1970s was a contributing factor to the accelerating inflation of the mid 1970s. In addition, several new sources of inflationary pressure began to develop. First the mobilisation of quasi money in 1968 and 1969 by the commercial banks to extend bank credit to private sector. Secondly, the private sector's demand for credit was beginning to accelerate in the early 1970s (see Looney, 1982).

The Bank's policy in the late 1960s and early 1970s was predicated on the belief that the curtailment of credit to the public sector could jeopardise the economy's development process. Hence, most of the central bank's actions at this time involved attempts to regulate the volume of credit allocated by the commercial banks to the private sector. In addition to the credit ceiling imposed on the private sector during the 1970s, the Bank raised the legal reserves requirement for demand deposits. Legal reserve requirements for non-sight deposits remained unchanged at 15 per cent. Also in 1970 banks were required to hold 16 per cent of their incremental deposits as government securities. The maximum interest rate payable on savings deposits was lowered to 4.5 per cent. The expressed purpose of regulations was to restrict the banks' overall lending activities. Therefore the private sector was forced to bear the entire burden of the Bank's credit policy.

In an official assessment of its performance for 1973 the Bank felt that its raising of the rate of interest proved effective in mobilising savings. By 1974 the Bank saw its major objective as largely one of restricting the increase of loans and credits which were for inflationary use while simultaneously encouraging the expansion of loans and credits for productive purposes and imports.

The Bank's policy in setting a ceiling on bank credits was limited to commercial banks only. No restrictions were placed upon the increase in loans and credit of specialised (by regulation and practice) banks because of the capacity increasing character of their lending operation. The net result of the Bank's various credit policies, despite all its talk of restraint, was an expansion of credit by 41 per cent during 1974. The volume of banking operations

continued to expand in 1975 as the assets and liabilities of the banks increased by 34 per cent. Expansion took place despite a decline of 11 per cent in the banking system's net foreign assets. Expansion therefore resulted largely from the rapid growth in bank credit to both the private and public sector.

Alarmed by the rapid expansion of liquidity, the Bank raised reserve requirements on savings and time deposits from 12 per cent to 15 per cent. In addition, reserve requirements placed on commercial banks were increased from 15 per cent to 30 per cent. No limits were applied to credit extended by specialised banks and, in fact, these banks were encouraged to lend through financial assistance extended by the government and Bank Markazi.

Inflationary pressures had become a major problem by 1976. The Bank now took the view that it was an excessively rapid increase in private sector liquidity that was the chief cause of the price increases. The Bank set the commercial bank credit ceiling of 1976 at 30 per cent. Also, the maximum lending rates of the specialised banks for industrial, mining and construction projects rose to 9 per cent. The Bank also increased its rediscount rate from 7 per cent to 9 percent for commercial activities. But these increases seemed insignificant and more of a token effort given that the consumer price index increased by a rate of 16.6 per cent (Looney, 1982, p189). The Bank's effort seemed too little and too late as the result was that neither an allocation of investment to the productive activities nor price stability were met. By 1977, inflation was approaching 30 per cent (on annual basis) during the first quarter of the year. Given the seriousness of the situation the monetary authorities would seem to have had little choice but to attempt to curb the expansion in liquidity

and restore some sort of stability to the economy. The maximum lending rate of the commercial banks was raised and in general there was a sharp switch away from the liberal credit policy of previous years.

Many of the Bank's problems were caused in fact by relatively immature commercial banks. For example, the authorities would have liked to have had around a 35 per cent increase in credit to the private sector in 1976. It turned out to be near 40 per cent. In all fairness to the Bank, the scope for effective monetary policy was severely constrained throughout the 1970s. The Bank was caught between the government's highly over-expansive fiscal policy on the one hand and a fairly unsophisticated commercial banking system on the other.

In 1978 because of political turmoil, an economic stagnation developed due to uncertainty about the future of the economy. The hoarding of money increased because of political unrest and lack of confidence in the banking system. This caused the banks to face an acute shortage of cash for financing their liabilities.

The traditional instruments of monetary policy available to the Bank used to affect the supply of money were either the stock of reserve money or the money multiplier. Insofar as the components of the reserve money are concerned, change in foreign denominated assets which are a reflection of the oil sector could not generally be considered to be a policy instrument for changing the stock of money. Nor could variations in credit from the Bank to the government be used by the Bank as an active instrument to adjust reserve money (because its item was usually adjusted passively to the government budgetary position). Thus the authorities were confined to concentrating on changing the net claims on the

private sector (principally the commercial banks) through which they could affect reserve money and affecting changes in the multiplier itself largely through alternating the banks' reserves to deposit ratio. However it has been argued that the Bank could have controlled the money supply at any rate of expansion if it had targeted medium or long-term price stability (Looney, 1982, p.197). Evidence based on the Bank's ability to sterilise foreign exchange flows would seem to indicate that the authorities had the power to control the money supply in the medium term.

After the 1979 revolution all banks and insurance companies were nationalised. Since then the banking system has consisted of the Central Bank (Bank Markazi) with usual functions of central monetary authorities, six commercial banks, three specialised investment credit institutions and several non-bank financial institutions.

The western style Iranian banking system was changed by a Banking law in 1983. Apart from declared objectives of the law, in practice the usury free banks were expected to become partners rather than mere creditors in development projects. Bank Markazi is by law in charge of improving the performance of the country's monetary and credit system. Broad guidelines are set forth each year by the annual meeting of the Bank's shareholders (key economic ministers) who also prescribe credit policy and short-term facilities. Long-term credit policy objectives must be submitted to the Majles (the parliament) for approval. The council on money and credit, composed of public officials and private sector representatives, acts as the central bank's policy board (see Amuzegar, 1993).

Short-term policy instruments at the Bank's disposal consist mainly of credit ceilings and minimum reserve requirements prescribed for commercial and specialised banks. Several new tools introduced by the 1983 banking law give the Bank additional and more specific regulatory powers. First, the Bank has been granted the power to set the minimum rate of return (interest charged by banks). These rates eliminate marginal and sub-par projects. Second, by determining the profit sharing rate between the banks and their clients in each sector of the economy the Bank can influence the amount of credit allocated by banks to various sectors. Third, by regulating and changing the rate of service fees charged by banks on forward transactions, the Bank can regulate the allocation of credit financing for these trades. And fourth, the Bank has the power to establish maximum limits for participation by banks in capitalisation of long term investment (see Amuzegar, 1993).

Commercial banks accept two types of deposits , interest free demand deposits in the form of chequing and saving and investment deposits for a minimum period of one year. But in order to attract investment, depositors are not treated merely as a bank creditor but actually as its partner in investment activities. Banks use these deposits as the agents of deposits in various forms of partnership or joint venture. Bank profits made by such transactions are shared with depositors according to the volume and duration of the deposits. No fixed amount or rate of return can be guaranteed to the depositors in advance. In addition to the commercial banks' requirement with Bank Markazi, commercial banks have been required to buy government notes at periodic intervals at an effective rate of return of 4-7 per cent. Minimum and maximum rates charged or

paid out for each category of commercial bank activity are determined by the Bank's Council on Money and Credit in advance with rules approved by the Council of Ministers.

Specialised banks deal mainly in long term projects of five years or longer duration in the form of debt financing or equity participation. The specialised banks can and do accept long-term deposits from the private sector. They are allowed to maintain government insured chequing and saving accounts at no fixed interest but with possibilities of participating in the banks' net profit. These banks are in effect development finance agencies that are supported by government to promote fixed investment in priority sectors. They offer more attractive terms to their borrowers than commercial banks. In return they provide lower-cost and longer-term funds to their customers than the commercial banks. Specialised banks are assisted and appraised by the government on the basis of the implicit return on their investment.

A large number of private financial institutions have also been active in the domestic credit market alongside the nationalised banks, mainly engaged in domestic and foreign trade, brokerage activities and services. In March 1989 Bank Markazi's Council on Money and Credit issued new regulations concerning the establishment, operation and financial reporting of these institutions. These funds were obliged to operate as non-trading units and were restricted in their operations. Also financial organisations with a mutual funds feature have been competing with commercial banks.

After 1978, government monetary policy has been virtually dictated by the public sector's borrowing requirements. The monetary authorities' obligation to

finance the government's budget deficit have overshadowed other considerations. For most of the 1980s the principal instruments employed by Bank Markazi to control the overall expansion of credit were quantitative quotas assigned to each bank and administrative guidelines regarding the composition of credit to the various sectors. Within the aggregate credit limit for these years, commercial banks were given credit ceilings based on their sources and use of funds. With the change in credit policy from administrative controls to market determination, the effective use of indirect instruments such as minimum reserve requirements came into effect again. For the first time since 1983, legal reserve ratios were changed in 1992. The ratio for demand and short-term investment deposits was raised from 27 per cent to 30 per cent. Long-term investment deposits had their ratios reduced to 15 per cent from 25 per cent.

In addition, in order to reduce liquidity in the market and to prevent commercial banks from lending beyond the guidelines, banks were required as of the first day of 1991 to hold, in addition to their reserves with the Central Bank, the equivalent of 30 per cent of their demand and sight deposits in the form of government securities (see Amuzegar, 1993).

Due mainly to the rising government deficit caused by the depressed private sector and later the war related expenditures, private liquidity increased by an average rate of 22 per cent a year between 1979 and 82. In 1982 the Council on Money and Credit raised the legal reserve requirement from 12 per cent to 17 per cent and placed ceilings on bank loans. In the summer of 1983 reserve requirements were raised from 17 per cent to 27 per cent because of the threat of inflation. The growth rate of private liquidity was brought down to 17.2 per cent.

The slow growth of the banking sector further intensified in 1984-85. As part of the new banking law the Council for Money and Credit established the minimum expected profit in various economic sectors ranging between 6 per cent and 12 per cent for lending and 4 per cent to 8 per cent for investment.

Until 1989 the government borrowing requirement was a major reason for the credit expansion as claims on the public sector had risen year by year. Due to a reduction of the budget deficit post 1989, the rate of expansion of the banking system's claims on the government was reduced to 11 per cent in 1990, and turned negative in 1991. The overall net credit expansion largely the budget shortfalls. Bank Markazi 's claim on the government rose from 28 per cent in 1979 to 77.8 per cent in 1991.

Because of credit restrictions imposed by the Bank, claims on the private sector in 1980-88 grew modestly. However, during the following three years, the annual growth of such claims rose considerably. Claims on public industrial enterprises also grew sharply at the beginning of the 1990s due to a higher effective cost of imports (see Amuzegar, 1993).

Net foreign assets remained largely stable for most of the 1980s. Although undergoing annual changes due to the improvement or deterioration in the external balance and the government's foreign exchange payment obligations. Under the government's new adjustment programme since 1989 and domestic oil price rationalisation, significant changes have taken place in the creation of domestic assets and private sector liquidity. As the financing requirement of the budget deficit was reduced through the sale of foreign exchange in the free market, bank credit was diverted to the private sector during 1990-1992. A good

portion of this credit went to public enterprises whose output price was still fixed but their imported inputs had to be paid at an exchange rate much higher than the official one.

There have been a number of shifts in monetary aggregates in the 1980s. First, there was a notable shift in the composition of private sector liquidity from currency holding and sight deposits to saving and time deposits. The ratio of quasi money to broad money rose from 44.4 per cent in 1981 to 51.2 per cent in 1991. The ratio of broad money to nominal GDP that had fallen to 58.2 per cent in 1981 went up to 63.2 per cent in 1991. Due to the existence of a free market in foreign exchange denominated assets which gave a higher real return and also provided a good hedge against inflation the portfolio shift in favour of foreign assets contributed to further devaluation of the domestic currency in the free market and thus to a further decline in rial denominated holdings.

2.3.2 The Fiscal Policy and Public Finance

During the period 1955-59, which was a period of economic boom, government showed little consideration about the disequilibrating effects of its fiscal policy in respect of its potential role in the mobilisation of domestic resources for investment and controlling the level and composition of aggregate demand. Easy access to oil revenues and external borrowing substituted for the need to reform the tax system for the implementation of fiscal policy. During 1955-62, between 50 and 60 per cent of government expenditure was financed by oil revenues or by domestic or foreign borrowing. The expansionary impact of the government budget deficit could be measured by the size of the total injection of the public

sector in the domestic economy minus withdrawals through different forms of taxation. The domestic budget deficit formed about 40 per cent of the total government expenditure and close to 7 per cent of GNP. Such a huge budget deficit exerted a further expansionary impact on the economy through the money supply. Indeed in the absence of a capital market and given that the domestic borrowing of the government was mainly from Bank Markazi, there existed a one to one relation between the budget deficit and the injection of high powered money into the economy. Such annual injections of high powered money through the government budget were on average equal to 50 per cent of the money supply in all years over the period under study. It was not only the case that the institutions for sterilising the monetary impact of the domestic budget deficit were non existent but also the experience of the revaluation loan fund in 1959 showed that there was an absolute lack of concern over such matters on the part of the government.

During the 1960s government domestic borrowing was totally financed by loans from the Central Bank i.e. Bank Markazi Iran. The mode of financing the budget deficit over the period had highly expansionary effects on the banking system's liquidity. The large increase in the net foreign assets of the banking system over this period is an indication of the extent to which oil revenues financed government expenditure. In the 1960-78 period the government consumption maintained a very high rate of growth of about 20 per cent per annum in average.

An important aspect of public finance over this period was the growing share of oil revenues in financing government expenditure and the low tax revenues by

the government. The share of oil revenues in total government revenue increased from about 50 per cent to about 75 per cent between 1963 and 1978. One implication of this was the relatively large and rapidly widening gap between government expenditure and its tax revenues. The domestic budget deficit increased from 11 to 32 per cent of GNP between 1963 and 78 period. The impact of the government budget on income distribution is therefore expected to have been mainly through the distribution of income generated by the government itself rather than a redistribution of the income generated in the private sector. In other words, the expenditure policy of the government is expected to have had a much more important bearing on income distribution than its taxation policy (see Karshenas, 1990).

On the basis of existing studies one can point out that the salient features of the tax system over the period 1955-78 were as follows: first; the overall tax yield was low and tax revenues played an increasingly less significant part in financing government expenditure over time. Secondly, the incidence of the tax system did not play a major part in the redistribution of income in the economy. Thirdly, there existed a great untapped potential for increasing national saving through taxation, particularly if these could be made to fall on the consumption of high income groups (Karshenas, 1990, p. 193).

In the absence of a deliberate policy of intervention by the government aimed at redistribution of income through specific fiscal measures, there is no reason to believe that the government budget would have automatically served to achieve a more equal distribution of income. Though such an objective was

mentioned in various government plans and budget documents, no specific policy measures were formulated with income distribution as their primary aim.

In Iran, an oil exporting country where the major part of public expenditure was largely financed by external resources, the need was not felt strongly enough for a tax system with in-built progressive elements. Also the relatively large share of public sector expenditure in such an economy is not likely to bring about a drastic change in income distribution. The reason is that the higher income groups which are in a more privileged position to take advantage of public services are less likely to appropriate the major share of benefits from public expenditure.

Overall, in the 1960-78 period, the taxation and expenditure policies of the government did little to ameliorate the growing concentration of income gains from productivity growth. The availability of oil income as easy access to foreign borrowing did away with the need to tax the consumption of high income groups in order to release resources for financing public expenditure and capital formation. This had an important impact on the consumption pattern in the economy, creating a fragmented consumer market and a weak growth of demand for items of mass consumption.

After 1979 the government's role in the economy was extended due to the nationalisation of the banking system, large industries and firms in mechanised farming. The outbreak of the war with Iraq in 1980 also enlarged the scale of government involvement in the economy. Despite extensive involvement of government in every aspect of the Iranian economy the ratio of government expenditure to GDP has been smaller than it was in 1978. That is, the

significance of the government sector in the economy has, relatively, declined over years, while its regulatory functions have been increased.

The central government's total revenues are derived from three main sources: oil and gas income sources from the export of oil and natural gas in which the state has a monopoly. Non-oil revenues consisted of tax receipts and non-tax earnings. Taxes are levied on income and wealth, production and consumption and foreign trade. The annual government revenues gradually declined from more than 34 per cent of GDP in 1978 to 10.5 in 1989 before rising again to 31 per cent in 1992. Excluding petroleum revenues, the government tax receipts fell from the already low level of 7.5 per cent of GDP in 1977 to 4.7 per cent in 1991 probably one of the world's lowest ratios before heading to 6 per cent in 1992 (see Amuzegar, 1993).

Overburdened by the cost of the war, handicapped by the difficulties of collecting taxes under the circumstances, and committed to reducing the tax burden on the poor, the government has been facing a sustained deficit in its annual budgets since 1978. The budget deficit ratio to GDP in the 1978-92 period has been ranging between the lowest 4.1 per cent in 1985 up to 14.6 per cent in 1980. The gap between government revenues and expenditure widened in 1988 once again with the budget deficit reaching more than 9.8 per cent of GDP. After the cease-fire in 1988, the economic recovery in the early 1990s boosted government revenues and reduced the ratio of budget deficit to GDP to 2.3 per cent.

The government's resolve in the first five year economic plan, space 1990-94, was to: (i) reduce its budget deficit to less than 2 per cent of GDP through a

reduction of public expenditure to below 20 per cent of GDP; (ii) to emphasise capital outlays at the expense of current programmes; and (iii) increase the share of non-oil revenues in its budget. For the near future, the planned increase in total revenues is based mainly on larger oil revenues. The reduction in the budget deficit is to be realised from exchange rate depreciation rather than a significant cut in non-essential current expenditure or a substantial increase in tax revenues. An increasing reliance on oil income in turn would make government finance more vulnerable to fluctuations in the world price of oil and for this reason the plan is to take a series of measures for reducing or eliminating a broad range of tax exemptions and subsidies and to diversify non-oil revenue sources through the establishment of a broad-based consumption tax and more efficient tax collection.

2.3.3 The Foreign Sector Regulations and the Exchange Rate Policy

Until a unified exchange rate system was adopted in March 1956, a dual exchange rate system based on the use of export certificates was in effect in the country. Up to May 1957 foreign reserves were converted at the old principal import rate that was 32.5 Rls per US dollar. In May 1957 foreign reserves were revalued at the new unified rate of 75.5, the proceeds of which were allocated to the Revaluation Loan Fund (RLF) at the National Bank (IMF, 1963, p.294). This unification of exchange rates did not amount to a devaluation of the exchange rate as far as the private sector was concerned. The rate applicable to them before March 1956, including the export certificates rate was 76.5. The main effect of this act was felt in the public sector- more than doubling the Rial value

of government oil revenues and turning the disguised subsidies on the import of essential goods into open subsidies.

During the 1950s the Iranian government maintained quantitative control over certain categories of imports, through which it protected particular industries on a selective basis. The same applies to tariffs which at 30 percent of total dutiable imports represented relatively high rates of protection for competitive imports. In the second half of the 1950s when Iran was regaining its share of the world oil market, together with large net inflows of foreign capital, there was a rapid accumulation of foreign exchange reserves in this period. This was the background which prompted the government to liberalise foreign trade and the massive domestic credit expansion through the revaluation loan fund in 1957. From 1958 the country had to increasingly draw down foreign exchange reserves to finance imports. During the three years of 1958-60 there was a cumulative drain on foreign exchange reserves of more than \$ 210 million (see Baldwin 1967, p. 57), so that by 1960 the country faced a reserve balance of payments crisis with foreign exchange reserves almost depleted. In September 1960 the country was left with foreign exchange reserves barely sufficient to finance a couple of weeks value of essential imports and the government was forced to take action through an IMF prescribed stabilisation programme.

The stabilisation programme consisted of a series of contractionary fiscal and credit policies and import controls put into effect over the 1960-1 period. Strict exchange and quantitative import controls were also imposed. By December 1961 the foreign exchange situation was improved and by March 1962 the stabilisation programme was officially terminated.

In the early 1960s' balance of payments crisis, the black market for foreign exchange sprang to life. In this period the premium in the black market -defined as the percentage excess of the black market rate for the US dollar over the official rate rose from 5.8 percent in 1960 to 21.0 percent in 1963 before falling back to 4.1 percent in 1966 as financial and economic conditions began to improve (see Pesaran, 1992, p. 115).

With increased economic and political stability and increasing revenue from oil exports the black market premium practically disappeared. In most of the 1970s, before 1979, Iran had an official and a free market rate of exchange in its commercial and non-commercial markets, and the two rates were very close. Active intervention by Bank Markazi disallowed any lasting disparity. For example during this period the central bank reportedly sold about \$ 7 billion on the free market to support the rial (see Amuzegar, 1993, p. 162).

After 1979, the maintenance of a free exchange market was abandoned and a dual exchange rate system followed almost immediately. All foreign exchange transactions were subjected to specific documentation. Gradually, a growing list of goods and services that were considered non-essential were denied the benefit of the official low rate and were shifted to other (higher) rates of exchange in a multiple rate regime. In the 1980s, exchange regulations went hand in hand with trade restrictions. All basic imports were rationed after 1982 following the outbreak of the war with Iraq. In the following years trade restrictions were tightened or relaxed according to the availability of foreign exchange.

Between 1979 and 1989 the premium of the exchange rate in the black market has been rising at a staggering average rate of 42 percent (per annum)

and in November 1989, the black market rate of the dollar reached its peak at over 20 times the official rate. When the black market rate is allowed to depart significantly from the official rate, the system becomes subject to serious microeconomic as well as macroeconomic distortion. The severe overvaluation of the official exchange rate encourages overinvoicing of imports and underinvoicing of exports and deprives the government of exchange revenue, encourages capital transfers abroad and generally erodes public confidence in the government's management of the economy. The high levels of premiums also create extensive opportunities for rent-seeking activities, promote corruption, and result in a considerable misallocation of resources primarily from manufacturing to trade and distribution.

Up to 1990 the country practised a complicated system of several different exchange rates. The basic official rate applied to oil exports revenues. There were two basic incentive rates applicable to the surrender proceeds from non-oil exports. Two other specific preferential and competitive rates existed for the importation of raw materials used in the production of 131 domestic products. There was a service rate for certain invisibles. There was an intervention rate at which the free market was fed by the banking system and finally there was a free market rate for all other private transactions.

Regulations governing import payments and non-oil receipts were significantly liberalised after the cease fire in 1989. Under the 1991 reforms, regulations concerning non-oil exports and the surrender of export proceeds were largely revamped (see Amuzegar, 1993, p. 165). As in the case of imports, only a general trade registration was henceforth required. Export proceeds could

be sold to the banking system at the floating rate or in the free market at the exporter's discretion. The exchange rate structure was also drastically simplified, but some restrictions on payments were maintained. In May 1992, the procedure for foreign exchange allocation was as follows: First, there continued to be the basic official rate at Rls 92.3=SDR 1. Receipts from oil and gas and official capital inflows and invisibles fell into this rate category. Payments at this basic rate were authorised for specific imports and for certain capital and invisible transactions. A competitive rate of Rls 600=\$ 1 applied to some of specific imports needed by domestic industrial enterprise, including raw materials, spare parts and consumer products and still needed approval and allocation. Third, the floating exchange(supplied by the banking system) rate which applied to all other transactions not covered by the other two rates. Finally a free market rate determined solely by the market forces continued to exist alongside the other rates.

The exchange regime was further modified as of March 21, 1993 in the direction of additional rial devaluation. The official floating exchange rate at Rls 1538 to \$ 1 announced at the start of the Iranian new year indicating a devaluation of about 100 per cent. This rate was re-evaluated slightly several times during 1993 reaching 1600 to the dollar by the end of July.

However, even as early as 1993, when the unification programme was adopted, under the recommendation of the IMF, some Iranian economists argued that the timing and pace as well as its design and administration could make the unification policy unsuccessful. This assessment was on the basis of some observations: first, the country had accumulated foreign debts with a

significant portion already due for repayment or due to mature in one year's time. On the other hand the actual foreign exchange earnings in 1992 had fallen considerably because of the fall in oil prices. The country's foreign reserves with the Bank of International Settlement (BIS) had decreased while its liabilities had risen, thereby limiting the amount of foreign exchange reserves that the central bank could count on to support the rial. Finally in spite of the central bank's plan to restrict the growth of liquidity (M2) to about 5.8 per cent in 1992, the actual growth rate was dramatically higher, 24.6 percent (Bank Markazi Annual Reports), building up inflationary pressures and adding to demand for foreign exchange. Therefore the relevant indicators were all pointing to an acute shortage of foreign exchange at the time of the unification programme in 1993. Not surprisingly the expectations of foreign exchange scarcity were already being reflected in the market through a widening of the gap between the floating and free market exchange rate(see Farzin, 1995, p.995) which ultimately forced the government to abandon its unification programme (at least for the time being) and devalue the rial to Rls 3000 for \$ 1 by the end of the 1994.

2.4 Summary and Concluding Remarks

In this chapter we have briefly reviewed the economic development of Iran in the period 1953-93. This review shows that, broadly speaking, the country experienced a relatively high rate of economic expansion between 1953 and 1979, during which Iran was transferred from a basically agrarian economy to a semi-industrial developing country. Aggregate consumption and investment grew persistently while the home market and foreign trade expanded considerably.

The economy was monetised and the banking system developed to a large extent. In this period rapid economic growth led to balance of payments crises on two occasions (i.e. late 1950s and late 1960s). The stabilisation programmes adopted by the government had the inevitable recessionary consequences but the economy recovered fairly quickly thanks to the increasing oil revenues. In spite of the rapid economic growth over the period, inflation did not appear as a major economic issue until the post oil boom of 1974.

Between 1979 and 1981 the economy suffered a deep recession largely due to the consequence of the revolutionary turmoil. In the early years of the wartime austerity period ,1981-88, although the government's restrictions and control over the economy intensified, oil revenue increased and the economy resumed its growth. This favourable cycle was reversed later in this period following the drastic fall in the price of oil in 1986. The economy began to recover again, from the recession, only after the cease fire and under a new and more pragmatic administration which took over in 1989. Despite years of recession in the period 1979-93 high inflation has been a major concern in the economy. The officially estimated rate of inflation for this period was more than 20 percent per annum on average. Although many factors, such as the war, the rapid increase in population and so on, have contributed to inflation, there has been an essentially uncomplicated link between the rise in liquidity, fed by the government budget deficits, and an increase in the price level in the country in this period.

For most of the years since 1979, the country experienced a deficit on the external account but with tight control over foreign trade the government managed to prevent a major balance of payments crisis in the 1980s. However,

trade liberalisation, exchange rate reforms and economic growth in the early 1990s (which caused a surge in import demand) led to a serious balance of payments deficit in 1993 that forced the government to negotiate with international creditors for rescheduling the country's foreign payments. Because of the rapid expansion of liquidity, particularly through the extension of bank credit to the public sector, several devaluations of the rial, have failed to restore the convertibility of the currency. While the economy is expanding in real terms, high inflation and an external accounts deficit remain two main issues for the economy in the mid 1990s.

Some broad observations can be drawn from this survey:

- (i) Oil revenue, which accrues to the government budget as an external fund, increases the multiplier effect of its expenditure and probably stimulates the private sector's investment.
- (ii) Because of the oil revenue, government expenditures have not been constrained by the tax effort and taxation has played a relatively minor role in the government fiscal stance in this period.
- (iii) Government budget deficits have largely been financed through borrowing from the domestic banking system with a highly expansionary effect on money stock.
- (iv) Government fiscal expansions have not shown a considerable crowding out effect on private sector investment.
- (v) Official interest rates have not been an effective measure regarding demand for credit from the banking system. The monetary authorities have controlled

the allocation of bank credit through legal reserve requirements and credit ceilings on commercial banks.

(vi) Open market operations were not used as a major source of finance for the public sector borrowing requirement. One can assume that, in effect, a zero sterilisation policy was adopted in this period.

(vii) Given the economy's structure, there has been a genuine shortage of foreign exchange in the economy except for the short period of the oil boom era 1974-77. High rates of economic growth could not have been maintained due to the balance of payments difficulties and international exchange reserves constraints.

These observations are considered in the following chapters of this thesis where we develop and estimate a macroeconomic model for Iran and then utilise the model for policy analysis in short-run and long-run equilibrium. In the next chapter we develop a structural model suitable for a formal analysis of the Iranian economy. Considering a standard macroeconomic model for a small open economy, we modify the model taking into account the Iranian economy's characteristics in the context of more general features of developing countries discussed in the literature. Estimation of the model in the following chapter, using time series of the macroeconomic data, reveals the extent to which the model approximates the economy.

Chapter III

Specification of the Model

3.1 Introduction

In chapter II we highlighted some of the main features of the development of the Iranian economy since the 1950s. In this chapter we specify a macroeconomic model which provides a theoretical framework for the subsequent analysis of the transmission mechanism of economic policies in the Iranian economy. In setting-up the model we take the standard macroeconomic relationships from mainstream economic theory and modify them for the purpose in hand, taking full account of the relevant literature on developing economies. Thus, an attempt is made to establish a macroeconomic framework that take account of the main characteristics of the Iranian economy which includes its developing country state.

3.2 The Model

The model is essentially a flexible-price dynamic variation of the traditional Mundell-Fleming (see Haque et al, 1990) model with certain developing country characteristics. A single good is produced domestically which can be sold at home or abroad. The home country has some monopoly power over the price of its output in the world market but it is a price-taker for its imports. Private agents may not be able to satisfy their demand for imports because the

authorities impose quantitative import restrictions that depend on the availability of foreign currency. On the financial side of the economy the degree of integration of the economy with the rest of the world depends on the degree of severity with which capital controls are enforced. In principle this can range from financial autarky to perfect capital mobility. The dynamics of the model arise from forward looking expectations, partial adjustment in the behavioural relationships and capital and foreign exchange stock accumulation. Since the rate of change of the current account and of total investment (public plus private investment) are endogenous, the model can explain medium-term growth and external debt accumulation. Because expectations are forward looking, variable values will depend not just on present but also on future values of the policy and exogenous variables.

3.2.1 Aggregate Demand

Real aggregate demand for domestic output is defined as the sum of consumption, private investment, government expenditure and the trade balance:

$$(3.1) \dots Ad_t = C_t + Pi_t + G_t + X_t - (\epsilon_t \cdot P_t^* / P_t) \cdot Z_t$$

where Ad_t is aggregate demand, C_t is real private consumption expenditure, Pi_t is real private domestic investment expenditure, G_t is real government expenditures on domestic goods and services which, in turn, consist of public sector development expenditure (i.e. government investment G_{it}) and public

sector consumption (G_c). X_t denotes real exports; e_t the nominal exchange rate (i.e. price of foreign currency in domestic currency terms); Z_t is real imports measured in units of foreign currency; P_t^* is the international price index and P_t is the domestic currency price of domestic output. As government total expenditure consists of development expenditure and consumption; and total investment in the economy consists of private investment plus public investment, we have two identities:

$$(3.2) \dots G_t = G_c + G_i$$

and

$$(3.3) \dots T_t = G_i + P_i$$

where T_t is total investment.

3.2.1.1 Consumption Function

Starting with the private consumption function, we turn to explain the components of aggregate demand. Generally speaking there are two principal lines of thought about the consumption function. One holds that consumers are not able to smooth their consumption over transitory fluctuations in income because of, for example, liquidity constraints. As a result consumption is too sensitive to current income to be consistent with the life cycle permanent income hypothesis. The second holds that a reasonable measure of permanent income is a distributed lag of past actual income and therefore the consumption function should relate consumption to such a distributed lag (see Hall 1978). A more general consumption function, embodying both ideas, might let consumption

respond to contemporaneous income and a distributed lag over past income. Here we consider the consumption function as follows.

$$(3.4) \dots \log C_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \log C_{t-1} + \alpha_3 \log Y_{dt} + \alpha_4 \log Y_{dt-1}$$

in equation (3.4), r_t is the domestic real rate of interest, C_{t-1} , Y_{dt} and Y_{dt-1} are the lagged real consumption, real disposable income and the lagged real disposable income respectively. α_i , $i = 0, \dots, 4$ are coefficients to be estimated.

The short-term interest semi-elasticity of consumption is measured by α_1 . A priori, it is difficult to assign a magnitude to α_1 . The effects of the real interest rate on consumption in developing countries have been extensively studied. For example Rossi (1988) investigated the determinants of private saving in 49 developing countries over the period 1973-83. He found a significant relationship between the real rate of interest and current real consumption. His model takes account of the observation that a significant fraction of the population in developing countries are affected by liquidity constraints that substantially diminish consumers' ability to substitute consumption intertemporally. Adopting a utility maximisation approach, he obtains a consumption function which can be interpreted as an approximation to the Euler equation for consumption incorporating credit constraints. His conclusion explicitly extends to regions such as the Middle East. Set against this, Giovannini (1985) provides empirical evidence on the question of whether saving (and therefore consumption) responds to the real rate of interest. In contrast to Rossi, Giovannini's results tend to reject the existence of a significant relationship between real interest

rates and consumption in LDC's. Giovannini's paper argues two points: "first, empirical estimates of the response of aggregate savings to the real interest rate, based on modification of 'Keynesian' consumption functions of the seventies, do not provide any support to the hypothesis that aggregate saving responds positively to the real interest rate. Second, estimates of the response to the expected real interest rate indicate that intertemporal substitutability in consumption is likely to be very small in the majority of countries studied, which other things equal, implies small interest elasticity of savings" (Giovannini, 1985, p. 198). Using annual data he found that in only five out of the 18 countries studied does the expected path of consumption change at all with changes in the real rate of interest. In the majority of cases the response of consumption growth to the real rate of interest is insignificantly different from zero" (Giovannini 1985).

The general specification of the consumption function suggested here (3.4) has a number of alternative hypotheses nested within it. If for example $\alpha_i = 0$; $i = 0, 1, 3, 4$ and $\alpha_2 = 1$ we have the simplest version of the permanent-income hypothesis adopted by Hall(1978)- with no liquidity constraints and in which current consumption is systematically related to its own past value. Hall concludes that if every deviation of consumption from its trend is expected and permanent then the best forecast of future consumption is just today's level adjusted for trend. Forecasts of future consumption are irrelevant since the information used in preparing them is already incorporated in today's consumption, (see Hall, 1978). If α_3 and $\alpha_4 = 0$ the specification would be consistent with more general Euler-equation type consumption function models

in which in the absence of new information, consumption grows at a rate that depends on the interest rate (see Rossi (1988), and Giovannini (1985)). However, a number of studies have shown that current disposable income would be important (i.e. $\alpha_3 \geq 0$) if liquidity constraints are binding for a significant portion of households. In this case, aggregate consumption would include a portion that is attributed to liquidity constrained households whose consumption is constrained by current income. With regard to the relationship between consumption, lagged consumption and the revision in permanent income, conditional on lagged information sets, Flavin (1981) explains conflicting empirical results found in Hall (1978) and Sargent (1978) by reference to their different formulation of permanent income. Using an alternative approach to test the permanent income-rational expectation hypothesis, he tests whether the marginal propensity to consume out of current income is significantly different from zero. His conclusion, based on empirical results, is that “the observed sensitivity of consumption to current income is greater than is warranted by the permanent income-life cycle hypothesis, even when the role of current income in signalling changes in permanent income is taken into account” (Flavin ,1981, p. 976).

The coefficient on the lagged disposable income term can also provide a test of the Blanchard hypothesis of a finite planning horizon for private agents. Haque(1988) shows that if the planning horizon of households that do not face liquidity constraints are of finite length then $\alpha_4=0$; otherwise α_4 will be negative. The empirical evidence in Haque and Montiel (1989) which is based on a sample of 16 developing countries indicates that a much larger proportion of a

developing country's population behave as if they were liquidity constrained than is typically found in studies for the United States. They therefore emphasise the importance of liquidity constraints in developing countries rather than finite horizon effects on private consumption.

3.2.1.2. Disposable Income

Real Consumer disposable income, a variable used in the consumption function above is defined to be GDP plus the earnings on net assets held abroad minus interest paid on domestic debt and direct taxes:

$$(3.5)... Y_{dt} = Y_t - \left(\frac{i_t^* \cdot e_t \cdot F_{pt-1}}{P_t} \right) - \left(\frac{i_{bt} \cdot D_{cpt-1}}{P_t} \right) - D_{tax_t}$$

in this equation i_t^* is the international nominal interest rate, F_{pt} is the stock of foreign assets held by the private sector (measured in foreign currency terms), i_{bt} is the interest rate charged by the domestic banking system, D_{cpt} is the stock of domestic bank credit held by the private sector and D_{tax_t} is real net direct taxes.

3.2.1.3 Private Investment

The total investment in the economy consists of public and private investment. Government investment (termed as development expenditure in the Iranian government budget bills) is a policy variable and therefore is not determined within the model. Private investment is a function of the real rate of interest, aggregate income, the capital stock of the economy, public sector investment

(government development expenditure), and banking credit extended to the private sector.

$$(3.6) \dots \log P_{it} = \kappa_0 + \kappa_1 r_t + \kappa_2 \log Y_t + \kappa_3 \log K_t + \kappa_4 \log G_{it} + \kappa_5 \log \left(\frac{D_{cpt}}{P_t} \right)$$

In equation (3.6) K_t is the capital stock of the economy.

Apart from government investment and domestic bank lending to the private sector, the terms in equation (3.6) are quite standard for an investment equation (see Haque et al, 1990). The significant effects of public sector investment and domestic bank credit on private sector investment in developing countries, have, however, been emphasised in a number of studies. (see for example Chhibber and Van Wijnbergen, 1992, Dailami, 1988, Shafik, 1992, and Karshenas, 1990). Here, therefore, we only discuss the decision to include these two variables in the private investment function of the model.

A clear consensus has emerged in recent years that, in contrast to developed countries, one of the principal constraints on investment in developing countries is the quantity rather than the cost of financial resources. Whilst the rate of return on investment in those countries typically tends to be quite high, real interest rates on loanable funds can be kept low (and indeed have been negative when the inflation rate is high) by government for a variety of reasons. Because the total amount of financing is limited and the price mechanism, in the capital market, is not allowed to operate smoothly, it would seem legitimate to hypothesise that the private investor in a developing country is restricted by the level of available bank financing. See for example Blejer and Khan (1984).

The importance of bank credit to private sector investment becomes evident once one considers the channels through which credit policies affect production and investment in the economy. In general there are three channels for these effects: (1) the indirect link between credit and overall aggregate demand when there is unused capacity and unemployment, (2) the direct link between working capital availability and current production and (3) the link between credit, investment and future production (see Keller, 1980). In developing countries the availability of investable funds and working capital is not only crucial for industrial production but also for small scale firms and agricultural farming- which produce a substantial portion of national output- that cannot borrow in the curb market because of relatively high interest rates charged in this market. The liquidity situation of firms and their access to funds from various sources determines not only the size of the current volume of production but also the extent of fixed capital formation undertaken by the firm (Keller, (1980)).

In economies characterised by underdeveloped financial markets the availability and cost of credit become important determinants of private sector investment. Following the classic work of McKinnon(1973) and Shaw(1973) a large body of literature has evolved highlighting the nature and extent of government intervention in the financial system of developing countries, particularly in the form of direct credit allocation and controlled official interest rate and their implications for economic growth, efficiency and investment (see for example Bruno, (1979), Buffie, (1984), and Van Wijnbergen (1983,a)). In most studies of private investment in developing countries credit rationing appears to have a decisive role in capital formation. For example in Turkey,

banks were able to circumvent low administered rates of interest by requiring customers to hold non-interest bearing compensating balances. Similarly, in Colombia, small and medium sized firms were often found to be credit constrained because of the inaccessibility of capital markets and inter-firm markets which cater exclusively for larger reputable firms. Again in Morocco, it was found that the degree of rationing diminished when financial liberalisation measures were adopted in the 1980s (see Chhibber et al 1992).

In the empirical literature the relationship between public and private investment is often posed as competitive or adversarial. For example Balassa (1989) is quoted as finding evidence of a negative relationship between public and private investment (see Chhibber et al 1992). However, Khan and Reinhart (1989) show that public investment has no significant effect on growth when private investment is included in the regression equation although their empirical results do not take into account the possibility of correlation between private and public investment. In part this shows the complexity of the interaction between public capital formation and profitability of the private sector. More importantly, it seems necessary to distinguish between public investment which can be broadly classified as infrastructure and that which can be classified as non-infrastructure activities. The former is likely to be more complementary than competitive with private sector profitability.

This is important not least because the financing of public investment requires a tax on the private sector. However Ogura and Yohe (1977) have argued that public investment not only provides direct consumption benefits to the private sector but also it reduces the costs of private sector investment, via

the externalities created by public investment. While too much investment in public infrastructure will not help because its financing might impose other costs on the private sector, too little public investment on the other hand may impose significant costs on the private sector. In a detailed study of the Nigerian manufacturing industry, referred to in Chhibber et al (1992), it has been shown that the breakdown of social infrastructure such as electricity supply has forced private companies in this country to acquire costly generators. The study shows that there are clear economies of scale in the provision of utilities, communications and social services from which private producers derive benefits (Chhibber et al 1992).

In the case of non-infrastructure public capital formation, particularly in manufacturing and mining, there is often competition between public and private sector investment. In many cases the same enterprise could have been in the private sector had the government not pre-empted their entry by establishing public enterprise to produce those goods or services. Private investors are reluctant to enter into activities where they must compete with public enterprise even when overall demand for the product is greater than the production capacity of public sector firms. The public firms typically get preference in credit and raw material allocation as well as in the location of distribution outlets. A study by Bleger and Khan (1984) is one of the earliest attempts to assess the impact of different types of public investment on private capital formation. The study found support for the hypothesis that investment in infrastructure has a positive effect on private investment whereas non-infrastructure investment has a negative impact. A more direct examination of this issue is provided in a paper

on the Turkish economy by Chhibber and Van Wijnbergen (1992) and a study on Egypt by Shafik (1992). The Turkish study finds evidence that non-infrastructure public investment has had a crowding-out effect on private investment. The study by Shafik on Egypt finds strong support for the proposition that the public infrastructure investment positively affected private investment in Egypt by reducing production costs and stimulating demand for private goods and services. The rebuilding of Egyptian infrastructure in the late 1970s and early 1980s provided support for the recovery in private investment although this was achieved at the cost of some crowding out at the margin in financial markets (see Chhibber et al, 1992).

Studies of the effect of government investment and domestic bank credit policy on private sector investment in Iran reveals similar features to those found in other developing countries mentioned above. For example, Karshenas (1990) comes to the conclusion that the rapid growth of government investment over the period 1960-1978 produced a strong impetus for private investment both from the demand and the supply side. On the demand side it contributed to the rapid expansion of the home market. On the supply side, government development expenditure is thought to have contributed to the profitability of private investment through direct cost reduction and other indirect positive externalities. Government investment in infrastructure such as transport, communications, energy and irrigation and on social developments such as education and health would have had obvious positive effects in this respect. Such complementary and dynamic interactions between public and private investment are expected to be particularly strong in economies with an ample supply of labour and substantial

possibilities for increasing the productivity of labour through the introduction of advanced technology (Karshenas, 1990, pp.172-73). Also in the Iranian economy, between 1960 and 1978, the financing of government investment by external funds (i.e. oil revenues) ruled out the possibility of financial crowding out of private investment. Overall, Karshenas's analysis leads us to conclude that government investment in the Iranian economy was likely to have exerted a strong positive influence on private investment and that the availability of bank credit to the private sector had had a significant bearing on private investment (Karshenas 1990). However Amuzegar (1993) shows that in the mid 1980s the government budget deficit rose to a very high level of its total expenditure and that there had been clear crowding out. This was mainly due to the government's anti inflationary policy designed to reduce the monetary expansionary effects of financing the budget deficit by borrowing from the domestic banking system. Monetary authorities had to restrain domestic credit to the private sector in order to modify the inflationary impact of financing the public sector borrowing requirement.

3.2.1.4 Export (Foreign) Demand

Exports in the model are a function of the real exchange rate and real output abroad (Y^*). This is regarded as the conventional approach to the modelling of exports as applied to LDCs (see Goldstein and Khan 1985). Thus in the conventional approach, exports volume are modelled as a demand equation depending on relative prices and on world income. Khan (1980) provides estimates of such an export demand function for 15 developing countries. He

finds significant price elasticities (at 5 per cent level) with the correct sign for most of the countries studied. He also found positive and significant income elasticities. However, Riedel (1984, 1988) has criticised this approach to modelling the demand for LDCs' exports on the grounds that export growth in LDCs is supply determined and that world income is largely irrelevant for LDC exports. On the basis of his empirical work on a group of newly industrial economies (NIE) he found high price elasticities of demand for these countries exports. He interpreted these results as existence of a close substitution for goods traded in the world markets. Muscatelli et al (1994) discuss the modelling of LDC exports taking into account Riedel's arguments and the recent works of Krugman (1980 and 1989). They suggest that dynamic mis-specification might have affected the results obtained by Riedel. They estimate an error correction model of a system of demand and supply for exports for a group of *three NIE* and find a high income and low price elasticities of export demand (which are usually found in empirical studies), and provide general support for the conventional modelling approach presented here.

In equation (3.7) below, we therefore expect a positive coefficient for both real external output and the real exchange rate (i.e. τ_1 and $\tau_2 \geq 0$). To incorporate partial adjustment, a lagged dependent variable is included in the estimated equation. This allow us to test for incorrect specification- due to estimation of an equilibrium relationship when the true relationship is a disequilibrium. Thus it is expected that $1 > \tau_3 > 0$.

$$(3.7) \dots \log X_t = \tau_0 + \tau_1 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + \tau_2 \log Y_t^* + \tau_3 \log X_{t-1}$$

In equation (3.7) Y_t^* is the rest of the world real income. It might appear that (3.7) implies that exports are determined entirely by foreign demand (and that domestic supply considerations exert no influence on their level). This is not the case. At any given output the rate at which domestic producers can increase exports depends on the adjustment process through relative prices, the current account and domestic production capacity. Consider an increase in exports, in the short-run, due to a rising demand in international markets, (i.e an increase in Y_t^*) this would improve the balance of payments position. Since the nominal exchange rate is fixed, an increase in foreign reserves would extend the monetary base and push up domestic prices, making home-produced goods less attractive for foreigners. In the long-run an improved foreign trade balance would raise demand for imports leading to new investment and capacity expansion (see equations for imports and aggregate production below).

3.2.1.5 Import Demand

The simplest formulation of an aggregate import demand function relates the quantity of imports demanded to the ratio of import price to domestic price (assuming a degree of substitutability between imports and domestic goods) and to domestic real income. Therefore a typical imports equation would be $Z_t = f(e_t \cdot P_t^* / P_t, Y_t)$. However in the context of developing countries a potential source of misspecification in the import equation may arise when no account is

taken of quantitative restrictions that are imposed on import flows. Import compression occurs when a government imposes direct controls on imports through tariffs, quotas and licensing schemes or devaluation of the currency for the purpose of servicing external debt. Assuming that the government takes measures to compress the aggregate volume of imports whenever it faces the need to accumulate foreign exchange reserves or reduce net official foreign liabilities, then the demand for imports function should include an explanatory variable to measure “reserves stringency”, for example the stock of real foreign reserves. Indeed, there is considerable evidence available that for many developing countries, the capacity to import is constrained by the stock of real international reserves (see Hemphill 1974, and Khan and Knight 1988). Considering the possibility that economic agents might not be able to increase their imports to the desired level because of, for example, government restrictions, a partial adjustment mechanism is incorporated by including a lagged import term in the equation. A rationale for this can be made on the basis that there are costs involved in the adjustment of imports to a desired flow and that only part of the adjustment is achieved within the period. Also, many imports are linked to contracts extending over a period of time and thus cannot respond promptly to changes in demand (see Khan, 1980a, p. 681). Also, since restricted foreign exchange availability frequently leads to the imposition of import controls in developing countries, the reserve-import ratio ($F_r/P_t * Z_t$) lagged one period is included in the estimating equation. The import equation therefore is specified as:

$$(3.8) \dots \log \left(\frac{e_t P_t^*}{P_t} \right) Z_t = \delta_0 + \delta_1 \log \left(\frac{e_t P_t^*}{P_t} \right) + \delta_2 \log Y_t + \delta_3 \log \left(\frac{Fr_{t-1}}{P_t^* Z_{t-1}} \right) + \delta_4 \log \left(\frac{e_{t-1} P_{t-1}^*}{P_t} \right) Z_{t-1}$$

where Fr_t is the foreign exchange value of international reserves held in central bank of the economy. In equation (3.8) we expect $\delta_1 \leq 0$ and δ_2 and $\delta_3 \geq 0$ and $1 \geq \delta_4 \geq 0$. Since the equation is specified in logarithms δ_1 and δ_2 are relative price and income elasticities respectively.

3.2.2 Aggregate Supply

Estimation of an aggregate production function involves a variety of theoretical and econometric difficulties (see, for example, Aigner and Chu 1968, Walters 1963, and Forsund et al 1980). In developing countries the difficulties are compounded not least because information on the capital stock is costly and troublesome to obtain. Indeed it is services of the capital stock rather than the capital stock itself which is the appropriate explanatory variable in a production function. However, since *capital services are unobservable and therefore usually assumed to be proportional to the capital stock*, data on the capital stock is typically employed in the estimating of production functions.

One important modification of the relationship between the capital stock and aggregate supply allows for a short run deviation of actual output from the economy's long term capacity output. For example, Khan and Knight (1981) and Agenor (1990) treat the growth of real output as a function of: the lagged

deviation of actual output from normal capacity level of output; and factors such as short run monetary disequilibrium. In this context changes in aggregate supply is written as:

$$(3.9) \dots \Delta \log Y_t = \theta_0 + \theta_1 \log \left(\frac{Y_t^c}{Y_{t-1}} \right) + \theta_2 \log \left(\frac{m_t^d}{m_t} \right)$$

where $\Delta \log Y_t = \log Y_t - \log Y_{t-1}$ and Y_t^c is the capacity level of aggregate output (see for example Behrman, 1977, where he calculates Y_t^c using the “through the peaks” method). $\log \left(\frac{m_t^d}{m_t} \right)$ captures short-run disequilibrium in the money market in which m_t^d is the long-run demand for money and m_t denotes actual real money balances. This formulation assumes that the rate of growth of output is positively related to the so called output gap and actual output adjusts to its capacity level in the long run.

This approach is similar to that outlined by Laidler and O'Shea (1980) in which an excess money supply will result in a temporary expansion of real income. However, this is an empirical issue and one would wish to remain agnostic about the extent to which monetary disequilibrium affects income without some empirical results (see Khan and Knight, 1981).

In our model we have derived two alternative aggregate production functions. First, in line with the above discussion (where a distinction is made between actual and long-run trend output), an aggregate production is specified on the assumption that actual output could deviate from its long-run trend as a result of transitory shocks. For this function we assume a Leontief production

function. The alternative aggregate supply equation is derived from a Cobb-Douglas production function which presumes that actual and trend output are always the same and that recessions or booms are not temporary but are caused by fundamental negative and positive shocks respectively (see Karakitsos 1992). Which of these two models best explains the data is considered in the next chapter of this thesis.

Starting from the Leontief production function, suppose that as a developing country the capital stock is the binding factor in Iran. Assuming $Y_t^c = \min[aK_t, bL_t]$ where Y_t^c is the capacity output and K and L are capital stock and labour factors in the production function respectively and a and b are parameters; we have the following aggregate production function:

$$(3.10)... Y_t^c = aK_t$$

In (3.10), a can be interpreted as the inverse of the capital output ratio which is expected to remain constant. In the short run the economy could deviate from its long run level mainly as a result of two factors: first, a short term excess money supply and second a fall in the level of imported intermediate goods (essential for the production of industrial goods), below the minimum level required for the economy to operate on its long-run trend level.

Regarding the short run monetary disequilibrium effect, an excess supply of money induces a short-run output effect as agents attempt, in accordance to the Pigovian effect, to change their spending and their holding of financial assets. This captures the spillover effects of monetary changes on output,(see

Agenor,1990). With respect to the effect of the shortage of imported intermediate goods, it is well known that in many developing countries aggregate output is heavily depend on imported semi-manufactured and intermediate goods (see Khan and Knight 1988). Iran is no exception: the importance of imported intermediate goods in the Iranian economy has been mentioned in almost every survey of this economy (see, for example, Amuzegar 1993, Pesaran, 1992, Karshenas 1990, Behdad 1986, Looney 1982, and Motamen 1979). About 60 per cent of imports, in every year of the period 1960-1993, consisted of raw materials and semi -manufactured goods. In the periods that the economy enjoyed more or less, a free trade regime (notably, the oil boom years of 1974-76), imports rose to levels several times higher those of other periods (for example 1985-86 and 1992-93- periods of limited foreign exchange reserves). In these periods actual output fell well short of the economy's normal capacity. This suggests that the availability of imported intermediate goods has been one of the main factors causing a short-run deviation of actual from capacity output.

Here we assume that a deviation of economic growth $\log Y_t - \log Y_{t-1}$ from its long run trend $\log Y_t^c - \log Y_{t-1}$ can occur under influences of the short-run monetary disequilibrium $\log m_t^{id} - \log m_t$ and a fall in the minimum level of imports to actual volume of imports $\log Z_t - \log Z_t$. Substituting for capacity output from equation (3.10) we can express actual aggregate output as a function of aggregate supply lagged one period, the capital stock of the economy, the short-run monetary disequilibrium and the ratio of minimum required imports to actual imports as follows:

$$(3.11) \dots \log Y_t = \theta_0 \log a + (1 - \theta_0) \log Y_{t-1} + \theta_0 \log K_t + \theta_1 (\log m_t^d - \log m_t) + \theta_2 (\log Z_t - \log Z_{t-1})$$

where Z_t is the minimum required level of imports and $\theta_i, i = 0, \dots, 2$ are coefficients to be estimated.

In order to obtain an estimating form of equation (3.11) some assumptions have to be made about short-term monetary disequilibrium and the required level of imports. Regarding the short-run monetary disequilibrium term we consider the adjustment mechanism, initially introduced by Chow (1960) and described as a standard adjustment mechanism for money market disequilibrium by Khan and Knight (1982). This adjustment process can be written as (see demand for money below):

$$(3.12) \dots \Delta \log m_t = \lambda (\log m_t^{ld} - \log m_{t-1}) \quad 1 \geq \lambda \geq 0$$

where $\Delta \log m_t = \log m_t - \log m_{t-1}$ and λ is the adjustment parameter. Rearranging equation (3.12) for $\log m_t^{ld}$ we obtain:

$$(3.12') \dots \log m_t^{ld} = \left(\frac{1}{\lambda}\right) \log m_t - \left(\frac{1-\lambda}{\lambda}\right) \log m_{t-1}$$

We further assume that the proportion of the minimum import requirement to the capital stock of the economy is a constant, which may be shown by

relationship $Z_{rt} = c \cdot K_t$, substituting for $\log m_t^{id}$ and $\log Z_{rt} = \log c + \log K_t$ into equation (3.11) and rearranging the equation we arrive at :

$$(3.13) \dots \log Y_t = (\theta_0 \log a + \theta_2 \log c) + (1 - \theta_0) \log Y_{t-1} + \theta_1 \left(\frac{1 - \lambda}{\lambda} \right) \log \left(\frac{m_t}{m_{t-1}} \right) + (\theta_0 + \theta_2) \log K_t - \theta_2 \log Z_t$$

This equation expresses aggregate output as a function of aggregate output lagged one period, a deviation in the actual demand for real money, the capital stock of the economy and imports. We expect that $(1 - \theta_0)$ and $(\theta_0 + \theta_2) > 0$ and $\theta_2 < 0$.

For the alternative aggregate supply function we consider a neo-classical Cobb-Douglas production function.

$$(3.14) \dots Y_t = A K_t^{\theta_0} \cdot L_t^{\theta_1}$$

where K and L are capital and labour inputs respectively and A , θ_0 and θ_1 are production function parameters. Lack of data on the capital stock could prevent the estimation of the above aggregate production function. To address this problem we modify the equation using the capital stock identity: $K_t = (1 - \rho) K_{t-1} + T_t$, where ρ is the depreciation rate of the capital stock and T_t is total investment in the current period. Substituting for the capital stock from the above identity in equation (3.14), the aggregate supply function, in log form, becomes:

$$(3.15)... \log Y_t = \log A + \theta_0 \log[(1 - \rho)K_{t-1} + T_{it}] + \theta_1 \log L_t$$

Next, we approximate (see footnote 1 below) the capital stock identity term in order to transfer equation (3.15) to a loglinear estimating equation for the production function.

$$(3.16)... \log \left[\sum_{i=0}^{t-1} (1 - \rho)^i T_{it-i} + (1 - \rho)^t K_0 \right] = \log 2 + \frac{1}{2} \log \sum_{i=1}^{t-1} (1 - \rho)^i \cdot T_{it-i} + \frac{t}{2} \log(1 - \rho) + \frac{1}{2} \log K_0$$

It will be noted that the net capital stock can be expressed as a summation of the net investment stream and the initial capital stock of the sample period.

$$(3.17)... K_t = \left[\sum_{i=0}^{t-1} (1 - \rho)^i \cdot T_{it-i} + (1 - \rho)^t K_0 \right]$$

where K_0 is the initial capital stock of the economy at the beginning of the sample period i.e. 1959. Therefore, approximating the lagged capital stock in equation (3.15) the aggregate supply function can be written as:

(1). We used the approximation

$$\log(x + y) = \log 2 + \frac{1}{2} (\log x + \log y) + \frac{1}{8} (\log x - \log y)^2 + \dots$$

where $x = (1 - \rho) \cdot K_{t-1}$ and $y = T_{it}$, the first-order term is considered to be adequate (see Haque et al (1990)).

$$(3.18) \dots \log Y_t = A' + \theta_0' \log K'_{t-1} + \theta_1 \log L_t + \theta_2' \log T_i$$

where

$$A' = \log A + \log 2$$

$$\theta_0' = \frac{\theta_0}{2}$$

$$\theta_2' = \frac{\theta_0 \theta_2}{2}$$

$$\log K'_{t-1} = \log 2 + \frac{1}{2} \sum_{i=1}^{t-(t-1)} (1-\rho)^{i-1} \cdot T_{i-(i-1)} + \frac{t-1}{2}(1-\rho) + \frac{1}{2} \log K_0$$

Parameter θ_2 , assigned to variable (Ti)- current period total investment, captures the effects of technological advance in the aggregate supply function. The current investment variable in the aggregate production function can, therefore, test the significance of the technological changes embedded in new investment in the economy. Estimation of equation(3.18) can also provide evidence on economies of scale in Iran. Finding a value close to unity for $\hat{\theta}_0 + \hat{\theta}_1$ is supportive evidence for the existence of constant returns to scale in Iran in the period 1959-93. Equation (3.18) can be estimated for different values of ρ over the interval (0,1) and (statistically) optimal values of θ_0' , θ_1 , and θ_2' will correspond to that value of ρ which maximises the \bar{R}^2 in equation (3.18).

3.2.3 Current Account of the Balance of Payments

According to macroeconomic theory, national income and domestic absorption relate to the external sector of the economy through the current account of the balance of payments. By definition, the current account must equal the difference between national income and domestic absorption. National income,

in turn equals, the sum of the value of domestic output and the net balance of factor earnings. Now, consider a developing country with sustained current account difficulties. In this economy if credit from either foreign or domestic sources was increased (with no change in domestic financial savings), to finance additional fixed capital formation, the immediate impact of this increase would be an addition to domestic absorption. If for example aggregate income did not increase along with domestic absorption and the increased level of investment was financed through domestic credit expansion there would be an overall balance of payments deficit and with it a loss of interest bearing foreign exchange reserves. If, on the other hand, the finance was achieved through an inflow of foreign funds there would be an overall balance of payments equilibrium but also there would be a need to pay interest on the increased level of foreign debt in the future. The immediate significant difference between the use of domestic and foreign credit is the effect on the level of the country's international liquidity.

Now, allowing time for output adjustment after the expansion, the new investment would add to domestic output. Assuming the profitability of the investment, the net addition to domestic output will be larger in value terms than the interest cost implied by the reduction in foreign exchange reserves or debt services paid for foreign debt and the current account will improve as domestic output exceeds domestic absorption. If however the proceeds from the credit expansion are not profitable, the initial current account deficit, that reflects the cost of investment, would be followed by a smaller but persistent deficit resulting from the excess of the interest cost over the rate of return of investment (see

Keller, 1980). According to the above discussion, the current account of the balance of payment (Ca_t) can be written:

$$(3.19) \dots Ca_t = Ni_t - P_t \cdot Da_t$$

where Ni_t is nominal national income and Da_t denotes real domestic absorption.

National income in is defined as:

$$(3.20) \dots Ni_t = Nft_t + P_t \cdot Y_t$$

where Nft_t is the net factor income transferred from abroad. Domestic absorption by definition is the sum of private consumption and investment plus the public sector expenditure.

$$(3.21) \dots Da_t = P_t \cdot C_t + G_t$$

Substituting for Ni_t from (3.20) in equation (2-19) and rearranging for Nft_t we obtain:

$$(3.22) \dots Nft_t = (Ca_t + P_t \cdot Da_t) - P_t \cdot Y_t$$

Also using the balance of payments (Bop) identity we have:

$$(3.23) \dots Bop_t = \Delta Fr_t = \left(\frac{1}{e_t}\right) Ca_t - (\Delta Fp_t + \Delta Fg_t)$$

where Fr is the stock of foreign exchanges of the central bank, Fp_t is foreign assets held by the private sector and Fg represents foreign assets held by the public sector. By definition, the current account of the balance of payments equals foreign trade plus net interest earned on foreign assets held by the central bank, private sector and public sector.

$$(3.24) \dots Ca_t = P_t \cdot X_t - e_t \cdot P_t^* \cdot Z_t + e_t \cdot Fae_t$$

where Fae_t is defined as:

$$(3.25) \dots Fae_t = i_t \cdot (Fr_{t-1} + Fp_{t-1} + Fg_{t-1})$$

Although each of these variables are determined by different relationships, both Fae_t and Nft_t relate to the same concept of the national accounts and measure an equivalent quantity which is the difference between the internal and external sector of the economy. Obviously Fae_t and Nft_t are equal (see footnote 1 below).

(1)-This can easily be shown as follows:

$$Ca_t = P_t \cdot Y_t - P_t \cdot Da_t + Nft_t$$

$$P_t \cdot X_t - e_t \cdot P_t^* \cdot Z_t + Fae_t = P_t \cdot Y_t - P_t \cdot Da_t = Nft_t$$

$$Fae_t = P_t \cdot \{Y_t - [Da_t + X_t - (e_t \cdot P_t^* / P_t) \cdot Z_t]\} + Nft_t$$

in order to aggregate income, Y , equals to aggregate demand, $[(Da_t + X_t - (e_t \cdot P_t^* / P_t) \cdot Z_t)]$ we must have:

$$Fae_t = Nft_t$$

3.2.4 Private Sector Foreign Assets

F_{p_t} in the model represents the amount of foreign assets held by the private sector. We determine F_{p_t} using the private sector budget constraint. Disposable income and consumer expenditure are linked to the net change in consumer wealth by the private sector's budget constraint (see Haque et al 1990).

$$(3.26) \dots Y_{d_t} = C_t + P_{i_t} + [(M_t - M_{t-1}) + e_t(F_{p_t} - F_{p_{t-1}}) - (D_{cp_t} - D_{cp_{t-1}})] / P_t$$

where M_t is the nominal money balance and D_{cp_t} denotes domestic credit extended to the private sector by the domestic banking system. Let $\Delta M_t = (M_t - M_{t-1})$ represent change in money supply, $\Delta F_{p_t} = (F_{p_t} - F_{p_{t-1}})$ denote the change in private sector holdings of foreign assets and $\Delta D_{cp_t} = (D_{cp_t} - D_{cp_{t-1}})$ show the change of domestic credit allocated to the private sector. The disposable income relationship (equation 2-26) can therefore be written as :

$$(3.26') \dots Y_{d_t} = C_t + P_{i_t} + (\Delta M_t - \Delta D_{cp_t} + e_t \Delta F_{p_t}) / P_t$$

Accordingly, disposable income of the private sector is allocated to consumption, private investment, and the net change in financial assets. We can solve equation (3-26') for F_{p_t} to obtain a relation which is derived from the private sector budget constraint.

3.2.5 Public Sector

The model's specification includes a description of the behaviour of the non-financial public sector. The public sector acquires assets in external markets (Fg_t), (a negative value of Fg_t denotes accumulated debt), as well as from the domestic banking sector (Dcg_t). For its revenue it relies on tax receipts (T_t , which include oil revenues) and interest on its foreign asset holdings. Public sector expenditure (G_t) consists of the purchase of domestic goods for consumption purposes as well as public sector investment (or development expenditure) and interest payments on domestic debts. Combining these elements, the public sector's budget constraint can be written as :

$$(3.27) \dots e_t \cdot \Delta Fg_t - \Delta Dcg_t = P_t \cdot (T_t - G_t) + i_t^* \cdot e_t \cdot Fg_{t-1} - i_{bt} \cdot Dcg_{t-1}$$

where ΔFg_t is the change in government holdings of foreign assets, and ΔDcg_t denotes the change in domestic banking credit claims on the public sector. It should be noted that in Iran, as in most developing countries, the absence of organised securities markets and/or their immaturity means that open market operations have not been a major source of funding the public sector borrowing requirement. Therefore, in equation (3.27) direct borrowing from the private sector is not considered as an option for the government's finance of its budget deficit.

3.2.6 Money Market

3.2.6.1 Supply of Money

The change in the money supply (ΔM_t) in period t consists of the change in foreign exchange reserves ($Bop_t = \Delta Fr_t$) and the change in domestic credit (ΔDc_t).

We have therefore considered the broad definition of money (M_2) in our model.

$$(3.28) \dots M_t = Dc_t + e_t \cdot Fr_t$$

and

$$(3.28') \dots \Delta M_t = \Delta Dc_t + e_t \cdot Bop_t$$

Foreign exchange reserves (Fr_t) are determined endogenously through the balance of payments (equation 3.23):

$$(3.29) \dots Fr_t = Fr_{t-1} + Bop_t$$

where $Bop_t = \Delta Fr_t$. Domestic credit on the other hand consists of domestic credit extended to the private sector and domestic banking claims on the public sector.⁶

Generally speaking, in an open economy, the domestic component of the money stock -namely the net level of domestic credit extended by the banking system- is taken to be the basic monetary policy tool. However any model of a developing country must recognise the linkage between government fiscal operations and the supply of money. For this reason, domestic credit extended to the public sector can be allowed to be determined endogenously in the following manner. Changes in domestic credit (ΔDc) can take place either through a change in the banking system's claim on the government (ΔDcg_t) or on the private sector

(ΔD_{cp_t}) , that is $\Delta D_{c_t} = \Delta D_{cg_t} + \Delta D_{cp_t}$. As was noted earlier, in our model we assume that the Government fiscal deficit is financed by domestic borrowing using cash balances held with banks or by borrowing abroad and converting the proceeds to domestic currency. Hence, government fiscal deficit results in an equivalent increase in the stock of domestic credit. Thus we have:

$$(3.30) \dots \Delta D_{c_t} = P_t \cdot (G_t - T_t) + \Delta D_{cp_t}$$

Only if the government were able to borrow domestically from the non-bank sector by selling bonds or bills would this identity extend to incorporate the direct borrowing of the private sector as another option of financing government budget deficit. Given the lack of a sufficiently developed domestic market for securities, the possibility of such a borrowing policy is denied.

Changes in domestic credit to the private sector is assumed to be exogenous to the model because it is determined by government monetary policy. Given the importance of the availability of bank credit for private sector investment and capital formation, and its impact on the money supply (and thence inflation), this formulation of the money supply equation recognises the impact of credit policy on the real part of the economy.

3.2.6.2 Demand for Money

There is wide agreement in the economic literature that the demand for money function should contain a scale variable (income and/or wealth) and opportunity cost variables representing yields on alternative real or financial assets relative to

yields on holding money (see Laidler, 1993). One important debate relates to the definition of the monetary aggregate and the choice of proxies for the income and opportunity cost variables. In addition, it remains to be seen whether other explanatory variables are important; and how to allow for adjustment to disequilibrium in the money market.

Neither theoretical nor empirical evidence is conclusive on which definition of money is most likely to be stably related to the macroeconomic variables which are expected to influence the demand for money. However, in many developing countries the available monetary policy instruments are directed to the volume of credit extended by the banking system. As a result, the total liabilities of the banking system, M_2 , may seem more relevant than a narrow definition like M_1 . There are also a number of other issues related to the definition of the money stock that warrant prior discussion. In a number of countries *the public sector is large and extends to the manufacturing sector and other industries*. Questions also surround the treatment of balances held in foreign currency. In Iran, residents' foreign currency held in domestic banks are treated as part of the money supply. Given fixed exchange rates and convertibility of domestic residents' foreign currency holdings, foreign exchange is as liquid as domestic currency. However, in countries where the formal exchange rate substantially differs from the curb market exchange rate, foreign currency balances may be held for different reasons from those relevant to holding than local currency balances; for example foreign currency holding may represent savings by residents spending prolonged periods outside the country or by firms exercising foreign exchange retention privilege (see Crockett and Evans 1978).

With respect to the scale variable, the empirical measurement of wealth is not straightforward. A variety of techniques have been suggested to enable the demand for money to be regressed against a wealth variable. However the available data do not permit us to employ such techniques in the context of the demand for money function for developing countries. Only for countries such as the UK and US, do sufficient time series data exist with which to construct some measure of the aggregate level of non-human wealth; (see Laidler 1993).

An opportunity cost variable in a demand function is intended to measure the yield on holding money against other assets. Since substitution can be made both between money and goods as well as between money and financial assets candidate opportunity cost variables would be the expected rate of inflation and expected rate of interest on alternative financial assets, respectively. However it is quite widely accepted that the relatively thin markets for financial securities in many developing countries make the substitution between money *and goods or* real assets quantitatively more important. This makes inclusion of the expected interest rate on financial assets somewhat irrelevant in developing countries; (see Khan, 1980). Also, it should be mentioned that observed interest rates in most developing countries are often determined by central banks and remain unchanged for long periods. Since changes are made fairly infrequently, the interest rate series display very little variation over time and thus make it exceedingly difficult, empirically, to detect any systematic relationship between money demand and an interest rate. In section 3.2.7 below, we discuss the determination of an equilibrium nominal rate of interest in the model in order to circumvent this problem.

A range of proxies for the expected inflation rate for the demand for money function can be found in the literature. Relevant here is Laidler's (1993) arguments that there are many instances, particularly when less developed countries are studied, in which the problem of measuring expected inflation can not be circumvented by resorting to the use of indirect measures (Laidler,1993, p.109). However many studies stress the importance of the expected inflation rate in the demand for money function for developing countries. Take Honohan (1994) for example who states that whether or not to include inflation in the demand for money function of industrial countries has become something of a side issue partly because of the many other opportunity cost variables which are relevant. It is however the central question for most developing countries especially where this is the only opportunity cost variable (Honohan, 1994, p. 220).

It is worth referring to some theoretical considerations regarding the expected signs and magnitudes of estimated coefficients of the demand for money function variables. Concerning the income elasticity of the *demand for money* there are two competing theoretical propositions. The first is that the use of money balances is subject to economies of scale and therefore that as real income increases the observed velocity of circulation will increase. On these grounds an income elasticity of demand for money somewhat less than unity may be expected. The second proposition is that the estimated income elasticity of the demand for money may be greater than unity because of upward bias induced by monetisation; (see Crockett and Evans 1978).

Goodhart (1989) provides a theoretical basis for the economies of scale in money demand function "Changes in real income are not so likely to have an equi-proportionate effect on the demand for money. As real income per-capita rises, transfer costs should not rise at the same rate, unless the technical progress responsible for the rise in real income has completely by-passed the payment-transmission mechanism. Moreover as income rises more companies will pass the point that makes it worthwhile for them to pay closer attention to cash management. So one would expect that the income elasticity of the demand for money for transaction purposes would be less than unity, though this effect may be offset to some extent by greater affluence reducing the frequency with which people will find it convenient to make transactions whether between assets and money or goods and money"(Goodhart, 1989, p.90).

The available evidence from studies related to developing countries permits two tentative generalisations to be made. First transaction balances defined as M_1 appear to be more subject to economies of scale than broadly defined money M_2 . That is, income elasticities tend to be lower for a narrow than for a broad definition of money. Second, broad money appears to be more of a luxury good in developing economies than advanced economies. While observed income elasticities in developed economies are sometimes below unity, developing countries tend to exhibit an income elasticity closer to 1.5. In a study of six Asian economies Aghevli et al (1979) found elasticities ranging from 1.33 to 1.85 for broad definitions of money. Mackenzie (1979) in a study of money demand in Egypt found an income elasticity for a broad money of about 1.5. Results of Morgan's (1979) estimation for five oil exporting countries including two from

the Middle East, were close to that of the Aghevli et al study mentioned above—long run income elasticities in this study ranged from 1.41 to 1.82. However, in a study of nineteen Latin American countries Galbis (1979) found elasticities generally below unity though dispersed over quite a wide range, which was perhaps not surprising in view of the more disturbed monetary experience of a number of Latin American countries in 1960s and 1970s.

Crockett and Evans (1978) in their estimation of the demand for money function in Middle Eastern countries report the following results "the coefficient on income turned out to be highly significant in nearly all cases. Although the coefficient estimates vary quite widely they are generally between 1 and 2 with the largest number in the range of 1 to 1.5" (Crockett and Evans, 1978, p. 553). In this study the income elasticity of demand for money in Iran was found to be about 1.4 for both broad and narrow definitions of money. Arize's (1994) study of the demand for money for three developing countries (Korea, Pakistan and Singapore) comes up with a similar result in the case of M_1 but somewhat different for M_2 . For example, his findings are not consistent with the long run real income estimates reported by Wong (1977) for Korea and by Aghevli et al (1979) for Singapore. Ahmad and Khan (1990) make use of annual data (1959-87) and report elasticities of .926 and 1.12 for M_1 and M_2 respectively (for Pakistan). Arize's (1994) estimates are 1.03 and 0.77 for M_1 and M_2 respectively (Arize, 1994, p. 225). This evidence in general suggests that one should expect a long run income elasticity of the demand for money for a typical developing country to fall in the range of just below unity to about 1.5. Our estimates of the

demand for money function presented in the next chapter will show whether or not this has been the case in the Iranian economy.

As far as the impact of the opportunity cost variable is concerned, theory suggests that the attractiveness of money balances would fall as the expected rate of inflation rises. However, empirical results are mixed in providing support for the proposition. Earlier studies; (see for example Morgan, 1979, and Galbis, 1979) failed to establish a significant relationship between the inflation rate and the demand for money in developing countries. For example Crockett and Evans (1978) sum up their research results in this respect (in Middle Eastern countries) as follows "Concerning the influence of inflation on the demand for money the results are much less clear-cut than for income elasticities. In some cases the coefficient was negative and significant but implausibly large (in absolute value)" (Crockett and Evans, 1978, p. 566). For example, the opportunity cost (of holding money) elasticities for the Iranian economy in Crockett and Evans study was estimated to be about $-.70$ while money demand studies in developed countries suggest an opportunity cost elasticity of between $-.2$ and $-.08$ in general. However, Arize (1994) using an error correction dynamic specification to estimate demand for money functions for three developing countries (Pakistan, Korea and Singapore), finds a weak effect of the expected inflation rate on the long run demand for money and a more significant impact on the short run money demand. This result is similar to that found by Parikh (1990) for the Indonesian demand for money.

Most studies concerning the interest rate effect on the demand for money in developing countries have found weak evidence of a clear influence of an interest

rate in a demand for money function. For example Haque et al (1990) estimating a macroeconomic model for 31 developing countries finds that money demand is quite interest -inelastic, with the short run elasticity estimated to be about $-.04$ (statistically significant at the 10 percent level) and the long run elasticity estimated at about $-.26$. In Haque et al (1993), a slightly different version of the Haque et al (1990) model was estimated for the same group of developing countries and again the interest elasticity of demand for money was found to be insignificant at the 5 per cent level. Crockett and Evans (1978) also find similar results regarding the impact of the interest rate on the demand for money function for Middle Eastern countries which are both small in magnitude and statistically insignificant. These results are similar to other studies of money demand in non-industrial countries. It is perhaps because of the absence of liquid asset alternatives to holding money for much of the population in many of these countries that the opportunity cost effect is indeed so apparently slight.

The other important aspect of the demand for money function that begs an explanation is the appearance of a lagged dependent variable in money demand equations. Laidler (1984) argues that the monetary transmission mechanism is more usefully described in terms of short-run disequilibrium: after a monetary shock, individuals find that their actual and desired money balance will diverge due to lags in the adjustment of money demand determinants. He provides an interesting description of why the monetary transmission mechanism may be subject to long and variable lags (see Stevenson et al, 1988, p. 181). This in turn led to the development of the buffer stock approach to the demand for money. This approach essentially argues that money fulfils a special role in the economic

system (see Goodhart 1984). Due to the liquid nature of money, the cost of adjusting money holdings is typically less than the cost involved in changing one's holdings of real or liquid financial assets. In an uncertain environment economic agents are likely to adjust their portfolios only when they perceive changes in the economic environment to be permanent rather than transitory. In the case of a money supply shock, only if this change is seen as permanent, will agents consider adjustment of their portfolios. However if the money supply increase was expected to be reversed in the next period it would be costly for them to adjust their expenditure portfolio of real and financial assets only to readjust them again in the next period. This results in a lag in the transmission mechanism, as an unexpected monetary shock leads to gradual portfolio adjustment.

Whilst the lagged dependent variable usually provides much of the statistical explanation in conventional demand for money functions Laidler (1993) however suggests that this variable cannot be rationalised in terms of partial adjustment when the money supply moves independently of demand and there is continuous market clearing. Importantly, this is an ad hoc adjustment mechanism and other approaches to modelling disequilibrium in the money market have been developed. Three broad approaches have been used in the literature. The first assumes that the chosen argument of the demand function adjusts slowly toward its long-run equilibrium value. Agents are therefore forced off their long-run function because of slow adjustment in either interest rates, output or the price level (Artis and Lewis, 1976, Goodhart, 1989, Laidler, 1993). The lagged dependent variable which appears in the equation then represents a slow real

balance effect. The second type of disequilibrium money models allow disequilibrium money holdings to influence a wide range of real and nominal variables. This approach needs a complete model of the economy where an excess supply of money in the short run may affect a vector of real or nominal variables such as output, prices, the exchange rate, the rate of interest and so on. If the monetary disequilibrium term appears in more than one equation, then the model yields cross-equation restrictions on the parameters of the long run demand function (see Cuthbertson and Taylor, 1986). This type of model has performed reasonably well for the US (Laidler and Bently, 1983), the UK (Davidson, 1987) and Australia (Jonson et al 1977). Some economists have mentioned advantages of the simultaneous estimation of the demand for and the supply of money in order to detect effects of short run money disequilibrium on the real part of the economy (see Laidler, 1993). Goodhart (1989) describes the approach as follows : "the approach has been to use the credit counterparts approach to the supply of money, which employs the identities that bank assets equal bank liabilities and that bank lending to the public sector is equal to its borrowing requirement less its borrowing from all other non-bank sectors, to model (the change in) the money stock in any period as the sum of the public sector borrowing requirement, debt sales to the non-bank public, bank lending to the private sector and external flows. The gap between the money stock thus estimated from the supply side and an estimated 'underlying' demand for money, then represents buffer or 'disequilibrium' money holdings (which can, of course be negative as well as positive), which in turn can enter as an explanatory

variable in all the other behavioural equations in the system"(Goodhart,1989, p.80).

In the third type of disequilibrium money model, it is assumed that shocks to the money supply are initially held in transactions balances whilst unanticipated balances are held in money balances, anticipated changes in the money supply lead to price changes (see Mackinnon and Milbourn, 1988, Carr and Darby, 1981, Cuthbertson and Taylor, 1985, 1986). The buffer stock money approach is not limited to exogenous changes of the money supply; even in the case of an endogenous increase in the money supply, unless this change is perceived as permanent, the economic agents are unlikely to adjust their portfolio to augment their transactions balances. The interesting aspect of this approach is that it introduces the concept of forward looking expectations in the demand for money functions; as agents attempt to find their optimal holding of money given that there are adjustment costs involved in the reallocation of their portfolio (Stevenson et al 1988).

The approach that we have adopted here is similar to the second type of approach to disequilibrium money discussed above. The demand for money function is specified within a macroeconomic model of the economy. The supply of money is determined in relation to the credit counterparts of the monetary system of the economy and is partially independent of money demand. On the other hand, the underlying demand for money is a function of interest rates and real income (as the scale variable). Short run differences between supply and the long-run demand for money affect the price level as well as the interest rate and

thereby the real part of the economy. The long run demand for money function can be specified as:

$$(3.31) \dots \log\left(\frac{M_t}{P_t}\right)^{ld} = \beta_0 + \beta_1 \cdot i_t + \beta_2 \cdot \log Y_t$$

where $\log\left(\frac{M_t}{P_t}\right)^{ld}$ is demand for real money in log form, i_t is the nominal rate of interest. This function is widely used in empirical work on the demand for money in developing countries (see Khan and Knight, 1982). If we define the excess money balance as:

$$(3.32) \dots Emb_t = \log\left(\frac{M_t}{P_t}\right) - \log\left(\frac{M_t}{P_t}\right)^{ld}$$

where $\log(M_t/P_t)$ is the actual stock of real money in log form and $\log\left(\frac{M_t}{P_t}\right)^{ld}$ represents the long-run or underlying demand for real money balances. In the traditional specification of the demand for money, dynamic behaviour is introduced through a partial adjustment or error-learning mechanism. Such a formulation, due to Chow (1960) amongst others argues that real money balances adjust in the following manner:

$$(3.33) \dots \Delta \log\left(\frac{M_t}{P_t}\right) = \lambda \left[\log\left(\frac{M_t}{P_t}\right)^{ld} - \log\left(\frac{M_{t-1}}{P_{t-1}}\right) \right]$$

where Δ is a first difference operator [$\Delta \log(M_t/P_t) = \log(M_t/P_t) - \log(M_{t-1}/P_{t-1})$] and λ is the coefficient of adjustment and $0 \leq \lambda \leq 1$. Equation (3.33) which is used extensively in the literature is referred to as the "standard" dynamic model in Khan and Knight (1982). The solution of equations (3.30) and (3.32) in terms of real money balances is:

$$(3.34) \dots \log\left(\frac{M_t}{P_t}\right) = \lambda \beta_0 + \lambda \beta_1 i_t + \lambda \beta_2 \log Y_t + (1 - \lambda) \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

This demand for money function with a lagged dependent variable appearing on right hand side is quite common in the money demand literature; (see for example Laidler(1993), Khan (1982, 1985) and Khan and Knight (1982)). The equation assumes that there is an underlying demand for money determined by the scale and opportunity cost variables (represented by equation 3.31). Any short run disequilibrium between money supply and the underlying demand for money could be restored by changes in: (i) money balances, (ii) the price level, (iii) any determinant of money demand or a combination of these factors. In our model, the right hand side of equation (3.34) adjusts to real money balance [i.e. $\log(M/P_t)$] according to the mechanism assumed by equation (3.33). If for example in equation (3.34) $\lambda=1$ the real money stock is in equilibrium to the underlying money demand. This could be the case for example if money supply movements are demand-determined. In the case of an unexpected and independent change in money supply, ($0 < \lambda < 1$), for instance because of a government monetary policy change, economic agents would move in order to

adjust their portfolio to augment their transactions balances holding of money and then the aggregate demand for money will tend towards its underlying value according to the assumed adjustment mechanism in equation (3.33).

3.2.7 Interest Rate

One of the main characteristics of developing countries regarding the determination of a nominal interest rate in the economy is the degree of controls exerted upon capital movements. Iran is no exception in this regard. The process of interest rate determination differs under alternative degrees of openness of the capital account of the balance of payments. In the case of a fully open capital account, some form of interest arbitrage will prevail with domestic interest rates depending on world interest rates. In contrast, when the economy restricts capital movements, the nominal interest rate will be determined mainly by domestic monetary conditions and expectations of inflation. Most developing countries however do not fall in either of these extreme cases so that interest rates, in general depend, on domestic money market conditions as well as on the expected rate of devaluation in the exchange rate and thereby world interest rates. From a policy perspective, it is important to detect the way in which these factors affect interest rates. For example, having a clear understanding of how an expected devaluation or a change in the supply of money influences interest rates is crucial for assessing the significance of one of the possible mechanisms through which stabilisation policies will affect aggregate demand. "Stabilisation programmes typically involve both exchange rate adjustments and tighter credit and monetary policies. If these policies generate an increase in the domestic real

interest rate there will be an additional channel through which aggregate demand will be affected" (Edwards and Khan , 1985, p.379).

Consider the extreme cases of (i) when the model economy is totally open to the rest of the world; and (ii) when its capital account is completely closed to the movement of capital. In the latter case, it is assumed that the nominal interest rate that would prevail in the economy is that interest rate which would clear the domestic money market in the absence of capital mobility. This shadow interest rate shown by, \tilde{i} , can be determined by equating the money supply that would be observed in this case to the demand for money. This shadow money supply (denoted by \tilde{M}_t) differs from the supply of money given by equation (3.28), (i.e. $M_t = Dc_t + e_t.Fr_t$), in that the effect of current private capital flows on the central bank's stock of foreign exchange reserves are removed (see Haque et al (1990)).

$$(3.35) \dots \tilde{M}_t = M_t + e_t.\Delta Fp_t$$

where Fp_t is foreign assets held by the private sector. Thus, recalling the money market equilibrium condition ,i.e. equation (3.34), the 'shadow' domestic interest rate, \tilde{i}_t , can be obtained by solving the following equation for \tilde{i}_t :

$$(3.36) \dots \log\left(\frac{\tilde{M}_t}{P_t}\right) = \lambda \beta_0 + \lambda \beta_1 \tilde{i}_t + \lambda \beta_2 \log Y_t + (1 - \lambda) \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right)$$

or

$$(3.36') \dots \tilde{i}_t = -\frac{\beta_0}{\beta_1} - \frac{\beta_2}{\beta_1} \log Y_t - \frac{(1 - \lambda)}{\lambda \beta_1} \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + \frac{1}{\lambda \beta_1} \log \frac{\tilde{M}_t}{P_t}$$

In equation (3.36') \tilde{i}_t is the nominal interest rate that would prevail in a closed economy if there were no private capital movements to and from abroad.

Now, consider the case of a fully open economy where there are no impediments to capital flows. Domestic and foreign interest rates will, in this case, be closely related. If we assume risk-neutral agents and no transaction costs, the following uncovered interest rate parity condition will prevail.

$$(3.37) \dots i_t = i_t^* + \left(\frac{Ee_{t+1} - e_t}{e_t} \right)$$

where $\left(\frac{Ee_{t+1} - e_t}{e_t} \right)$ is the expected exchange rate of international currency for the period (t+1) at the period (t). i_t^* is the international rate of interest. Here we abstract from problems associated with information lags or transaction costs or other factors which might cause domestic interest rates, in a fully open economy, to respond with delay to a change in the foreign rate of interest or exchange rate expectations. The economy under observation (i.e. the Iranian economy) however like most developing economies is subject to capital controls. A straightforward way of constructing a model for such an economy is to combine the closed and open economy extremes. (Edwards and Khan,1985), (Haque et al 1990, 1993). We therefore specify the nominal interest rate as a linear combination of the nominal interest rate that would prevail in the closed and open economy as derived above.

$$(3.38) \dots i_t = \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1-\phi) \tilde{i}_t$$

where i_t^* is the international interest rate and \tilde{i}_t is the nominal rate of interest that would prevail in an economy completely closed to capital transactions. ϕ can be interpreted as an index measuring the degree of openness of the economy. If $\phi=1$ the model economy is fully open and equation (3.38) collapses into the interest arbitrage condition (i.e. equation (3.37)). In the case of $\phi=0$ the capital account is closed and equation (3.38) becomes equal to the 'shadow' interest rate of the closed economy equation (3.36'). In the intermediate case of a semi-open economy the parameter ϕ will lie between zero and unity. The closer to unity is ϕ the more open the economy will be. Estimating ϕ from the data makes it possible to determine the degree of openness of the financial sector of the economy .

The relevance of \tilde{i}_t and \tilde{M}_t to our discussion of the demand for money and estimation of ϕ becomes apparent once we recall that in equation (3.34), (money market equilibrium), i_t represented the market determined interest rate which is unobserved in the economy under consideration. To circumvent this issue the shadow interest rate and the shadow money balance notion given by equations (3.36) and (3.36') can be used to provide the model with an estimable demand for money equation. This issue is addressed in the next chapter where the behavioural equations are estimated.

3.3 Summary and Concluding Remarks

In this chapter we have set out the structure of a macroeconomic model. The resultant model that emerged is basically a variant of the traditional Mundell-Fleming model with specification modifications designed to take account of the particular characteristics of the Iranian economy. A single good is produced domestically that can be sold at home and abroad and there is an imported good. The specification of private consumption is conventional and takes account of the effects of the real rate of interest, disposable income and the lagged dependent variable on current aggregate consumption. Total investment consists of private investment and government investment. Government investment, which has quite a significant effect on the Iranian economy because of the importance of oil revenue is assumed to be a policy variable in the model. Private investment is a function of aggregate income, the capital stock of the economy, the real rate of interest as well as government investment and domestic bank credit to the private sector. The latter two variables are included in the private investment function to test the empirical significance of them on private investment-a factor which is highlighted in several studies of private investment in developing countries.

All agents in the economy are assumed to be price-takers for imports while exerting some monopoly power over the price of exports in the world market. This assumption could be justified for Iran as a major oil exporting country in the sample period. However, to take account of an important characteristic of developing countries availability of foreign exchange- the lagged reserves to imports ratio is included in the import demand function as an explanatory



variable designed to measure the effects of exchange controls on import demand. Two alternative aggregate supply functions have been derived: one, in the Keynesian macroeconomic tradition, allows actual output to deviate from its long-run trend and the other, a neo-classical full employment production function. The two were derived with the intention of using the time series data of the Iranian economy to distinguish between them.

On the financial side some of the main features of the typical developing country are integrated in the model by relevant assumptions. The most widely accepted of these characteristics include the absence of markets for domestic securities, the presence of capital controls and officially determined interest rates on bank assets and liabilities. The market determined interest rate is formulated as a weighted average of the international (uncovered parity) interest rate and a domestic shadow interest rate. This shadow interest rate is that which would clear the domestic money market in the absence of capital mobility. Formulation of the market determined interest rates allows us to estimate an index of the effective degree of capital control through the revised demand for money function. The approach adopted here also permits the estimation of the interest rate sensitivity of consumption and private investment and demand for money where a market determined rate of interest is unobservable (as in Iran).

In the next chapter, the behavioural equations of the model, outlined here, are estimated using an appropriate method. Estimation methodology, data sources and definitions, the treatment of expectations and unobserved variables are discussed at the beginning of the chapter and are followed by a report of the empirical results with their implications for the Iranian economy.

Chapter IV

Estimation of the Macroeconometric Model

4.1 Introduction

In chapter III a macroeconomic model was developed to explore, within a developing country context, the channels through which economic policy instruments affect domestic aggregate demand and supply and to identify the parameters that govern their effectiveness. The model was based on standard theoretical considerations and the main features of the Iranian economy. The resultant model is a flexible-price dynamic version of the traditional Mundell-Fleming model, modified to take account of the characteristics of developing countries. A single good is produced domestically that can be sold at home and abroad and there is an imported good. The specification of private consumption is conventional, assuming as it does that its determinants are: the real rate of interest, disposable income and lagged aggregate consumption. Total investment is sub-divided to the private investment and government development expenditure, the latter treated as an exogenous variable. Private investment is a function of aggregate income, the real aggregate capital stock and real the rate of interest. In order to test the effects of government development expenditure and

domestic bank credit on private capital formation, these two variables are also included in the private investment function. All agents in the economy are assumed to be price-takers for imports in the international markets while exerting some monopoly power over the price of exports in the world market. However, because Iran is a developing country, the availability of foreign exchange (measured by the lagged reserves to imports ratio) is included in the import demand function as an explanatory variable to capture the effects of exchange controls on imports. Two alternative aggregate production functions are derived: one is a full employment neo-classical production function the other is an aggregate production function which permits short-run deviations of actual output from its long-run trend. The choice between the two functions is determined by the best fit to the data.

On the financial side, some of the main features of developing countries are integrated into the model. These include the absence of a market for domestic securities. The presence of capital controls and the official determination of interest rates on bank assets and liabilities. The market determined interest rate is formulated as a weighted average of the international (uncovered parity) interest rate and a domestic shadow interest rate. This shadow interest rate is that which would clear the domestic money market in the absence of capital mobility. Having constructed the market determined interest rate we can estimate an index of the effective degree of capital mobility in the economic system; and the interest rate sensitivity of consumption, investment and the demand for money (typically not achievable where market determined interest rates are unobservable as in the Iran).

4.2. The Structure of the Model

From the specification of the simultaneous equations model a set of structural equations consistent with the equations and identities can be found. Table (4.1) summarises the structure of the model. Definition of the exogenous the endogenous variables of the model is given in tables (4.2) and (4.3) respectively.

Table 4.1 Specification of the model

| | |
|-------------|---|
| (4.1)... | $Ad_t = C_t + P_t + G_t + X_t - (e_t \cdot P_t^* / P_t)Z_t$ |
| (4.2)... | $Da_t = P_t + C_t + G_t$ |
| (4.3)... | $\log C_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \log C_{t-1} + \alpha_3 \log Y_d_t + \alpha_4 \log Y_d_{t-1}$ |
| (4.4)... | $Y_d_t = Y_t + (i_t^* \cdot e_t \cdot Fp_{t-1}) / P_t - (i_t \cdot Dcp_{t-1}) / P_t - Dtax_t$ |
| (4.5)... | $\log P_t = \kappa_0 + \kappa_1 r_t + \kappa_2 \log Y_t + \kappa_3 \log K_{t-1} + \kappa_4 \log G_t + \kappa_5 \log (Dcp_t / P_t)$ |
| (4.6)... | $T_t = G_t + P_t$ |
| (4.7)... | $\log X_t = \tau_0 + \tau_1 \log (e_t \cdot P_t^* / P_t) + \tau_2 \log Y_t^* + \tau_3 \log X_{t-1}$ |
| (4.8)... | $\log (P_t^* \cdot e_t / P_t)Z_t = \delta_0 + \delta_1 \log (e_t \cdot P_t^* / P_t) + \delta_2 \log Y_t + \delta_3 \log (Fr_{t-1} / P_{t-1}^* \cdot Z_{t-1})$ $+ \delta_4 \log (P_{t-1}^* \cdot e_{t-1} / P_{t-1})Z_{t-1}$ |
| (4.9)... | $\log Y_t = A + \theta'_0 \log K'_{t-1} + \theta_1 \log L_t + \theta'_2 \log T_t$ |
| (4.10)... | $G_t = Gc_t + G_i$ |
| (4.11.1)... | $T_t = (Dtax_t + Indtax_t) + Oilr_t$ |
| (4.11.2)... | $Dtax_t = Dtax_0 + dtaxr \cdot (Y_t)$ |
| (4.11.3)... | $Indtax_t = Indtax_0 + indtaxr \cdot (Y_t)$ |
| (4.12)... | $Nft_t = (Ca_t + P_t \cdot Da_t) - P_t \cdot Y_t$ |
| (4.13)... | $Ca_t = P_t \cdot X_t - e_t \cdot P_t^* \cdot Z_t + e_t \cdot Fae_t$ |
| (4.14)... | $Fae_t = i_t^* \cdot (Fr_{t-1} + Fp_{t-1} + Fg_{t-1})$ |
| (4.15)... | $Bop_t = (1 / e_t)Ca_t - (\Delta Fp_t + \Delta Fg_t)$ |
| (4.16)... | $Fr_t = Fr_{t-1} + Bop_t$ |
| (4.17.1)... | $Fp_t = Fp_{t-1} + \Delta Fp_t$ |
| (4.17.2)... | $\Delta Fp_t = (1 / e_t)[P_t \cdot (Y_d_t - C_t - P_t) - (\Delta M_t - \Delta Dcp_t)]$ |
| (4.18.1)... | $Fg_t = Fg_{t-1} + \Delta Fg_t$ |
| (4.19)... | $M_t = M_{t-1} + e_t \cdot Bop_t + \Delta Dcg_t + \Delta Dcp_t$ |
| (4.20)... | $Dc_t = Dc_{t-1} + \Delta Dcg_t + \Delta Dcp_t$ |
| (4.21)... | $Dcg_t = Dcg_{t-1} + \Delta Dcg_t$ |
| (4.22)... | $Dcp_t = Dcp_{t-1} + \Delta Dcp_t$ |
| (4.23)... | $\log \left(\frac{M_t}{P_t} \right) = \lambda \beta_0 + \lambda \beta_1 i_t + \lambda \beta_2 \log Y_t + (1 - \lambda) \log \left(\frac{M_{t-1}}{P_{t-1}} \right)$ |

Table 4.1 continued

$$(4.24) \dots \log\left(\frac{M_t}{P_t}\right)^{ld} = \beta_0 + \beta_1 i_t + \beta_2 \log Y_t$$

$$(4.25.1) \dots \Delta \log\left(\frac{M_t}{P_t}\right) = \lambda \left[\log\left(\frac{M_t}{P_t}\right)^{ld} - \log\left(\frac{M_{t-1}}{P_{t-1}}\right) \right]$$

$$(4.25.2) \dots Emb_t = \log\left(\frac{M_t}{P_t}\right) - \log\left(\frac{M_t}{P_t}\right)^{ld}$$

$$(4.26) \dots \tilde{M}_t = M_t + e_t \cdot \Delta F p_t$$

$$(4.27) \dots r_t = i_t - \left(\frac{EP_{t+1} - P_t}{P_t} \right)$$

$$(4.28) \dots \tilde{i}_t = -\frac{\beta_0}{\beta_1} - \frac{\beta_2}{\beta_1} \log Y_t - \frac{(1-\lambda)}{\lambda\beta_1} \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right) + \frac{1}{\lambda\beta_1} \log\left(\frac{\tilde{M}_t}{P_t}\right)$$

$$(4.29) \dots i_t = \phi \left(i_t^* + \frac{Ee_{t+1} + e_t}{e_t} \right) + (1-\phi) \tilde{i}_t$$

$$(4.30) \dots EP_{t+1} = P_{t+1} + u_{t+1}$$

Table 4.2 Exogenous variables of the model

Gc= Real government consumption expenditure

Gi= Real government investment expenditure

dtaxr= Direct taxation rate

indtaxr= Indirect taxation rate

Oilr= real oil revenues

ΔFg = Net change to foreign assets held by public sector (nominal)

ΔDcg = Net change in domestic credit to public sector (nominal)

ΔDcp = Net change in domestic credit to private sector (nominal)

e= Nominal, official exchange rate

Y*= Real world income (approximated by OECD income in 1985 price)

P*= World consumer price index (WCPI)

i*= International interest rate (3 months London market)

i_b= Formal interest rate charged by the domestic banking system

L= Labour force

Table 4.3 Definition of the endogenous variables of the model

| | |
|---------------------------------|--|
| Ad= | Real aggregate demand |
| Da= | Real domestic absorption |
| C= | Real private consumption |
| Yd= | Real disposable income |
| Pi= | Real private investment |
| Ti= | Real total investment |
| X= | Real export |
| Z= | Real import |
| Y= | Real aggregate output |
| G= | Real total government expenditure |
| T= | Real total government revenues |
| Dtax= | Real direct taxation |
| Indtax= | Real indirect taxation |
| Nft= | Nominal net factor income from abroad |
| Ca= | Nominal current account of the balance of payments |
| Fae= | Nominal foreign assets earnings (in foreign exchange terms) |
| Bop= | Nominal balance of payments (in foreign exchange terms) |
| Fr= | Nominal foreign exchange reserves (in foreign exchange terms, US dollars) |
| Fp= | Nominal foreign assets held by private sector (in foreign currency terms) |
| Fg= | Nominal foreign assets held by public sector (in foreign currency terms) |
| M= | Nominal money supply (broad definition of money i.e. M_2) |
| Dc= | Nominal domestic credit |
| Dcg= | Nominal domestic credit to public sector |
| Dcp= | Nominal domestic credit to private sector |
| (M/P) | Money market equilibrium |
| $\left(\frac{M}{P}\right)^{ld}$ | Real, long-run demand for money |
| Emb= | Excess money balance |
| \tilde{M} | Nominal, shadow money balance |
| r= | Real rate of interest |
| \tilde{i} | Nominal 'shadow' interest rate |
| i= | Nominal (market determined) interest rate |
| EP_{t+1} | Expected price of the next period in the current period |

From the structural equations given in table (4.1) we only have to estimate the behavioural equations of the model which contain unknown parameters. The behavioural equations to be estimated are the consumption function (eq. 4.3), the private investment equation (eq. 4.5), export (foreign) demand (eq. 4.7), import demand (eq. 4.8), the aggregate production function (eq. 4.9), the demand for

money (eq. 4.23) and the market determined interest rate (eq. 4.29). These equations are repeated for convenience in table (4.4)

Table 4.4 The behavioural equations of the model

(4.3)... $\log C_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \log C_{t-1} + \alpha_3 \log Yd_t + \alpha_4 \log Yd_{t-1}$

(4.5)... $\log P_t = \kappa_0 + \kappa_1 r_t + \kappa_2 \log Y_t + \kappa_3 \log K_{t-1} + \kappa_4 \log G_t + \kappa_5 \log \left(\frac{Dcp_t}{P_t} \right)$

(4.7)... $\log X_t = \tau_0 + \tau_1 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + \tau_2 \log Y_t^* + \tau_3 \log X_{t-1}$

(4.8)... $\log \left(\frac{P_t^* e_t}{P_t} \right) Z_t = \delta_0 + \delta_1 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + \delta_2 \log Y_t + \delta_3 \log \left(\frac{Fr_{t-1}}{P_{t-1}^* Z_{t-1}} \right)$
 $+ \delta_4 \log \left(\frac{P_{t-1}^* e_{t-1}}{P_{t-1}} \right) Z_{t-1}$

(4.9)... $\log Y_t = A + \theta_0' \log K_{t-1} + \theta_1 \log L_t + \theta_2' \log T_t$

(4.23)... $\log \left(\frac{M_t}{P_t} \right) = \lambda \beta_0 + \lambda \beta_1 i_t + \lambda \beta_2 \log Y_t + (1 - \lambda) \log \left(\frac{M_{t-1}}{P_{t-1}} \right)$

(4.29)... $i_t = \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1 - \phi) \tilde{i}_t$

4.3 Estimation Methodology

In order to estimate the behavioural equations mentioned above we have to address two issues: (i); unobserved variables and (ii); expectations. Also we note that OLS would not yield unbiased estimators because of the stochastic regressors.

4.3.1 Unobserved variables

The absence of data on the market determined interest rates (i_t) and certainly the real rate of interest (r_t) is typical of most developing countries. The relevant

market-determined interest rate is that for loans in informal or curb markets. Time series data on such interest rates are not available. In Iran, as in most developing countries, the official interest rates reported by the central bank (Bank Markazi Iran) refer to the discount rate of the central bank (before 1979) and to the bank rate of return on time deposits and investment accounts after 1979. These rates do not capture the marginal cost of funds and cannot be taken as the market determined interest rate. Thus the consumption function (eq. (4.3)), the private investment function (eq.(4.5)) and the money demand function (eq. (4.23)), cannot be estimated as they stand. To address this issue we eliminate (i_t) and (r_t) from these equations by appropriate substitutions. To eliminate (i_t) from the demand for money function we substitute for (i_t) from equation (4.29), in the money demand function .

$$(4.31) \dots \log\left(\frac{M_t}{P_t}\right) = \lambda\beta_0 + \lambda\beta_1 \left\{ \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1 - \phi) \left[-\left(\frac{\beta_0}{\beta_1}\right) - \left(\frac{\beta_2}{\beta_1}\right) \log Y_t \right. \right. \\ \left. \left. - \left(\frac{1 - \lambda}{\lambda\beta_1}\right) \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right) + \left(\frac{1}{\lambda\beta_1}\right) \log \frac{\tilde{M}_t}{P_t} \right] \right\} + \lambda\beta_2 \log Y_t + (1 - \lambda) \log \frac{M_{t-1}}{P_{t-1}}$$

Rearranging the equation we have:

$$(4.32) \dots \log \frac{M_t}{P_t} = \Omega_0 + \Omega_1 \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + \Omega_2 \log Y_t + \Omega_3 \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + \Omega_4 \log \frac{M_{t-1}}{P_{t-1}} \\ + \Omega_5 \log \frac{\tilde{M}_t}{P_t}$$

where

$$\begin{aligned} \Omega_0 &= \lambda\phi\beta_0 & \Omega_1 &= \lambda\phi\beta_1 & \Omega_2 &= \lambda\phi\beta_2 \\ \Omega_3 &= (1 - \lambda)(\phi - 1) & \Omega_4 &= (1 - \lambda) & \Omega_5 &= (1 - \lambda) \end{aligned}$$

We also could substitute for r_t from the real rate of interest relationship (eq. 4.27) in the consumption function and private investment. The result is two equations for $\log C_t$ and $\log P_i$ as functions of i_t . The relationship for i_t can be used again to eliminate i_t from these two equations. Taking the consumption function first we have:

$$(4.33) \dots \log C_t = \alpha_0 + \alpha_1 \left(i_t - \frac{EP_{t+1} - P_t}{P_t} \right) + \alpha_2 \log C_{t-1} + \alpha_3 \log Yd_t + \alpha_4 \log Yd_{t-1}$$

Substituting for i_t we have:

$$(4.34) \dots \log C_t = \alpha_0 + \alpha_1 \left\{ \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1 - \phi) \left[-\left(\frac{\beta_0}{\beta_1} \right) - \left(\frac{\beta_2}{\beta_1} \right) \log Y_t - \left(\frac{1 - \lambda}{\beta_1} \right) \log \left(\frac{\tilde{M}_{t-1}}{P_{t-1}} \right) + \left(\frac{1}{\lambda \beta_1} \right) \log \left(\frac{\tilde{M}_t}{P_t} \right) \right] - \left(\frac{EP_{t+1} - P_t}{P_t} \right) \right\} + \alpha_2 \log C_{t-1} + \alpha_3 \log Yd_t + \alpha_4 \log Yd_{t-1}$$

After rearranging the revised consumption function becomes:

$$(4.34') \dots \log C_t = \alpha_{01} + \alpha_{11} \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + \alpha_{12} \log Y_t + \alpha_{13} \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + \alpha_{14} \log \frac{\tilde{M}_t}{P_t} - \alpha_{15} \left(\frac{EP_{t+1} - P_t}{P_t} \right) + \alpha_2 \log C_{t-1} + \alpha_3 \log Yd_t + \alpha_4 \log Yd_{t-1}$$

where

$$\alpha_{01} = \alpha_0 + \alpha_1(\phi - 1) \left(\frac{\beta_0}{\beta_1} \right); \quad \alpha_{11} = \alpha_1 \phi; \quad \alpha_{12} = \alpha_1(\phi - 1) \left(\frac{\beta_2}{\beta_1} \right)$$

$$\alpha_{13} = \alpha_1(\phi - 1) \left(\frac{1 - \lambda}{\lambda \beta_1} \right); \quad \alpha_{14} = \alpha_1(1 - \phi) \left(\frac{1}{\lambda \beta_1} \right)$$

For the private investment equation, substituting for r and i_t , respectively yields:

$$(4.35) \dots \log P_i = \kappa_0 + \kappa_1 \left(i_t - \frac{EP_{t+1} - P_t}{P_t} \right) + \kappa_2 \log Y_t + \kappa_3 \log K_{t-1} + \kappa_4 \log G_i + \kappa_5 \log \left(\frac{Dcp_t}{P_t} \right)$$

and:

$$(4.36) \dots \log P_i = \kappa_0 + \kappa_1 \left\{ \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1 - \phi) \left[- \left(\frac{\beta_0}{\beta_1} \right) - \left(\frac{\beta_2}{\beta_1} \right) \log Y_t - \left(\frac{1 - \lambda}{\lambda \beta} \right) \log \left(\frac{\tilde{M}_{t-1}}{P_{t-1}} \right) + \left(\frac{1}{\lambda \beta_1} \right) \log \left(\frac{\tilde{M}_t}{P_t} \right) \right] - \frac{EP_{t+1} - P_t}{P_t} \right\} + \kappa_2 \log Y_t + \kappa_3 \log K_{t-1} + \kappa_4 \log G_i + \kappa_5 \log \left(\frac{Dcp_t}{P_t} \right)$$

Finally we arrive at:

$$(4.36') \dots \log P_i = k_{01} + k_{11} \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + k_{12} \log Y_t + k_{13} \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + k_{14} \log \frac{\tilde{M}_t}{P_t} - \kappa_1 \left(\frac{EP_{t+1} - P_t}{P_t} \right) + \kappa_3 \log K_{t-1} + \kappa_4 \log G_i + \kappa_5 \log \left(\frac{Dcp_t}{P_t} \right)$$

where

$$k_{01} = \kappa_0 + \kappa_1 (\phi - 1) \frac{\beta_0}{\beta_1}; \quad \kappa_{11} = \kappa_1 \phi; \quad \kappa_{12} = \kappa_1 (\phi - 1) \frac{\beta_2}{\beta_1} + \kappa_2$$

$$\kappa_{13} = \kappa_1 (\phi - 1) \left(\frac{1 - \lambda}{\beta_1 \lambda} \right); \quad \kappa_{14} = \kappa_1 (1 - \phi) \left(\frac{1}{\beta_1 \lambda} \right)$$

Eliminating r and i_t from the above mentioned equations we therefore have the following set of simultaneous equations to estimate:

Table 4.5 Estimating form of the behavioural equations

(revised) consumption function

$$(4.34') \dots \log C_t = \alpha_{01} + \alpha_{11} \left(i_t^* + \frac{Ee_{t+1} + e_t}{e_t} \right) + \alpha_{12} \log Y_t + \alpha_{13} \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + \alpha_{14} \log \frac{\tilde{M}_t}{P_t} \\ - \alpha_{11} \left(\frac{EP_{t-1} - P_t}{P_t} \right) + \alpha_2 \log C_{t-1} + \alpha_3 \log Y_d + \alpha_4 \log Y_{d,t-1}$$

where

$$\alpha_{01} = \alpha_0 + \alpha_1(\phi - 1) \frac{\beta_0}{\beta_1}; \quad \alpha_{11} = \alpha_1 \phi; \quad \alpha_{12} = \alpha_1(\phi - 1) \frac{\beta_2}{\beta_1} \\ \alpha_{13} = \alpha_1(1 - \lambda) \frac{(\phi - 1)}{\beta_1 \lambda}; \quad \alpha_{14} = \frac{\alpha_1(1 - \phi)}{\beta_1 \lambda}$$

(revised) private investment

$$(4.36') \dots \log P_{it} = \kappa_{01} + \kappa_{11} \left(i_t^* + \frac{Ee_{t-1} - e_t}{e_t} \right) + \kappa_{12} \log Y_t + \kappa_{13} \log \frac{\tilde{M}_{t-1}}{P_{t-1}} + \kappa_{14} \log \frac{\tilde{M}_t}{P_t} \\ - \kappa_{11} \left(\frac{EP_{t-1} - P_t}{P_t} \right) + \kappa_3 \log K_{t-1} + \kappa_4 \log G_{it} + \kappa_5 \log \frac{Dcp_t}{P_t}$$

$$\kappa_{01} = \kappa_0 + \kappa_1(\phi - 1) \frac{\beta_0}{\beta_1}; \quad \kappa_{11} = \kappa_1 \phi; \quad \kappa_{12} = \kappa_1(\phi - 1) \frac{\beta_2}{\beta_1} + \kappa_2 \\ \kappa_{13} = \kappa_1 \frac{(1 - \lambda)(1 - \phi)}{\beta_1 \lambda}; \quad \kappa_{14} = \kappa_1 \frac{(1 - \phi)}{\beta_1 \lambda}$$

Export (foreign) demand

$$(4.7) \dots \log X_t = \tau_0 + \tau_1 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + \tau_2 \log Y_t^* + \tau_3 \log X_{t-1}$$

Import demand

$$(4.8) \dots \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) Z_t = \delta_0 + \delta_1 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + \delta_2 \log Y_t + \delta_3 \log \left(\frac{Fr_{t-1}}{P_{t-1}^* \cdot Z_{t-1}} \right) \\ + \delta_4 \log \left(\frac{e_{t-1} \cdot P_{t-1}^*}{P_{t-1}} \right) Z_{t-1}$$

Table 4.5 continued

(Modified) aggregate production function

$$(4.9)... \text{Log} Y_t = A' + \theta_0' \log K_{t-1} + \theta_1 \log L_t + \theta_2' \log T_{it}$$

where

$$\log K_{t-1} = \log 2 + \frac{1}{2} \log \sum_{i=1}^{t-(1-1)} (1-\rho)^{i-1} \cdot T_{it - (i-1)} + \frac{t-1}{2} (1-\rho) + \frac{1}{2} \log K_0$$

$$\theta_0' = \frac{\theta_0}{2}$$

$$\theta_2' = \frac{\theta_0 \theta_2}{2}$$

(revised) demand for money function

$$(4.32')... \log \left(\frac{M_t}{P_t} \right) = \Omega_0 + \Omega_1 (i_t^* + \frac{E e_{t+1} - e_t}{e_t}) + \Omega_2 \log Y_t + \Omega_3 \log \frac{\tilde{M}_{t-1}}{P_{t-1}} \\ + (1-\lambda) \log \frac{M_{t-1}}{P_{t-1}} + (1-\phi) \log \frac{\tilde{M}_t}{P_t}$$

where

$$\Omega_0 = \lambda \phi \beta_0 ; \quad \Omega_1 = \lambda \phi \beta_1 \quad \Omega_2 = \lambda \phi \beta_2 \\ \Omega_3 = (1-\lambda)(\phi-1)$$

In this section we revised those behavioural equations of the model which included unobserved variables (i.e. r and i) as their explanatory variables. By proper substitution for r and i we managed to derive a set of estimable equations which are presented in table (4.5). However, it should be noted that estimating these equations using OLS method would not yield unbiased and consistent estimates. It is evident that some of the explanatory variables of some of the equations are themselves dependent variables and therefore are correlated with the disturbances terms in the simultaneous equation system. For this reason there is a contemporaneous feedback between the endogenous variables of the system. OLS on any single equation therefore gives biased and

inconsistent parameter estimates. We therefore will have to use a consistent estimator provided by the method of instrumental variables (IV) or a specific form of (IV) namely 2SLS method.

4.3.2 Expectations

The second issue to be addressed involves the assumed mechanism for expectation formation to be employed in the model. The assumption of rationality implies that forward looking agents form their expectations of prices on the basis of all available information, including the structure of the model. This implies that prediction errors should be non-systematic.

$$(4.37) \dots P_{t+1} = EP_{t+1} + \mu_{t+1}$$

where μ_{t+1} are white noise random terms. To estimate the model some proxies are needed for EP_{t+1} . A candidate proxy is the actual value of P_{t+1} . There are two possible methods of estimation. One procedure involves substitution of the realised (observed) values for the expected values and using some appropriate instrument variables. The instruments for the realised variables are taken from the predicted values obtained from the regression of the realised variable on a matrix of variables selected from the information set (Ω_t); (see MacCallum, (1976)). This so called substitution method thus requires replacement of rationally expected variables by forecasts. The other procedure is the Errors in Variables Method (EVM) (see Wickens, 1982). This method is based on drawing an explicit expression for the rationally expected variables from the

model. These are substituted for the expected variables and the model is estimated using any implied parameter constraints. Thus in this method, the realised variables are treated as additional endogenous variables of the model and all equations are estimated together.

Wickens (1982) shows that (EVM) is the more robust and has some advantages over the alternative method. To adopt the Errors in variable method a number of assumptions are to be made about the structural model: (i), it is assumed that in no equation does a realised and expected values of the same variable appear; (ii), it is assumed that the system is identified; (iii), it is assumed that the structural disturbances are serially independent (see Wickense (1982)). Assuming serial independency of random variables we notice that these assumptions are met in our model. For the purpose of estimation of the model specified here, we can derive an additional equations for EP_{t+1} , replace it with its realised values and then estimate the model with the additional equation. The reduced form equations for P_t can be obtained by linearising the model, solving it for P_t , advancing it one period, taking expectations conditional on the information set (Ω_t) and solving for EP_{t+1} (see Haque et al, 1990). An alternative way of looking at this is to estimate equations containing expected variable (i.e Ep_{t+1}) by replacing its realised value (P_{t+1}) and using lagged values of the exogenous variables of the estimating equation (i.e variables in the information set Ω_t) as instrument variables in our 2SLS method, (see Maddala, 1992, ch. 10).

4.4 Estimation results

We now turn to the estimation results of the behavioural equations of the model given in table (4.5). We discuss alternative specifications of the behavioural equations to point out findings of the empirical work that merit emphasis in the context of the Iranian economy. Our discussion of estimation results of the behavioural equations approach to that specification of these equations which we think explains the economic behaviour, reflected in the time series data, the best. These finally chosen estimated equations are repeated in table (4.6) at the end of this section (4.4) for convenience.

It was noticed that in order to obtain a set of consistent estimates we have used the 2SLS method to estimate the structural parameters of the model. Most of these parameters are obtained directly. However, values of parameters related to the unobservable interest rate and the real rate of interest; and also value of the parameters ϕ and λ (which measure the degree of capital mobility and excess money adjustment respectively) had to be extracted from the estimated values for parameters of the revised equations for consumption (eq. 4.34'), private investment (eq. 4.36') and the demand for money (eq. 4.32'). Data used in this study are taken from issues of the International Monetary Fund's *International Financial Statistics (ISF)* and the *World Economic Outlook*, and also issues of the Iranian central bank's (Bank Markazi Iran) *Annual Reports* (see appendix 4.A to this chapter for the details of the data sources). Data are annual covering the period 1959-1992. All stock data are measured at the end of the period and the price data are period averages.

$\log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right)$ and $\log Y_t$ improves the result in the sense that the sign of the lagged dependent variable turns positive and its significance increases. However, the overall result does not change markedly. The coefficients on lagged disposable income and the international interest rate (uncovered parity) remain insignificant at the 5 percent level. Estimating the consumption function with these variables omitted from the regression we obtain the following estimates:

$$(4.39) \dots \log C_t = .96 - .21 \left(\frac{EP_{t+1} - P_t}{P_t} \right) + .14 \log \left(\frac{\tilde{M}_t}{P_t} \right) + .28 \log C_{t-1} + .45 \log Y_t$$

(t-ratios) (2.2) (-1.25) (2.3) (2.7) (4.4)

$\bar{R}^2 = .992$; $DW = 2.21$; $\chi^2_{sc(1)} = 2.5$; $\chi^2_{ff(1)} = 2.2$; $\chi^2_{n(2)} = .98$; $\chi^2_{h(1)} = 1.5$

The goodness of fit of the estimated equation remains almost the same. An interesting point to note is the positive and significant effect of the (shadow) real money balance on consumer expenditure. The proportional change of consumption with respect to the (shadow) money balance can be used to calculate the value of marginal effect of the real (shadow) money balance on aggregate consumption, $\left(\frac{\partial C_t}{\partial (\tilde{M}_t / P_t)} \right)$, which in turn can be interpreted as the

Pigovian effect (see Morishima (1972)). This estimate suggests that a 10 percent increase in real (shadow) money balances increases the aggregate consumption expenditure by as much as 1.4 percent. However, when we estimate the consumption function excluding the expected inflation rate (which appears to have no significant effect, at 5 percent level, on the dependent variable) the

significance of the money balance variable is eroded- as the results of the following regression indicates:

$$(4.40) \dots \log C_t = .68 + .08 \log \left(\frac{\tilde{M}_t}{P_t} \right) + .32 \log C_{t-1} + .49 \log Y_d$$

$$(t \text{ - ratios}) \quad (1.56) \quad (1.33) \quad (2.9) \quad (4.5)$$

$$\bar{R}^2 = .99, \quad DW = 1.89, \quad \chi^2_{sc(1)} = .025; \quad \chi^2_{ff(1)} = 1.6; \quad \chi^2_{n(2)} = .29; \quad \chi^2_{h(1)} = 3.3$$

On the basis of these results we can suggest that in the economy under observation, when inflation is expected, an increase in real money balances has a positive and significant effect on aggregate consumption expenditure; yet when the influence of the expectation of inflation is removed, the influence of money balance on aggregate consumption becomes insignificant.

Estimating the aggregate consumption function omitting real (shadow) money balances yields:

$$(4.41) \dots \log C_t = .13 + .39 \log C_{t-1} + .57 \log Y_d$$

$$(t \text{ - ratios}) \quad (.90) \quad (4.0) \quad (6.0)$$

$$\bar{R}^2 = .99; \quad DW = 2.1, \quad \chi^2_{sc(1)} = .41; \quad \chi^2_{ff(1)} = .02; \quad \chi^2_{n(2)} = .79; \quad \chi^2_{h(1)} = 2.5$$

With regard the effect of the real rate of interest on consumption, we found a negative (but significant only at 10 percent level) coefficient international interest rate variable $(i^* + \frac{Ee_{t+1} - e_t}{e_t})$ of magnitude -.013. We have the following relationship for this semi-reduced form coefficient (see eq. (4.34') in table (4.4)):

$$(4.42) \dots \alpha_{11} = \alpha_1 \phi = -0.13$$

(t - ratio) (-1.9)

The estimated value for the parameter ϕ (the degree of capital mobility) derived from the estimated results of the demand for money function discussed below, was found to be .62. From the above (4.42) relationship, we, therefore, have $\alpha_1 = -.02$. The chosen estimated consumption function could thus be written as:

$$(4.43) \dots \log C_t = .13 - .02r_t + .39 \log C_{t-1} + .58 \log Y_d$$

(t - ratios) (.90) (-1.9) (2.7) (4.4)

$$\bar{R}^2 = .99; \quad DW = 2.2; \quad \chi^2_{sc(1)} = .41; \quad \chi^2_{ff(1)} = .02; \quad \chi^2_{n(2)} = .79 \quad \chi^2_{h(1)} = 2.5$$

All the estimated parameters carry the expected a priori signs although the intercept term appear to be insignificantly different from zero.

In most studies of the consumption function in developing countries the effects of the real rate of interest on consumption have been found to be insignificant and/or negligible. However, Rossi(1982) finds a significant but small real interest elasticity in the consumption function. Also Haque et al (1990) and (1993) find a negative (but significant only at the 10 percent level) relationship between consumption and the real rate of interest. Our finding of a negative interest semi-elasticity in the consumption function for the Iranian economy in the sample period(1959-91) is consistent with the results of the above mentioned studies of the aggregate consumption function in developing countries. However, it should be noted that the estimated semi-elasticity in our consumption function is almost negligible in magnitude indicating a mere 0.2 percent fall in

consumption for a 10 percent increase in the real rate of interest (i.e. an increase of interest rate for example, from 10 percent to 11 percent).

The coefficient on the lagged consumption variable is about .39 and significant while that on disposable income is about .58 indicating a highly significant influence of disposable income on consumer expenditure. Since the relationship is log-linear these coefficients are elasticities. The estimated income elasticity of consumption can be used to derive the marginal propensity to consume at the sample mean. The income elasticity of consumption

$\left(\frac{\partial C_t}{C_t} / \frac{\partial Y_d_t}{Y_d_t}\right) = .58$ can be written as $\left(\frac{\partial C_t}{\partial Y_d_t} / \left(\frac{C_t}{Y_d_t}\right)\right) = .58$ where the denominator

term is the average propensity to consume and for our sample period in the

Iranian economy is computed as $\left(\frac{\sum_{t=1959}^{1991} C_t}{\sum_{t=1959}^{1991} Y_d_t} = \frac{187535.6}{266032.2} = .705\right)$. This gives us the

useful information that the average propensity to consume, at the point of sample mean, in the time period 1959-91 in Iran has been about 70 percent while the marginal propensity to consume in this economy turns out to be about 0.41

$$\left(\frac{\partial C_t}{\partial Y_d_t} = (.58)(.705) = .41\right).$$

From our estimation results the long-run income elasticity of consumption

$\left(\frac{\alpha_3}{1 - \alpha_2} = \frac{.58}{1 - .39}\right) = .95$; is found to be 95 percent. These are close to the results of

a study of the consumption function carried out for the Iranian economy for the sample period, 1959-85 (see Kiani, 1992). In Kiani's study, which is a single

equation model, estimating the short-run and long-run income elasticity of consumption were respectively 72 percent and 96 percent.

In general our empirical results suggest that disposable income is the most important explanatory variable in the consumption function. This is contrary to the Hall(1978) specification of the permanent income hypothesis (support for this hypothesis would have required a significant parameter on the lagged consumption variable with a magnitude close to unity). Haque et al (1993), in their study of a group of developing countries find that the coefficient of the current disposable income takes the value of 30 percent. They interpret this (on the basis of their specification of the consumption function in per capita form) as an estimate of the fraction of household in the population which are liquidity-constrained. households in the population. In a similar specification of the consumption function in our macroeconomic model (i.e. in per capita form) we found the estimated value of the coefficient on current disposable income to be about 0.60.

4.4.2 Private investment

The estimating version of the private investment function (eq. (4.36')) turned out to be a function of aggregate income, the capital stock, public sector investment, domestic credit to the private sector, real (shadow) money balances, the expected rate of inflation and the international (uncovered parity) interest rate. We have the following estimation results:

$$\begin{aligned}
(4.44) \dots \log P_{it} = & -15.7 - .007 \left(i_{it}^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + 1.28 \log Y_t + .5 \left(\frac{Ep_{t+1} - P_t}{P_t} \right) - .013 \log \left(\frac{\tilde{M}_{t-1}}{P_{t-1}} \right) \\
& (t\text{-ratios}) \quad (-2.6) \quad (-.39) \quad (2.8) \quad (.63) \quad (-.04) \\
& - 1.3 \log \left(\frac{\tilde{M}_t}{P_t} \right) + 2.0 \log K_t + .007 \log G_{it} + .41 \log \left(\frac{Dcp_t}{P_t} \right) - .16 \log P_{it-1} \\
& (t\text{-ratios}) \quad (-2.4) \quad (2.16) \quad (.04) \quad (.93) \quad (-.76) \\
\bar{R}^2 = & .92; \quad DW = 1.7; \quad \chi^2_{sc(1)} = .02; \quad \chi^2_{ff(1)} = .13, \quad \chi^2_{n(2)} = .12; \quad \chi^2_{h(1)} = .017
\end{aligned}$$

The equation fits the data reasonably well. DW and other diagnostic statistics are insignificant at the 5 percent level. However, some of the estimated parameters, notably that of the lagged private investment variable, are not statistically significant at 5 percent level indicating that there is no significant effect from some variables on private investment expenditure. Nevertheless, the key variables in the private investment function (aggregate income and the capital stock) appear to have a significant and large elasticity impact compared to estimates of some other empirical works, (see for example Haque et al (1990)).

Excluding the international interest rate from the regression does not change the estimation results much. Parameters on the lagged (shadow) money and government investment are not significant at the 5 percent level. Estimating the equation omitting these variables, the overall goodness of fit improves yet the sign on the coefficient on the lagged dependent variable remains negative and is insignificant at the 5 percent level. This could be because of the collinearity between private investment and the capital stock. Recall that $K_t = (1 - \rho)K_{t-1} + (P_t + G_{it})$ and inclusion of the capital stock variable could have affected the significance of lagged private investment. We examined the issue by estimating the equation excluding the capital stock from the private investment

function. The coefficient on lagged private investment in this case appeared positive and significant at 7 percent level.

However, current (real) banking credit to the private sector still does not seem to exert any significant effect on private investment. In most studies of private investment in developing countries (see Chhibber et al (1992)), domestic credit to the private sector and public investment are both found to be highly influential in private capital formation (see also Blejer and Khan, 1984). In the case of Iran, particular reference may be made to a *study carried out by* Karshenas(1990). He finds a significant effect of government investment and domestic banking credit on private investment in Iran in the sample period (1959-77). He considers a linear regression model of the form:

$$(4.45) \dots IP_t = a_1 + a_2IG_t + a_3CR_t + a_4K_{t-1} + u_t$$

where IP is private sector investment, IG refers to public sector investment, CR denotes availability of bank credit to the private sector and K is the actual capital stock. Using time series for these variables published by Iran's central bank (Bank Markazi Iran) and the IMF, *International Financial Statistics (IFS)* and calculating the capital stock by cumulatively adding real gross private investment as a measure to the private capital stock he applies the OLS method to this equation which yields the following results:

$$(4.46) \dots IP = 237 + .99IG_t + .36CR_t - .08K_{t-1}$$

(t-ratios) ... (3.1) (3.8) (2.13) (-1.8)

$\bar{R}^2 = .98; \quad DW = 1.92$

On the basis of this regression and similar results obtained from estimating an equation that includes the long-run foreign capital flow as an additional explanatory variable, Karshenas (1990) concludes that bank credit and particularly government investment exert a positive and highly significant influence on private investment.

Although we have chosen a log-linear form for our private investment function in the model mainly because it allows private investment to react in proportion to a rise and fall in the explanatory variable. Also on the assumption of constant elasticities, it avoids the problem of a drastic fall in the elasticities as investment rises. However, two points should be made about Karshenas's results compared to our findings. First, the model estimated by Karshenas only covers the period (1959-77) which refers to just the early part of the sample period covered in our study. Secondly, in the regression model specified by Karshenas aggregate income is not included amongst the explanatory variables. This is important because (highly) significant effects of government investment and bank credit on private investment in Karshenas's model may have been magnified because of the absence of the aggregate income variable in the private investment function.

In our estimated equation (4.44), the lagged dependent variable turned out to be negative and insignificant at the 5 percent level. Estimation of the equation excluding the lagged dependent variable yields a similar results with both the

capital stock and aggregate income exerting positive and highly significant effect on private investment while the expected rate of inflation still does not appear to have any significant effect on private investment. Excluding the expected rate of inflation term from the regression does not change the overall goodness of fit or other statistics in any considerable manner. In another estimation experiment we further excluded the domestic credit to the private sector. According to these results aggregate income, the capital stock and the (shadow) real cash balance, together explain about 93 percent of the changes in the private sector investment:

$$(4.47) \dots \log P_t = -14.9 + 1.4 \log Y_t - 1.01 \log \left(\frac{\tilde{M}_t}{P_t} \right) + 1.68 \log K_t$$

$$(t - ratios) \quad (-5.8) \quad (8.6) \quad (-4.2) \quad (3.7)$$

$$\bar{R}^2 = .926; \quad DW = 1.85; \quad \chi^2_{sc(1)} = .007; \quad \chi^2_{ff(1)} = .24; \quad \chi^2_{n(2)} = .139; \quad \chi^2_{b(1)} = .33$$

Recall that in the previous section, when discussing the private consumption function, it was noted that the real (shadow) money balance had a positive effect on consumption. This may explain the negative effect of the term $\log \left(\frac{\tilde{M}_t}{P_t} \right)$ on private investment in the estimated equation (4.47), as an increase in consumption expenditure could eventually reduce saving and is likely to impact upon investment negatively. To see the mechanism by which the real (shadow) money balances transmit to private capital formation in this model, it is helpful to note that the shadow money balance is defined as $\tilde{M}_t = M_t + e_{t,t} \Delta F p_t$, where $\Delta F p$ is the change in foreign assets held by the private sector. From eq. (4.17.2) in table 4.1, we know that:

$$(4.17.2)... \Delta Fp_t = \frac{1}{e_t} \left\{ P_t [Yd_t - (C_t + Pi_t)] - (\Delta M_t - \Delta Dcp_t) \right\}$$

and substituting for ΔFp in the shadow money identity (eq. (4.26)) repeated above, we obtain:

$$(4.48)... \tilde{M}_t = M_t + e_t \left\{ \frac{1}{e_t} [Yd_t - (C_t + Pi_t)] - (\Delta M_t - Dcp_t) \right\}$$

Rearranging the above equation (4.48) for Pi with considering that:

$M_t - \Delta M_t = M_{t-1}$ we have:

$$(4.49)... Pi_t = \frac{\Delta Dcp_t}{P_t} - \frac{\tilde{M}_t}{P_t} + \frac{M_{t-1}}{P_t} + (Yd_t - C_t)$$

If we consider private saving as the difference between the private sector's disposable income and consumption i.e. $Ps=Yd-C$ and substitute for $Yd-C$ in the above equation (4.49) we obtain:

$$(4.50)... Pi_t = \left[\left(\frac{\Delta Dcp - \Delta \tilde{M}_t}{P_t} \right) + Ps_t \right]$$

Thus for private sector investment to equal private saving ($Pi=Ps$), a change in domestic credit to the private sector must equal the change in shadow money balances. Now, if shadow money balances increase at a greater rate than

domestic credit to the private sector, and assuming a stable private saving behaviour, private investment has to fall to satisfy the above identity Thus:

$$(4.51) \dots P_{it} = pi(P_{st}, \Delta D_{cpt}, \Delta \tilde{M}_t, \dots)$$

(+ (+) (-)

Returning to the estimated private investment function (equation (4.47)), we are now in a position to interpret this specification of the private investment function paying particular attention to the effects of government investment and the domestic credit to private sector on private investment found more generally in the literature. First, recalling that $K_t = (1-\rho)K_{t-1} + (G_t + P_{t-1})$ and $\tilde{M}_t = M_t + e_{it}\Delta Fp_t$ the insignificant effect of public investment on private investment found could be due to collinearity between the capital stock and public investment on one hand and between ‘shadow’ real money balances and banking credit to the private sector on the other. Comparing all the diagnostic tests and the goodness of fit criteria, amongst many estimating experiments, the best result was the regression in which: the current capital stock was replaced by its lagged form, government investment was included and the ‘shadow’ real money balances variable replaced (lagged) domestic credit to the private sector. With respect to the real rate of interest, this variable did not appear to be statistically significant in different specifications of the equation; and typically the estimate magnitude was negligible. The estimated coefficient for this latter variable is -.021 with a t-ratio of -1.24. Recall that from the revised private investment eq. (4.36’) we had $\kappa_{11} = \kappa_1\phi$ where parameter ϕ measures the degree

of capital mobility in the economy, ϕ is estimated to be .62. From the relationship above we, therefore, have $\kappa_1(.62) = -.021$ and thus, $\kappa_1 = -0.035$. Thus estimated private investment can be shown as:

$$(4.52) \dots \log P_{it} = -10.87 - .035r_t + .79 \log Y_t + 1.45 \log K_{t-1} + .41 \log G_{it} - .95 \log \left(\frac{Dcp_{t-1}}{P_{t-1}} \right)$$

(t-ratios) (-3.7) (-1.24) (2.4) (2.4) (3.0) (-2.41)

$\bar{R}^2 = .91; \quad DW = 1.89; \quad \chi^2_{sc(1)} = .88; \quad \chi^2_{ff(1)} = .03; \quad \chi^2_{n(2)} = .66; \quad \chi^2_{h(1)} = .002$

This estimate equation seems to be reasonable approximation for private investment behaviour in the Iranian economy in the sample period under examination. The regression explains variations in actual private capital formation and the explanatory variables have the expected signs. With the exception of the real rate of interest, all the coefficients are significantly different from zero at the 5 percent level.

Most studies of investment behaviour in developing countries do not include an interest rate as an explanatory variable because of the absence of reliable data on this variable in these countries (see Blejer and Khan (1984)). The approach adopted here allowed us to identify the effect of the real rate of interest on private investment (although it turned out to be statistically insignificant). While we find no significant effect of the real rate of interest on private investment in Iran in the sample period (1959-91) it should be noted that Haque et al (1990) and (1993) find a small (and significant at the 10 percent level) effect of the real rate of interest on investment in their sample of developing countries.

The income elasticity of the demand for investment is found to be relatively high, in accordance with the flexible-accelerator family of investment theories. The lagged capital stock also appeared to have a strong influence on investment. Two additional explanatory variables in our specification of the private investment are the banking system's credit to the private sector and public sector investment as two additional explanatory variables. The importance of public investment in the Iranian economy, as a major oil exporting country, needs no introduction. Almost 50 percent of the total capital formation in this economy during the time period 1959-91 has been due to government action. Our estimation results (eq. 4.52) support the significance of public sector investment on private investment in Iran. However, our empirical results, are mixed with respect to the effect of the bank credit on private sector investment. In some versions of the regression, with the overall acceptable specification, we found no significant effect for the domestic banking credit. Regarding the direct link between public sector expenditure and expansion of domestic credit, the authorities have frequently imposed quantitative restrictions on the extension of bank credit to the private sector (notably when they felt that inflation was likely to rise). This may go some way towards explaining the insignificance of current domestic credit to the private sector in the regressions which also include public investment. The negative sign on the coefficient on the lagged domestic credit to private sector can be interpreted on the grounds that a previous period credit to the private sector is regarded as its current period liability, (interest or principal of which has to be repaid) hence indicating a negative effect on the current period investment.

4.4.3 Foreign trade

The estimated export function fits the data reasonably well. All coefficients in the estimated equation bear the expected sign. In our estimated version of the export function we added a dummy variable to allow for the significance of the war years (1981-87) on the economy's exports. This is justified because the country's foreign trade, mainly dominated by the oil exports, could have been affected substantially by the war. The Iranian ports at the Persian Gulf, where the major oil exporting terminals are located, and the petroleum industry's installations are mainly situated in the south and south-west of the country. These areas were in and near to the war-torn zones and were severely damaged in the war.

The estimated form of the exports (foreign) demand function has therefore a dummy variable in addition to eq. 4.8 as an additional explanatory variable. This dummy variable takes the value one for the years 1981-87 and zero for the rest of the sample period. The estimation results are as follows:

$$(4.53) \dots \log X_t = -9.2 + .94 \log \left(\frac{e_t P_t^*}{P_t} \right) + .90 \log Y_t^* + .64 \log X_{t-1} - .64 Dum$$

(t-ratios) (-2.3) (2.22) (2.7) (5.9) (-4.5)

$\bar{R}^2 = .86; \quad DW = 1.84; \quad \chi^2_{sc(1)} = .19; \quad \chi^2_{ff(1)} = .62; \quad \chi^2_{n(2)} = 5.4, \quad \chi^2_{h(1)} = .43$

We would call this equation an export (foreign) demand function because the coefficients on domestic price P and foreign income Y* are negative and positive respectively which are expected in a demand function. The fitted equation indicates a significant exports response to relative price changes. The price elasticity of the demand for exports is about .94 (not significantly different from

unity) and significant at the 5 percent level. Regarding the estimated value of the coefficient on the lagged dependent variable (i.e. $\log X_{t-1}$) the long-run price elasticity of exports is still larger ($2.4 = .94 / (1 - .64)$) indicating a quite elastic (foreign) demand for the country's exports in the long-term. It should be noted that our estimated value for the price elasticity of exports for the Iranian economy is larger than estimates reported by Haque et al (1990) and (1993), for a sample group of developing countries; but is close to some estimates reported by Khan(1974) and Goldstein and Khan(1985). The estimated price elasticity of demand for Iran's exports may seem surprisingly large as the exports of the country in the sample period consisted mainly of oil, which is a recognised necessary commodity for industries everywhere in the world. However, it will be noted that the country's share in the international oil markets has never been large enough to secure monopolistic power. Because of this, a unilateral increase in the price of the country's oil exports would have been met by a shift in demand, especially in the longer-term, toward output from other oil exporting countries. Iran has had no choice but to observe the market determined prices.

The (foreign) income elasticity of demand for exports is also high (.90 in impact and 2.6 in the long-run). This suggests that the economy would benefit from foreign trade in a period of steady economic growth in the world. A 10 percent increase in world income would raise demand for the country's exports by as much as 25 percent in the long-term. Finally, as expected, our empirical results support the hypothesis that exports were negatively and significantly affected during the years that the country was at war with the neighbouring country Iraq(1981-87).

As for the exports demand equation, a dummy variable was added to the import demand regression- to test the hypothesis that the country's imports were negatively affected during the war years of 1981-87. Here we report two specifications of the estimated imports demand function, for the reason discussed below. First, we consider that version of imports demand equation (eq. 4.8) which includes current period aggregate income. In the second experiments we add lagged aggregate income to the regression's explanatory variables as well. Taking these in order:

$$\begin{aligned}
 (4.54) \dots \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) Z_t &= -2.8 + 2.3 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + .66 \log Y_t + .048 \log \left(\frac{Fr_{t-1}}{P_t^* Z_{t-1}} \right) \\
 &\quad (t-ratios) \quad (-1.5) \quad (1.1) \quad (2.9) \quad (.048) \\
 &\quad + .49 \log \left(\frac{e_{t-1} \cdot P_{t-1}^*}{P_{t-1}} \right) Z_{t-1} - .47 \text{Dum} \\
 &\quad (t-ratio) \quad (3.1) \quad (-4.2) \\
 \bar{R}^2 &= .899; \quad DW = 1.2; \quad \chi^2_{sc(1)} = 7.7; \quad \chi^2_{ff(1)} = 3.8; \quad \chi^2_{n(2)} = 1.1; \quad \chi^2_{h(1)} = .16
 \end{aligned}$$

Although the coefficients have the expected signs and the regression fits the data reasonably well, the DW statistic turns out to be significant at 5 percent level, (for n=31 and k=6 the critical value for DW at 5 percent level of significance is 1.61). Inspecting the lagrange multiplier test for residual serial correlation reported by $\chi^2_{sc(1)} = 7.7$ confirms that there could be some form of misspecification or a serial correlation problem in the regression. DW could be significant as a consequence of having omitted variables that are themselves autocorrelated (see Maddala (1993)). We have included the lagged import variable in this equation to allow for adjustment- it represents an assumed

partial adjustment process. The partial adjustment process is incorporated in the behavioural equations of the model on the basis of the assumption that the economic agents may not be able to adjust their demand to the desired level. This is particularly justifiable in a developing country where as was mentioned earlier, economic agents are frequently constrained by the availability of foreign exchange. In this case, to see whether the serial correlation is caused by omitted variables one can test for omitted variables using appropriate tests (see Maddala, 1992, p.254). Inspecting the Reset test (reported by $\chi^2_{ff(1)} = 3.8$, we find this test also to be significant at 5 percent level. The appropriate remedy in this case would be to estimate the model including some variables that are autocorrelated with other explanatory variable that should have been included in the equation but omitted. We therefore reestimate the demand for imports function including lagged aggregate income as an explanatory variable.

Among different specifications the best results, on the basis of the diagnostic tests and goodness of fit criteria, were found to be as follows:

$$(4.55) \dots \log\left(\frac{e_t P_t^*}{P_t}\right) Z_t = -.58 - .013 \log\left(\frac{e_t P_t^*}{P_t}\right) - 1.6 \log Y_{t-1} + 2.07 \log Y_t + 1.1 \log\left(\frac{Fr_{t-1}}{P_{t-1}^* Z_{t-1}}\right) +$$

(t - ratios) (-.35) (-.119) (-4.1) (4.9) (2.7)

$$.58 \log\left(\frac{e_{t-1} P_{t-1}^*}{P_{t-1}}\right) Z_{t-1} - .35 \text{Dum}$$

(t - ratios) (5.6) (-4.0)

$$\bar{R}^2 = .932; \quad DW = 1.97; \quad \chi^2_{sc(1)} = .007; \quad \chi^2_{ff(1)} = 1.19; \quad \chi^2_{n(2)} = 1.6; \quad \chi^2_{h(1)} = .007$$

The goodness of fit is slightly improved while DW and all other diagnostic test statistics are satisfied at the 5 percent level. We therefore have a reasonably good

characterisation of imports demand in the economy- all coefficients have the expected sign and all the diagnostic statistics are satisfied at 5 the percent level.

The economic rationale behind the final specification of the demand for imports equation including lagged aggregate income as an explanatory variable and bearing a negative coefficient, can be explained as follows. The assumed partial adjustment process suggests that economic agents adjust their imports only partially to their desired level because of, for example, the scarcity of foreign exchange at the formal rate. If in one period (say period $t-1$) aggregate income increased improving the foreign exchange reserves, this would have increased the actual level of imports in that period leaving a relatively smaller fraction of the desired level of imports left to be fulfilled at the current period (t), hence a negative effect of the lagged income variable on the current period imports demand.

The estimated import demand equation reveals *some features of the Iranian* economy in the period under consideration. The price inelasticity and high income elasticity of the demand for imports indicate that while in this period growing real income has been exerting a strong effect on the demand for imports; because imports have mainly consisted of necessary goods and services the demand for imports have been largely unresponsive to changes of prices.

This leads to one observation concerning economic development in Iran in this period. A main characteristic of the economic development has been the import substitution strategy adopted by successive governments- designed to establish a non-oil industrial sector in the economy which is capable of providing an alternative source of income when the oil reserves are depleted. But the

estimation results reported above suggest that in the sample period the country's dependency on imported goods and services has been growing- a feature which undermines the objective of the development strategy.

Another finding referred to above, is the significant effect of foreign exchange reserves on import demand. In earlier chapters of this thesis it was noted that the restrictive effect of the availability of foreign exchange on import is well recognised as a common characteristic of developing countries. Haque et al (1990), (1993), in their estimation of the demand for imports in a group of developing countries find similar results concerning the significant effect of foreign exchange constraint on import demand. Khan and Knight(1988) also report similar estimates for these coefficients. As in the case of the export demand function, a dummy variable intended to capture the effects of the war years, turns out to be significant at the 5 percent level thereby supporting the hypothesis that import demand was negatively affected during the war.

Our estimation of foreign trade equations suggests that trade is more responsive to income than to real exchange rates also the Marshall-Lerner condition is satisfied in this model in the long-run but not on impact, (the sum of the price elasticities for exports and imports is slightly less than one in the short-run but more than one in the long-term ($\eta_{ex} + \eta_{im} = 2.6 - .074 = 2.58$)). This suggests that a real devaluation of the currency would in the long-run improve the trade balance of the economy.

4.4.4 Aggregate supply

In the previous chapter we specified two production functions and it was decided to let the empirical evidence reveal which production function best explained the available data. First, consider the neo-classical production function that related inputs to aggregate output. We assumed a Cobb-Douglas production function:

$$(4.56) \dots Y_t = A \cdot K_t^{\theta_0} L_t^{\theta_1}$$

where Y_t , K_t and L_t are aggregate output, the capital stock of the economy and labour inputs respectively. A , θ_0 and θ_1 are parameters of the production function. Estimating this regression in log form we obtained:

$$(4.57) \dots \log Y_t = .64 + .82 \log K_t + .23 \log L_t$$

$$(t\text{-ratios}) \quad (2.3) \quad (7.3) \quad (.21)$$

$$\bar{R}^2 = .85; \quad DW = .22; \quad \chi^2_{sc(1)} = 24; \quad \chi^2_{ff(1)} = 23.2; \quad \chi^2_{n(2)} = 2.05; \quad \chi^2_{h(1)} = .003$$

RSS = 1.0318

Inspecting the diagnostic tests reveals that we have evidence of misspecification in our regression. In an attempt to respecify the regression we modify the specification of the equation using the capital stock identity (i.e. $K_t = (1 - \rho)K_{t-1} + T_t$ where ρ is the rate of capital stock depreciation and T_t is total current investment) and came up with the following expression for the aggregate production function:

$$(4.58) \dots \log Y_t = A' + \theta_0' \log K'_{t-1} + \theta_1 \log L_t + \theta_2' \log T_t$$

where

$$A' = \log A + \theta_0 \log 2$$

$$\theta_0' = \frac{\theta_0}{2}$$

$$\theta_2' = \frac{\theta_0 \theta_2}{2}$$

and

$$\log K'_t = \log 2 + \frac{1}{2} \sum_{i=0}^{t-1} (1-\rho)^i T_{t-i} + \frac{t}{2} (1-\rho) + \frac{1}{2} \log K_0$$

Recall that K_0 was the initial capital stock of the economy. Estimating this production function we have:

$$(4.59) \dots \log Y_t = 2.4 + .14 \log K'_{t-1} + .70 \log L_t + .50 \log T_t$$

$$(t\text{-ratios}) \quad (11.0) \quad (2.7) \quad (5.9) \quad (15.2)$$

$$\bar{R}^2 = .98; \quad DW = 1.6; \quad \chi^2_{sc(1)} = .46; \quad \chi_{ff(1)} = 1.9; \quad \chi_{n(2)} = 2.2; \quad \chi_{h(1)} = .3$$

The regression fits well, all four diagnostic tests are satisfied at 5 percent level and all variables have the expected sign and highly significant. In this regression the effect of the capital stock on output comes through the previous stream of investments (K'_{t-1}) and the current period investment (T_t). The highly significant coefficient on current total investment reflects the effects of embedded technological change on aggregate supply working through the new investments. It will be noted that in the time period under consideration, 1959-91 Iran's economy has been transformed from a mainly agrarian economy to a semi-industrial developing economy dominated by oil, petrochemical, mining and manufacturing sectors. This structural change required a persistent process of

installation of new capital goods and machinery that changed aggregate supply capacity enormously.

The effects of both capital and labour in the estimated equation appear to be highly significant and positive. Since we have modified the initial production function we have the following set of relationships between the semi-reduced form coefficients of the estimated equation and the structural coefficients of the Cobb-Douglas production function:

$$(4.60) \dots \log A + \theta_0 \log 2 = 2.4$$

$$\frac{\theta_0}{2} = .14$$

$$\frac{\theta_0 \theta_2}{2} = .50$$

From these relationships we obtain values for the structural parameters of the production function which are $A=9.0$, $\theta_0 = .28$ and $\theta_2=3.57$. Accordingly our structural production function is estimated as :

$$(4.61) \dots \log Y_t = 9. K_t^{.28} \cdot L_t^{.70}$$

It will be noted that the production function exhibits roughly constant returns to scale as we have $\theta_0 + \theta_2 = .98$ (which is quite close to unity).

To test for constant returns to scale in our production function (eq. 4.56), we can either use a t-test procedure (see Maddala, 1992, p. 159) or alternatively derive restricted and unrestricted residual sum of squares of the regression and

use the F-test. Unrestricted residual sum of squares (URRS) is obtained estimating the regression $\log Y_t = A + \theta_0 \log K_t + \theta_1 \log L_t$ (eq. 4.57) which was found to be $URRS=1.0318$. To obtain restricted residual sum of squared (RRSS) we impose the restriction $\theta_0 + \theta_1 = 1$ or $\theta_1 = 1 - \theta_0$ and then estimate the equation in per labour form:

$$(4.62) \dots \log\left(\frac{Y_t}{L_t}\right) = .64 + .83 \log\left(\frac{K_t}{L_t}\right)$$

(t - ratios) (.94) (9.4)

$$\bar{R}^2 = .74; \quad RRSS = 1.0332$$

The F-test is defined as

$$(4.63) \dots F = \frac{(RRSS - URRS) / r}{URSS / (n - k - 1)}$$

where r is number of restrictions and k and n are number of explanatory variables and observations respectively (in our case $r=1$; $k=2$ and $n=32$). Calculating F-test from the above formula we obtain $F=.04$ which is insignificant at the 5 percent level (F with d.f. 1 and 20 is 4.17).

Given this empirical support for the constant returns to scale condition in the economy, we impose this condition on the alternative production function which in this case could be expressed in per labour form. We had the following regression:

$$(4.64) \dots \log\left(\frac{Y_t}{L_t}\right) = A' + \theta_0' \log\left(\frac{Y_{t-1}}{L_{t-1}}\right) + \theta_1' \log\left(\frac{m_{t-1}}{m_t}\right) + \theta_2 \log\left(\frac{Z_t}{K_t}\right) + \theta_2' \log\left(\frac{K_t}{L_t}\right)$$

where

$$\begin{aligned} A' &= \theta_0 \log a + \theta_2 \log b \\ \theta_0' &= (1 - \theta_0) \\ \theta_1' &= \theta_1 \left(\frac{1 - \lambda}{\lambda}\right) \\ \theta_2' &= \theta_0 + \theta_2 \end{aligned}$$

On estimating this rather ad hoc production function in per labour form we obtain the following:

$$(4.65) \dots \log\left(\frac{Y_t}{L_t}\right) = 1.34 + 0.64 \log\left(\frac{Y_{t-1}}{L_{t-1}}\right) - 0.08 \log\left(\frac{m_{t-1}}{m_t}\right) + 0.13 \log\left(\frac{Z_t}{K_t}\right) + 0.15 \log\left(\frac{K_t}{L_t}\right)$$

(t-ratios) (3.5) (4.7) (-.46) (3.1) (1.2)

$$\bar{R}^2 = .93; \quad DW = 1.14; \quad \chi^2_{sc(1)} = 6; \quad \chi^2_{ff(1)} = 4.8; \quad \chi^2_{n(2)} = 7.6; \quad \chi^2_{h(1)} = 4.0$$

Although the regression has a reasonably good fit, the DW statistic and other diagnostic tests are all significant and reveal specification problem in the regression. The coefficient on the term $\log\left(\frac{m_{t-1}}{m_t}\right)$, which measures the short-run monetary disequilibrium effect on aggregate supply is negligible indicating no considerable influence from money disequilibrium on aggregate output. Excluding this term from the regression and replacing the lagged import capital ratio as an index for the required level of imports we have the following estimation results:

$$(4.66) \dots \log\left(\frac{Y_t}{L_t}\right) = 1.03 + .68 \log\left(\frac{Y_{t-1}}{L_{t-1}}\right) + .20 \log\left(\frac{K_t}{L_t}\right) + .148 \log\left(\frac{Z_{t-1}}{K_{t-1}}\right)$$

(t-ratios) (3.79) (6.13) (2.06) (4.73)

$$\bar{R}^2 = .95; \quad DW = 1.4; \quad \chi^2_{sc(1)} = 3.4; \quad \chi^2_{ff(1)} = 3.1; \quad \chi^2_{n(2)} = 4.8; \quad \chi^2_{h(1)} = 3.1$$

Notably the goodness of fit and DW statistics are improved and all the diagnostic tests are now satisfied at the 5 percent level of significance. According to this regression per labour output is affected positively and significantly by the per labour capital stock. A 10 percent increase in the per labour capital stock causes a 2 percent increase in per labour output. The lagged ratio of imports to the capital stock, an index of the required level of imports in the economy, also appears to have a significant effect on per labour output. We estimated a version of the aggregate production function (eq. 4.58) including variable Z as an additional explanatory variable in it. When the set of explanatory variables contain both total current investment Ti and imports Z variable Z exerts no significant effect on the aggregate output. Once we excluded either Ti or Z from the regression the remaining variable appeared to have a significant effect on aggregate output. It seems therefore, that there is a strong correlation between Ti and Z in this economy which of course should be obvious from the fact that the country's imports during the time period 1959-91 have been dominated by capital and machinery goods as well as raw materials all imported for the purpose of capital formation or expanding potential aggregate output.

In both versions of our aggregate supply function both capital and labour inputs influence aggregate output. In the per labour form of the estimated function the hypothesis that money market disequilibrium may affect aggregate output was rejected but evidence could be found to support the hypothesis that

changes in imports exert some influence on output. Finally we found the neo-classical production function to be a better approximation for explaining aggregate output in this economy; and that the production function exhibited constant returns to scale condition.

4.4.5 Demand for money and capital movement

We revised the demand for money function in order to eliminate the unobservable market determined interest rate, i_t , from the equation, and arrived at equation (4.32'). Estimating this revised demand for money function yields:

$$(4.67) \dots \log\left(\frac{M_t}{P_t}\right) = -0.65 - 0.0016\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}\right) + 0.128 \log Y_t - 0.23 \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right) + 0.64 \log\left(\frac{M_{t-1}}{P_{t-1}}\right) + 0.51 \log\left(\frac{\tilde{M}_t}{P_t}\right)$$

(t-ratios) (-1.61) (-.28)
(1.69) (-1.4)
(4.5)

(t-ratio) (3.3)

$$\bar{R}^2 = .996; \quad DW = 2.03; \quad \chi^2_{sc(1)} = .139; \quad \chi^2_{ff(1)} = .94; \quad \chi^2_{n(2)} = 1.6 \quad \chi^2_{h(1)} = .23$$

The regression provides an excellent fit; and the DW statistic and all diagnostic tests are satisfied at the 5 percent level of significance. All the coefficients have the expected sign but some of them are not statistically significant at the 5 percent level. Estimating the equation excluding the lagged real (shadow) money

$\left(\log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right)\right)$ does not change the result considerably and still the international

interest rate $\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}\right)$ appears to have no significant effect on the real

demand for money. Estimating the equation with both the lagged 'shadow' real

money balance and international interest rate (uncovered parity) omitted from the regression we have:

$$(4.68) \dots \log\left(\frac{M_t}{P_t}\right) = -.86 + .16 \log Y_t + .52 \log\left(\frac{M_{t-1}}{P_{t-1}}\right) + .38 \log\left(\frac{\tilde{M}_t}{P_t}\right)$$

(t-ratios) (-2.3) (2.5) (5.2) (3.3)

$$\bar{R}^2 = .996; \quad DW = 1.75; \quad \chi^2_{sc(1)} = .26; \quad \chi^2_{ff(1)} = 1.09; \quad \chi^2_{n(2)} = 1.9; \quad \chi^2_{h(1)} = .02$$

The estimation results seem slightly improved. The variables on the right hand side explain the demand for money almost entirely. Using the estimated values we can extract the structural parameters of the demand for money function. We have the following relationships:

$$(4.69)(*) \dots \phi \lambda \beta_0 = -.86$$

$$\phi \lambda \beta_1 = -.0016$$

$$(*) \quad \phi \lambda \beta_2 = .16$$

$$(*) \quad (1 - \lambda) = .52$$

$$(*) \quad (1 - \phi) = .38$$

where the sign (*) shows those estimated values significant at the 5 percent level.

From $(1-\phi)=.38$ we have $\hat{\phi} = .62$ and from $(1-\lambda)=.52$ it results that $\hat{\lambda} = .48$.

Substituting for ϕ and λ in the other relationship we obtain

$$\hat{\beta}_2 = .53; \quad \hat{\beta}_1 = .005 \text{ and } \hat{\beta}_0 = -2.9.$$

According to these results we estimate that the degree of capital mobility ($\phi = .62$) in the Iranian economy during the period 1959-91 has been 62 percent. In

other words although the capital account of the economy has not been closed to the rest of the world (the case $\phi=0$), there has not been a perfect capital mobility either ($\phi =1$). This finding differs from that of Haque et al (1990), (1993) in their study of a sample group of developing countries in that they report perfect capital mobility for these developing countries. The strict and tight surveillance of foreign trade and financial transfers of the private sector by the monetary authorities during the war years (1981-87), may have contributed to this imperfect capital mobility in Iran. However, the fact that private capital, although not perfectly, has been transferred abroad, indicates a private sector ability to circumvent the official barrier, adopted to prevent the private capital movements.

The finding of $\lambda=.48$ also seem interesting. From our setting of the adjustment process of the short-run money market disequilibrium λ was identified as the inverse of the time constant $\left(\lambda = \frac{1}{\tau} \right)$ required for the adjustment of the real money balances to the underlying long-run demand for money. Our estimate of λ suggest that the time period needed for completion of the adjustment process for short-run disequilibrium in the money market was about two periods (years).

The approach adopted here to formulate the market determined interest rate (i) in the model, using the concept of the 'shadow' money balance defined as $\left(\tilde{M}_t = M_t + e_t \cdot \Delta Fp_t \right)$ allowed us to estimate the structural parameters of the money demand function. The coefficient on the interest rate turned out to be of negligible size $\beta_1=-.005$, and statistically insignificant at the 5 percent level. Note

that this result is obtained despite the fact that we had not included the inflation rate or the expected rate of inflation in the money demand function. In some empirical works of the demand for money in developing countries it is argued that unresponsiveness of money demand to the interest rate probably has been due to the inclusion of the inflation rate in the demand for money function. Our results of estimating the demand for money function with no independent inflation rate variable as an explanatory variable provides no support for this view. Haque et al(1990) ,(1993) find a negative (but insignificant at 5 percent level) interest rate effect on money demand. We also find a negative coefficient on the interest rate in the money demand function but the estimate is of negligible size and is statistically insignificant.

Having established the irrelevance of the interest rate in the demand for money in the Iranian economy in the time period under observation, we now attempt to estimate an alternative demand for money function replacing the expected inflation rate as the opportunity cost of holding money instead of the interest rate. First consider the following regression:

$$(4.70) \dots \log\left(\frac{M_t}{P_t}\right) = \beta_0 + \beta_1\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}\right) + \beta_2 \log Y_t + \beta_3\left(\frac{EP_{t+1} - P_t}{P_t}\right) + \beta_4 \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

where $\left(\frac{EP_{t+1} - P_t}{P_t}\right)$ is the expected rate of inflation. Estimating this equation we

obtain:

$$(4.71) \dots \log\left(\frac{M_t}{P_t}\right) = -1.2 + +.007\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}\right) + .31 \log Y_t + .24\left(\frac{EP_{t+1} - P_t}{P_t}\right) + .84 \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

(t-ratios) (-3.1) (1.2) (4.6) (.93) (19.5)

$$\bar{R}^2 = .994; \quad DW = 1.90; \quad \chi^2_{sc(1)} = .009; \quad \chi^2_{ff(1)} = .006; \quad \chi^2_{n(2)} = .02, \quad \chi^2_{h(1)} = .09$$

The expected rate of inflation appears to have an insignificant effect on the demand for money. Estimating the equation with the inflation rate as a proxy for the expected rate of inflation we obtain:

$$(4.72) \dots \log\left(\frac{M_t}{P_t}\right) = -1.3 + +.005\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}\right) + .24 \log Y_t - .82\left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) + .90 \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

(t-ratios) (-4.1) (1.0) (4.4) (-3.7) (26.9)

$$\bar{R}^2 = .996; \quad DW = 1.75; \quad \chi^2_{sc(1)} = .43; \quad \chi^2_{ff(1)} = .89; \quad \chi^2_{n(2)} = 2.4, \quad \chi^2_{h(1)} = 2.3$$

The coefficient on the inflation rate is highly significant bearing a negative sign as expected. This means that in the Iranian economy inflation, rather than the interest rate, is a better proxy for the opportunity cost of holding money. The coefficient on the international interest rate term is of negligible value and is insignificant at the 5 percent level. Recall that no significant effect for this variable was found when the demand for money equation excluded the inflation rate from the regression (eq. 4.68). This finding is in contrast to the results reported by Haque et al (1990). On the basis of their findings of perfect capital mobility in these developing countries, (i.e. $\phi=1$), they conclude that the international interest rate can be used to proxy for the market determined interest rate in these countries for them the market determined interest rate

$$\left[i_t = \phi \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) + (1 - \phi) \tilde{i} \right] \text{ reduces to } \left[i_t = \left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) \right].$$

However, our estimation results indicates that in the Iranian economy in the sample period under observation, i.e. 1959-91 the degree of capital mobility has been less than perfect ($\phi=.62$). It is not therefore surprising that in our estimation of the demand for money function, not only do we find no evidence to support the hypothesis that the international interest rate can be used to proxy the market interest rate, but also the coefficient on the international interest rate appears to be statistically insignificant.

Estimating the money demand excluding the term $\left[\left(i_t^* + \frac{Ee_{t+1} - e_t}{e_t} \right) \right]$ from

the above demand for money function yields the following result:

$$(4.73) \dots \log\left(\frac{M_t}{P_t}\right) = -1.3 + .23 \log Y_t - .83 \left(\frac{P_t - P_{t-1}}{P_t}\right) + .92 \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

(t-ratios) (-4.1) (4.3) (-3.9) (30.5)

$$\bar{R}^2 = .997; \quad DW = 1.70; \quad \chi^2_{sc(1)} = .66; \quad \chi^2_{ff(1)} = .22; \quad \chi^2_{n(2)} = 2.1; \quad \chi^2_{h(1)} = 1.3$$

All the variables bear the expected sign and are highly significant. All the diagnostic test are satisfied and the goodness of fit is high. The regression therefore seems to explain satisfactorily variations in the demand for money in this economy. The short-run income elasticity of the demand for money is .23 and the corresponding long-run elasticity of the demand for money is about 2.8. The long-run income elasticity of money demand is rather larger than expected although, a long-run elasticity of the demand for money substantially above unity is common in developing countries (see Haque et al (1990) ,(1993)). The negative and highly significant coefficient on the inflation rate with a value of .83

is explained by reference to the fact that, for most of the period 1959-91 there has been sustained high inflation in Iran and as a result the inflation rate is a good indicator of the opportunity cost of holding money.

To summarise the estimation results of the simultaneous equation model we have repeated these results in table (4.5) for convenient.

Table 4.5 2SLS estimate of structural parameters

Consumption function

$$(4.43) \dots \log C_t = .13 - .023r_t + .39 \log C_{t-1} + .58 \log Y_d$$

$$(t \text{ - ratios})$$

$$\bar{R}^2 = .991; \quad DW = 2.2; \quad \chi^2_{sc}(1) = .41; \quad \chi^2_{ff}(1) = .02; \quad \chi^2_n(2) = .79 \quad \chi^2_{h(1)} = 2.5$$

Private investment

$$(4.52) \dots \log P_i = -10.87 - .035r_t + .79 \log Y_t + 1.45 \log K_{t-1} + .41 \log G_t - .95 \log(Dc_{P_{t-1}} / P_{t-1})$$

$$(T \text{ - ratios})$$

$$\bar{R}^2 = .91; \quad DW = 1.89; \quad c_s^2(1) = .88; \quad c_n^2(1) = .029; \quad c_n^2(2) = .66; \quad c_n^2(1) = .002$$

Export demand

$$(4.53) \log X_t = -9.2 + .94 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) + .90 \log Y_t^* + .64 \log X_{t-1} - .60 Dum$$

$$(T \text{ - ratios})$$

$$\bar{R}^2 = .86, \quad Dw = 1.84; \quad \chi^2_{sc}(1) = .19; \quad \chi^2_{ff}(1) = .62; \quad \chi^2_n(2) = 5.4; \quad \chi^2_{h(1)} = .43$$

Import demand

$$(4.55) \dots \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) Z_t = -.013 \log \left(\frac{e_t \cdot P_t^*}{P_t} \right) - 1.6 \log Y_{t-1} + 2. \log Y_t + .11 \log \left(\frac{Fr_{t-1}}{P_{t-1}^* \cdot Z_{t-1}} \right)$$

$$(t \text{ - ratio})$$

$$+.58 \log \left(\frac{e_{t-1} \cdot P_{t-1}^*}{P_{t-1}} \right) Z_{t-1} - .35 Dum$$

$$(t \text{ - ratio})$$

$$\bar{R}^2 = .93; \quad DW = 1.97; \quad \chi^2_{sc}(1) = .007; \quad \chi^2_{ff}(1) = 1.19; \quad \chi^2_n(2) = 1.6; \quad \chi^2_{h(1)} = .008$$

Table 4.5 continued

Aggregate Production function

$$(4.59) \dots \log(Y_t) = 2.4 + .14K_{t-1} + .70 \log L_t + .50 \log T_t$$

$$(11.0) \quad (2.7) \quad (5.9) \quad (15.2) \quad (t\text{-ratios})$$

$$\bar{R}^2 = .98 ; \quad DW = 1.60 ; \quad \chi_{sc}^2(1) = .46 ; \quad \chi_{\sigma}^2(1) = 1.9 ; \quad \chi_{\sigma}^2(2) = 2.2 ; \quad \chi_h^2(1) = .3$$

Demand for money

$$(4.73) \dots \log\left(\frac{M_t}{P_t}\right) = -1.3 - .005i_t + .24 \log Y_t - .83\left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) + .92 \log\left(\frac{M_{t-1}}{P_{t-1}}\right)$$

$$(-4.1) \quad (1.2) \quad (4.3) \quad (-3.9) \quad (30.5) \quad (t\text{-ratios})$$

$$\bar{R}^2 = .997 ; \quad DW = 1.70 ; \quad \chi_{sc}^2(1) = .66 ; \quad \chi_{\sigma}^2(1) = .22 ; \quad \chi_{\sigma}^2(2) = 2.1 ; \quad \chi_h^2(1) = 1.3$$

4.5. Summary and concluding remarks

The primary purpose of this chapter has been to estimate the key parameters of a standard macroeconomic model for the Iranian economy in the time period 1959-91. In this chapter we estimated the macroeconometric model, specified in chapter III, using the 2SLS method and annual time series data of the Iranian economy published by the IMF. The estimated model turned out to be a reasonable proxy of the Iranian economy in period 1959-91. All estimated functions explain much of the variation in actual variables. Goodness of fit for all the estimated equations is above 91 percent except for the exports (foreign) demand function which is about 86 percent. Overall, the estimated model represents a standard macroeconomic model adapted to accommodate a developing economics' main characteristics.

Aggregate consumption expenditure in the Iranian economy in the sample period of 1959-91 has been mainly responsive to the real disposable income of the private sector and to some extent to the previous period consumption expenditure. No evidence could be found of a significant effect of the real rate of interest on consumption expenditure. The short-run and long-run income elasticity of consumption turned out to be 58 percent and 95 percent respectively, close to some other estimates of this economy. Our results therefore reject the Hall (1978) specification of the permanent income hypothesis in the Iranian economy in this period. The most influential explanatory variables on private investment were real aggregate income and the capital stock of the economy. Our estimates also indicate that public sector investment exerts a significant and positive effect on private capital formation (although in some estimated version of the investment function this effect appeared to be insignificant probably due to crowding out effects of the government expenditure in the Iranian economy). No significant relationship was found between the interest rate and private investment, although the sign on the interest rate coefficient in the investment function was negative in accordance with economic theory. Export (foreign) demand was found to be responsive to price changes but import demand appeared quite price inelastic. Considering the nature of the imports and the immense necessity of the imported capital and intermediary goods in the economic development of the country, a price inelastic demand for imports reflects a familiar characteristic of the Iranian economy. The income elasticity of the demand for imports on the other hand is quite large (2.07) suggesting that in Iran, as in most developing countries the major difficulties of the economy lie on the supply side-demand appears quite strong for home and imported goods and is largely dependent on aggregate income. Also our estimates show that the coefficient on the lagged reserve-import ratio is significant and positive reflecting the foreign exchange constraint in the economy. The Marshall-Lerner condition is satisfied

in our model in the long-run but not on impact. The per capita stock of capital affects current output significantly and positively with a short-run elasticity of about .20 and of close to .62 in the long-run. The capital stock and the labour force both appeared to exert significant and positive influences on aggregate output. Current investment was also found to have a strong effect on aggregate supply, reflecting the technological change embedded in new investments. The estimated production function exhibited constant returns to scale. Except for that on the interest rate, the coefficients in the estimated demand for money function are all significant and of the expected sign. The estimated income elasticities are .23 and 2.8 in the short-run and long-run respectively. The coefficient on the inflation rate in the demand for money function was found to be negative and highly significant. One interpretation of this is that the inflation rate should be regarded as the opportunity cost of holding money in this economy over the sample time period. Our modelling approach allowed us to estimate the effective degree of capital mobility (indexed by the parameter ϕ). The estimate of ϕ in our study of the Iranian economy turns out to be about .62 indicating, a relatively high degree of capital mobility in this economy. This finding implies that economic agents find ways (and certainly in the long-run) to get around official barriers adopted to curb private capital transfers.

These findings have a number of implications for policy. As Haque et al (1993) argue "...the existence of capital mobility, for example, aggravates the destabilising potential of exchange rate overvaluation, and thus emphasises the importance of avoiding exchange rate misalignment. At the same time, it underlines the futility of financial repression as a means of keeping domestic interest rates low to stimulate investment."(Haque et al 1993 p.353). However, while correction of an existing exchange rate misalignment will move the economy in the right direction, we should note that this will only happen slowly due to the satisfaction of the Marshall-Lerner

condition in the long-run and the sustained balance of payments deficit. Therefore complementary demand management policies are needed to correct external balances in the short-run.

Finally, it will be noted that although estimation of the parameters of a model are useful in indicating how it fits diverse circumstances, this is only an intermediate step in assessing the value of the model for policy-making purpose. If the multipliers linking endogenous variables with the policy instruments are very sensitive to changes in the parameters, the robustness of the model and the degree of precision in forecasting with the model will be low. To assess the usefulness of the model estimated above we could investigate two types of issues: (i), whether the key parameters of the structural model are stable through the time, and (ii), how sensitive the policy implications are to changes in the parameters. We will address these issues in the next chapters of this thesis. In Chapter V structural stability of the model is examined through the application of standard Chow tests to the main behavioural equations of the model; and the implication of impact policy analysis are discussed. In chapter VI we simulate the model dynamically to investigate its dynamic stability and the associated policy implications.

Appendix 4.A

Data used in this study are taken from International Monetary Fund, *International Statistics (IFS)* and the *World Economic Outlooks* and are annual, covering the period 1959-1992. All stock data are measured at the end of the period and the price data are period average. The definition of variables and the IMF line number are as follows:

P= Consumer price index 1985=100 (line 64)

Fr=Net international reserves (line 1ld)

G= Real total expenditure of government (line 82)

Y= Real gross domestic product in 1985 price (line 99a)

Dc= Net domestic credit of consolidated banking system (line 32)

M= Money supply, M2, as foreign reserved valued in domestic currency plus domestic credit (line 32)

X= real export of goods and services (line 90c divided by P)

Z= Real imports of goods and services (line 98c divided by P)

C=Real private consumption expenditure (line 96f divided by P)

Gc= Real government consumption expenditure (line 91f divided by p)

Gi= Real government development expenditure (line 82 minus line 91f divided by P)

Pi= Real private investment expenditure (line 93I minus Gi divided by P)

Ti= total investment (line 93c divided by P)

Nft= Net factor income from abroad (line 98.n, nominal)

Ca= Current account (line 73. ad multiplied by line ae)

Bop= Net surplus balance of payments (line 78.d)

Dc= domestic credit (line 32)

Dcg= Domestic credit extended to the public sector (line 32 an)

Dcp= Domestic credit extended to the private sector (line 32d)

P*= World price index (line 001)

i*= International interest rate (IMF Year book)

Y*= OECD GdP in 1985 price

Chapter V

Structural Stability and Policy Analysis in the Short-run

5.1 The Structural Stability

5.1.1 Introduction

A basic assumption of the model studied in the previous chapter was that the parameter vector did not vary across the sample of observations. That is the parameter vector was the same for all observations in the sample. However, if we are able to reject the hypothesis that the location parameters were constant for all observations then the OLS or 2SLS estimators *would not have the desired* properties. The relevant tests of equality between subsets of coefficients in two or more linear regression models, first discussed in Rao (1952), are usually referred to as the Chow tests (1960).

5.1.2 The Main Purpose of the Structural Stability Tests

The most common use for structural stability tests is as a general test of specification, because rejection of coefficient constancy constitutes evidence against the specification of the estimated model. Alternatively, it may be intended to use the model for forecasting, and the confidence which with the forecast are

regarded will be related to how stable the relation is over the sample data available (Pesaran et al (1985)).

Thus, testing for the structural stability of the macro economic model developed and estimated in the previous chapters serves the following purposes: first, it provides information on whether or not the model is correctly specified. This is important because our analysis of the economy's characteristics was based on the estimated coefficients of the behavioural equations. Second, given the structural stability of the model, it is possible to derive the IS-LM curves of the model which can then be used for the short-run impact multiplier and policy analysis of the economic system. Finally, structural stability of the model suggests that the model may be useful for the purpose of prediction. For the dynamic simulation of the model, presented in chapter VI of this thesis and utilised to analyse the transmission mechanisms of policy changes in the economic system, it is necessary to have established that the structural parameters of the model remain invariant for the entire sample period.

5.1.3 Tests for the Structural Stability

To test the hypothesis of parameter constancy or structural stability of the regression models, some tests have been proposed. These tests can be described as (i) the analysis of variance tests, and (ii) the prediction tests. The first category examines whether the regression coefficients differ between sub-samples. However, economists have also been concerned with the slightly different question of whether an estimated model performs well outside the period over which it was estimated. The prediction tests deal with this latter question. In

deriving these tests, usual assumptions for linear regression models are made. These assumptions include: non-stochastic regressors, linearity, independence and normality of the disturbances with zero mean and constant variance. These assumptions may well not hold in practice so Chow tests are conditional on the model first passing other diagnostic tests. In general where the tests are applied using an inappropriate estimator for the coefficient, their performance would be poor. For example, this is illustrated for the analysis of variance tests when the errors are serially correlated (see Pesaran et al (1985)). It should be noted that the tests on variance equality are much more sensitive to the failure of the normality assumption than the tests on coefficient equality (Scheffe (1959)).

Dummy variables can also be used to test for stability of regression coefficients. The definition of the appropriate dummy variables depends on whether we are using the analysis of variance test or the predictive test for stability. Some have argued in favour of using dummy variables in preference to the Chow's tests (see Maddala 1992, ch. 8). However, one should be cautious in making inferences about the stability of coefficients by looking at the t-ratios of the dummy variables alone. It is possible that the F-ratio for the entire set of coefficients is significant and still the t-ratios for each of a set of coefficients are insignificant. What one should do in any particular example is to use the F-tests and then use the t-tests on individual dummy variables only if they correspond to economically meaningful hypotheses (see Madalla, (1992)).

Pesaran et al (1985) generalise the likelihood ratio test of structural stability to simultaneous equations systems and non-linear models. According to them, the necessary condition for this is "that the maximum likelihood estimator can

be obtained and usual regularity conditions, which ensure their optimality properties are satisfied" (Pesaran et al (1985) P. 290). However, the computation of these test statistics may be quite involved and very much depends on the particular stability hypothesis to be tested. Anderson and Mizon (1983) give specific expressions for Wald and Lagrange multiplier versions of this likelihood ratio tests to provide a joint test of all parameters in the context of simultaneous equation models. Pagan and Nicholls (1984) report tests suitable for linear simultaneous equation models as well as dynamic models. Models with lagged dependent variables raise a variety of different problems. For example, whereas with a static model it may be quite legitimate to examine whether a model will "backcast" as well as "forecast" well, this is not so in a model with a lagged dependent variable. The prediction failure tests (Chow's second test) when used in the case of model with lagged dependent variables, generally tests for one step ahead predictive performance (see Pesaran et al (1985)).

Given a decision to employ stability tests the question arises how to split the sample period. In general the points at which it is thought most likely that the relationship changed should be chosen to split the sample into sub-periods. This judgement may be based on a change in the pattern of the data series or on institutional or theoretical information. In this study, in which the Iranian economy's time series is used for the estimation of a macroeconometric model, for reasons discussed in previous chapters, mainly referred to dramatic changes in socio-economic environment of the country following the 1979 revolution, we decided to split the sample period into two sub-periods (1959-79) and (1980-1991).

In what follows structural parameter constancy is tested between the sub-periods (1959-79) and (1980-91) for the main behavioural; equations of the model estimated in chapter IV. These equations explain aggregate consumption (C_t), private investment (P_t), aggregate supply(Y_t), and the real demand for money (M/P_t).

Chow's first test, known as the analysis of variance test in the literature, is given as:

$$(5.1).....F_{a.v.} = \frac{(\hat{e}'\hat{e} - (\hat{e}'_1\hat{e}_1 + \hat{e}'_2\hat{e}_2)) / (k + 1)}{(\hat{e}'_1\hat{e}_1 + \hat{e}'_2\hat{e}_2) / (n_1 + n_2 - 2k - 2)}$$

which is distributed as F(k+1, n₁+n₂-2-2k). In (5.1) $\hat{e}'\hat{e}$ is the residual sum of squares for the whole period while $\hat{e}'_1\hat{e}_1$ is residual sum of squares for the first sub-period and $\hat{e}'_2\hat{e}_2$ for the second period. k is the number of the explanatory variables of the regression and n_i i=1,2 denotes number of observations for the sub-periods. The number n-2k-2 therefore, refers to the degree of freedom (d.f.). Let RSS₁ and RSS₂ be the residual sum of squares from the two separate regressions and RRSS be the residual sum of squares from the pooled regression (it is called 'restricted' because of the restriction $\beta_1=\beta_2$). If we show (RSS₁ +RSS₂) by URSS (unrestricted residual sum of squares) and n=n₁+n₂, the analysis of variance test can be shown as:

$$(5.1').....F_{a.v.}=[(RRSS-URSS)/(k+1)]/[URSS/(n-2k-2)]$$

Chow's second test, also known as the predictive failure test or the predictive test for stability is given as:

$$(5.2).....F_{p.f.} = \frac{(\hat{e}' \cdot \hat{e} - \hat{e}'_1 \cdot \hat{e}_1) / n_2}{\hat{e}'_1 \cdot \hat{e}_1 / (n_1 - k - 1)}$$

which has an F-distribution with d.f. n_2 and n_1-k-1 , where k is the number of the explanatory variables. This test was intended for testing the hypothesis of coefficient equality when there were insufficient degrees of freedom in the second period. However, it should be noted that $F_{p.f.}$ in equation (5.2) is not just a test of coefficient equality for these cases and can be applied to test the structural stability of the model what ever the degree of freedom is in the second period. Again letting $RSS_1 = \hat{e}'_1 \cdot \hat{e}_1$ and $RSS = \hat{e}' \cdot \hat{e}$ we have:

$$(5.2').....F_{p.f.} = [(RSS - RSS_1) / n_2] / [RSS_1 / (n_1 - k - 1)]$$

5.1.4 Application of the Chow's tests

We now use Chow's first and second tests to establish the structural stability of the main behavioural equations of the model estimated by 2SLS method. We have summarised the tests results in table (5.1). Details of calculation are given in appendix (5.A1) at the end of this chapter.

These results clearly support the hypotheses that the parameters of the main behavioural equations of the model have been stable in the time period (1959-91). On the basis of Chow's both first and second test structural stability of the consumption function, private investment and the real demand for money in the

sample period 1959-91 cannot be rejected at the 5 percent level of significance. With respect to aggregate production function the results are mixed. For the production function in

Table 5.1 Summary of the results of Application of the Chow tests

| | First test (analysis of variance test) | | | Second test (prediction test) | | |
|--|---|-----------------------------|-------------------------------|----------------------------------|-----------------------------|--------------------------------|
| | (d.f.) | critical value of F-test | value of F in the model | (d.f.) | critical value of F test | value of. F in the model |
| Consumption function | | | | | | |
| logC | (3,26) | 2.38 | 1.04 | (12,17) | 2.95 | 1.05 |
| Private investment | | | | | | |
| logPi | (5,22) | 2.66 | 0.39 | (12,15) | 2.48 | 0.53 |
| Aggregate supply | | | | | | |
| LogY | (4,24) | 2.78 | 3.6 | (12,16) | 2.42 | 1.67 |
| Aggregate supply in per labour form | | | | | | |
| log(Y/L) | (5,21) | 2.68 | 0.655 | (13,13) | 2.58 | 1.28 |
| Money demand | | | | | | |
| log(M/P) | (5,21) | 2.68 | 1.33 | (11,11) | 2.50 | 0.69 |

non-per labour form, analysis of variance test fails to satisfy at 5 percent level, while the prediction test comes up in favour of parameter constancy of this regression. Regarding the relative power of the two tests this may lead to the interpretation that the aggregate production function in non pre labour form is either misspecified or is the subject of a structural shift. However, as the results presented in table (5.1) indicate both Chow's tests for aggregate production function in per-labour form are satisfied at the 5 percent level of significance. In chapter IV we found empirical evidence supportive of constant return to scale for the aggregate production function in the model. Regarding the Chow tests results of table (5.1) we have used estimated per-labour form production

function in our impact multiplier analysis of the model in the next section of this chapter and dynamic simulation of the macroeconomic model presented in chapter VI for policy simulation purpose.

The prediction failure test was satisfied at 5% level of significance for all four regressions. The prediction failure test is a powerful test against a very broad class of specification errors and, therefore, indicates that the model developed and estimated in this study is correctly specified. It goes without saying that the structural stability of a macroeconomic model is an important aspect of its reliability as it is widely believed that the structural parameters of the economy are stable. Any structural analysis of the economy relies on the estimated parameters without which this interpretation may appear baseless. In the next part of this chapter we use the estimated model to analyse its policy implications for the economy in the short -run equilibrium.

5.2 The IS-LM Paradigm and Policy Implications of the Model in Short-run

5.2.1 Introduction

Having established the structural stability of the model we now explore the structure of the model through the determination of short-run equilibrium conditional on the expected values of the exchange rate and the price level one period ahead. The dynamics of the model in the longer-term is examined in the chapter VI.

On the most general level, the credibility of an empirical model is dependent on a showing that its major features are consistent with mainline theory, and the

latter is usually formulated in the IS-LM-BP terms for the analysis of stabilisation policy and in aggregate demand-aggregate supply, AD-AS terms for the analysis of the macroeconomic effects of supply shocks. For non-economist observers an econometric model may seem a complicated structure that cannot be understood because of its large and intricate nature. It is accordingly appropriate to analyse basic properties of an econometric model in these highly simplified and aggregate terms as a first step in model verification.

It is well known that establishing the elasticity of IS, LM and BP curves provides basic information about the predicted outcome of fiscal and monetary policies in a given model. The combination of inelastic LM and elastic IS implies fiscal crowding out and potent monetary policy, whereas elastic LM and inelastic IS lead to potent fiscal and weak monetary effects. Estimation of these locuses therefore provides a useful diagnostic tool for characterising these policy responses in a given model. This may direct attention to particular equations or parameters in one or other sector in need for further examination and testing. An attractive feature of the IS-LM-BP framework is that it can be used to perform qualitative comparative static analysis in which the economic model is shocked in such a way so as to induce a shift in either the IS or LM curve or both and the resulting equilibrium is then determined (see Klein et al (1991)).

In what follows the IS-LM-BP curves of the model are derived using the estimated behavioural equations of the model summarised in table (4.5). The estimated parameters determine the slopes of the IS-LM-BP curves. With structural stability of the model, concluded from the previous section, it is assumed that these slopes remain stable throughout the policy examination.

5.2.2 The IS curve

To derive the IS curve we substitute for consumption function (C_t), private investment (P_{it}), export (foreign) demand (X_t) and import demand (Z_t) in the goods market equilibrium condition. For the consumption function we had the following estimated result:

$$(4.43) \dots \log C_t = .13 - .02r_t + .39 \log C_{t-1} + .58 \log Y_{dt}$$

where r is the real rate of interest and Y_d denotes the disposable income of the private sector. Y_d or the disposable income was defined as:

$$(4.4) \dots Y_{dt} = Y_t + ((i_t^* \cdot e_t \cdot F_{pt}) / P_t) - ((i_{bt} \cdot D_{cpt-1}) / P_t) - D_{tax_t}$$

where i_t^* is the international interest rate, e_t is the nominal exchange rate, F_{pt} represents foreign assets held by private sector, i_{bt} denotes the formal domestic interest rate charged by the banking system, D_{cpt} stands for the domestic credit extended to the private sector, and P_t and D_{tax_t} are price level (consumer price index) and direct tax respectively. In order to substitute for Y_{dt} in the estimated consumption function (eq. (4.43)), Y_{dt} has to be expressed in log form. Taking logarithms of the disposable income identity (eq. (4.4)) and expanding it about the sample means gives the following approximation of this relationship:

$$(5.3) \dots \log Y_{dt} = \log 2 + .25 \log Y_t + .25 \log (i_t^* \cdot e_t \cdot F_{pt} / P_t) - .25 \log (i_{bt} \cdot D_{cpt-1} / P_t) - .25 \log D_{tax_t}$$

Substituting from (5.3) for $\log Y_d$ into the estimated consumption function (eq.(4.34)) we have:

$$(5.4) \dots \log C_t = .13 - .02r_t + .39 \log C_{t-1} + .58 [\log 2 + .25 \log Y_t + .25 \log (i_t \cdot e_t \cdot F_{pt}) / P_t] - .25 \log (i_t \cdot D_{cpt-1} / P_t) - .25 \log D_{tax_t}$$

For the purpose of substitution in the goods market equilibrium condition, above consumption function as well as the estimated equation for private investment, export demand and import demand, which all are in log linear form, this identity also should be transformed into the log linear form. Approximating this identity the following expression is obtained:

$$(5.5) \dots \log Y_t = 2.25 \log 2 + .125 \log C_t + .125 \log P_t + .25 \log G_t + .25 \log X_t - .25 \log Z_t$$

Substituting for $\log C_t$ from equation (5.4) and estimated versions of $\log P_t$, $\log X_t$ and $\log Z_t$ from table (4.5), in the previous chapter, in equation (5.5) and rearranging for $\log P_t$ we arrive at the following aggregate demand function:

$$(5.6) \dots \log P_t = [-8.5 + .20 \log C_{t-1} - .07 \log ((i_t \cdot e_t \cdot F_{pt}) / P_t) - .07 \log (i_t \cdot D_{cpt-1} / P_t) + .76 \log K_{t-1} - .5 \log (D_{cpt-1} / P_{t-1}) + .68 \log X_{t-1} + 1.7 \log Y_{t-1} - .11 \log F_{rt-1} + .11 \log P_{t-1} - .11 \log e_{t-1} - .5 \log Z_{t-1}] + [.95 \log Y_t^* + 1.01 \log P_t^* - .3 \text{Dum} + 1.01 \log e_t + 1.06 \log G_t + .21 \log G_{it} - .08 \log T_t - .029 i_t + .029 \log EP_{t+1} - 5.9 \log Y_t]$$

Assuming all the other variables remain constant in the short-run we would have a downward curve in (P, Y) space for the aggregate demand. It will be noted that the equation of the aggregate demand takes the form:

$$(5.7) \dots P_t = p(i_t, EP_{t+1}, G_t, T_t, P_t^*, \dots)$$

$$(-) \quad (+) \quad (+) \quad (-) \quad (+)$$

which gives the model a fairly standard IS curve with the domestic price level expressed as a function of the nominal interest rate (i_t), the price level expected next period (EP_{t+1}) and exogenous variables such as government spending (G_t), taxation (T_t) as well as predetermined variables. Assuming goods market equilibrium and assuming the price level remains constant in the short-run, with output and interest rate as the main variables of the system, rearranging equation (5.6) for interest rate (i_t) we obtain:

$$(5.8) \dots i_t = [-293.1 + 6.9 \log C_{t-1} - 2.4 \log((i_t^* \cdot e_t \cdot F_{pt})/P_t) - 2.4 \log(i_t \cdot D_{cpt-1}/P_t) + 26.2 \log K_{t-1} - 17.2 \log(D_{cpt-1}/P_{t-1}) + 23.4 \log X_{t-1} + 58.6 \log Y_{t-1} - 3.8 \log Fr_{t-1} + 3.8 \log P_{t-1} - 3.8 \log e_{t-1} - 17.2 \log Z_{t-1}] + [32.7 \log Y_t^* + 34.8 \log P_t^* - 10.3 \text{Dum} + 34.8 \log e_t + 36.5 \log G_t + 7.2 \log G_{it} - 2.7 \log D_{tax_t} + \log EP_{t+1} - 34.5 \log P_t - 203.4 \log Y_t]$$

which gives a rather steep IS curve.

The interest insensitive of the IS curve that we are concerned with here, may fail the Keynesian effect. It is argued, that although the increase in real money balance through the Keynesian effect brings a fall in the interest rate, expenditure does not respond, leaving aggregate demand insufficient. Considering real wealth as a determinant of expenditure (through the Pigou or real balance effect) could ensure that even in the two Keynesian limiting cases, the macroeconomic system will attain full employment equilibrium. The particular version of the wealth effect, proposed by Patinkin (1965), argues that

if wealth include the real money balances, expenditure may depend on wealth, and thus real balances. Therefore, a wealth effect provides an additional mechanism whereby the economy could return to the equilibrium following a fall in aggregate demand.

The relevance of this argument to our case is that on the one hand we have derived a rather steep IS curve that renders expenditure insensitive to change in the price level in the absence of the Pigou effect. But on the other hand, in versions of the estimated consumption function (equation (4.40)) we find a significant and positive real-cash balance effect on the aggregate consumption function that could be interpreted as the Pigovian effect on the private expenditure (see Morishima (1972)). Therefore, although the aggregate demand curve derived from the estimated model turns out to be rather vertical, however, on the basis of the estimated consumption function we can come to conclusion that assuming an increasing aggregate supply curve this ensures that the economy will settle at full employment.

5.2.2 The LM Curve

To derive the LM portion of the model we use the “shadow” money (eq. (4.26)) and the “shadow” interest rate (eq. (4.29)) relationships. Substituting the balance of payments relationship into the foreign exchange reserves identity we obtain:

$$(5.9)... Fr_t = Fr_{t-1} + [(1/e_t).Ca_t - (\Delta Fp_t + \Delta Fg_t)]$$

where all the variables are defined as before. Fr_t is foreign exchange reserves, e_t is the nominal exchange rate, Ca_t denotes current account of the balance of payments and ΔFp_t and ΔFg_t are the rate of change of foreign assets held by the private and public sector respectively. The shadow money balance ($\tilde{M}_t = M_t + e_t \cdot \Delta Fp_t$) can be written as:

$$(5.10) \dots \tilde{M}_t = Dc_t + e_t \cdot Fr_t + e_t \cdot \Delta Fp_t$$

Substituting from (5.9) for Fr into the above equation we have:

$$(5.11) \dots \tilde{M}_t = Dc_t + e_t \cdot [Fr_{t-1} + (1/e_t) Ca_t - \Delta Fg_t]$$

Approximating this equation about the sample means and rearranging the variables yields:

$$(5.12) \dots \tilde{M}_t = 2\log 2 + .25\log Dc_t + .25\log Ca_t + .5\log e_t + .25\log Fr_{t-1} - .25\log Fg_t$$

The only endogenous variable in this equation is the current account of the balance of payments (Ca_t). To eliminate this variable from the equation we have to write the current account's relationship in log linear form. We, therefore, approximate the Current account identity (4.13) about the sample means which gives a log linear relationship for $\log Ca_t$ as a function of $\log X_t$, $\log Z_t$, $\log P_t$, $\log e_t$, $\log i_t^*$, $\log Fr_{t-1}$, $\log Fg_{t-1}$ and $\log Fp_{t-1}$. Substituting from the estimated regression of the demand for exports ($\log x$) and the demand for imports ($\log z$), (summarised in

table (4.5)) into the current account equation and then the result for $\log Ca_t$ back in equation (5.12) and rearranging the equation gives an expression for the real “shadow” money balance as follows:

$$(5.13) \dots \log \frac{\tilde{M}_t}{P_t} = [1.078 + .04 \log X_{t-1} + .05 \log Y_{t-1} - .003 \log P_{t-1} - .015 \log Z_{t-1} - .003 \log e_{t-1} + .307 \log Fr_{t-1} + .03 \log Fp_{t-1} + .03 \log Fg_{t-1}] + [.68 \log e_t + .25 \log Dc_t + .06 \log P_t^* + .056 \log Y_t^* - .05 \text{Dum} - .935 \log P_t - .065 \log Y_t + .125 \log i_t^* - .25 \log \Delta Fg_t]$$

To eliminate the real “shadow” money balance from the above expression recall that we had derived the following equation for the “shadow” interest rate (\tilde{i}_t):

$$(4.28) \dots \tilde{i}_t = -\frac{b_0}{b_1} - \frac{b_2}{b_1} \log Y_t - \frac{(1-\lambda)}{\lambda \beta_1} \log \left(\frac{\tilde{M}_{t-1}}{P_{t-1}} \right) + \frac{1}{\lambda \beta_1} \log \left(\frac{\tilde{M}_t}{P_t} \right)$$

where the “shadow” money balance (\tilde{M}_t) in the model is defined as ($\tilde{M}_t = M_t + e_t \Delta Fp_t$). In the previous chapter estimation of the demand for money function provided us with the values of the structural parameters ($\beta_i, i = 0, 1, 2$) as well as λ and ϕ . These values were $\beta_0 = -2.9, \beta_1 = -.005, \beta_2 = .53, \lambda = .48$ and $\phi = .62$.

Substituting from equation (5.13) for $\left(\log \left(\frac{\tilde{M}_t}{P_t} \right) \right)$ into the estimated form of the

“shadow” interest rate (\tilde{i}_t , eq. (4.28)) and rearranging the equation we arrive at the following expression for the “shadow” interest rate:

$$(5.14)... \tilde{i}_t = [-1028.4 + 216 \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right) - 16.6 \log X_{t-1} - 20.8 \log Y_{t-1} - 1.25 \log\left(\frac{P_{t-1}}{e_{t-1}}\right) + 6.24 \log Z_{t-1} - 127.7 \log Fr_{t-1} - 12.5 \log Fp_{t-1} - 12.5 \log Fg_{t-1}] + [-283 \log e_t - 25 \log P_t^* - 104 \log Dc_t - 23.3 \log Y_t^* + 12.5 \text{Dum} + 389 \log P_t + 133.04 \log Y_t - 52 \log i_t^* + 104 \log \Delta Fg_t]$$

which express the nominal “shadow” interest rate as a function of the price level, exchange rate and domestic credit:

$$(5.15)... \tilde{i}_t = i(P_t; Dc_t, e_t, \Delta Fg_t, \dots)$$

$$(+)\quad (-)\quad (-)\quad (+)$$

Assuming that money market is in equilibrium we can derive the models LM curve from the above relationship (5.14). The monetary aggregated controlled by the authorities in this setting is the stock of domestic credit (Dc_t). The shadow interest rate depends on credit policy, government external borrowing, the exchange rate policy, the current account outcome and money demand variables.

Substituting for the “shadow” interest rate from the above equation (5.15) into the domestic market determined interest rate relationship in the model [i.e.

$$i_t = \phi(i_t^* + \frac{Ee_{t+1} - e_t}{e_t}) + (1 - \phi)\tilde{i}_t] \text{ yields:}$$

$$(5.16)... i_t = [-390.1 + 82. \log\left(\frac{\tilde{M}_{t-1}}{P_{t-1}}\right) - 6.3 \log X_{t-1} - 8 \log Y_{t-1} - 1.25 \log\left(\frac{P_{t-1}}{e_{t-1}}\right) + 2.4 \log Z_{t-1} - 48.5 \log Fr_{t-1} - 4.75 \log Fp_{t-1} - 4.75 \log Fg_{t-1}] + [-1081.6 \log e_t - 9.5 \log P_t^* - 39.5 \log Dc_t - 8.8 \log Y_t^* + 4.75 \text{Dum} + 147.8 \log P_t + 50.5. \log Y_t - 19.7 \log i_t^* + 39.5 \log \Delta Fg_t + 0.62 i_t^* + 0.62 \log Ee_{t+1}]$$

This gives the domestic market determined interest rate as a function of the domestic price level, domestic credit, and other exogenous and predetermined variables and represents the models LM curve.

$$(5.17) \dots i_t = i(P_t; D_{ct}, i_t^*, E(e_{t+1}), \dots)$$

$$(+)\quad (-)\quad (-)\quad (+)$$

Assuming fix-price level in the short-run, a rather steep LM curve from equation (5.35) can be drawn which is relevant at the point of the sample mean and neighbourhood of that point.

In the IS-LM framework the effectiveness of monetary policy in affecting aggregate demand is determined by the slopes of the IS and LM curves. Monetarist optimism about the effectiveness of monetary policy is frequently represented by a steep LM curve and a flat IS curve. With an interest -inelastic demand for money and interest-sensitive expenditure, changes in the money stock exert a strong influence on aggregate demand. The textbook Keynesian doubt about the efficacy of monetary policy are presented by changing the relative slopes of the two curves. In this case, increasing the money stock has little effect since the interest -elastic demand for money function underlying the flat LM curve ensures that changes in the money stock generates only small changes in the interest rate while these changes in turn exert little impact on aggregate demand due to the interest -inelastic investment function underlying the steep IS curve.

In our case, however, while the IS curve has larger slope compared to the LM curve, but both IS and LM curves appear to be quite steep indicating the

underlying interest -inelastic expenditure and demand for money function in this economy. We therefore do not appear to have either the monetarist or the Keynesian extreme cases in our empirical study of the Iranian economy. The IS-LM slopes give the impression that the monetary policy in this economy is impotent in affecting the real income in equilibrium level. It will be noted that while unlike the monetary approach, in which domestic monetary policy is impotent, in the Mundell-Fleming model, from which our model has its main characteristics, monetary policy exerts some influence on equilibrium income. However, the same result can be obtained from a Mundell-Fleming model assuming zero sterilisation. Because an increase in the money stock will increase real income and reduce the domestic interest rate while the balance of payments remains in deficit. Balance of payments deficit in longer term in turn reduces the money stock returning the variables to their original values. On the other hand, considering the wealth effect it could be argued that a more accurate presentation of the monetarist mechanism would involve a simultaneous rightward shift of IS. reflecting a direct wealth effect on expenditure. We mentioned the evidence of the wealth effect in our estimated consumption function earlier. Since there has been no extensive use of open market operations in this economy, the government's ability to sterilise balance of payments changes on the money supply is also limited, leaving some doubt about the exact effect of the monetary policy on the real income in the Iranian economy.

A potential crowding-out mechanism works through the general price level. If an increase in public sector expenditure generate a rise in prices the real money stock is reduced, increasing interest rates and reducing wealth, both of

which tend to reduce private expenditure. For complete crowding out to take place through this mechanism, however, the economy must be at full employment. This is because an increase in real government expenditure at full employment must be associated with a fall in real private expenditure.

5.2.3 The External Balance (the BP Schedule)

As a flex-price version of the Mundell-Fleming model, our model incorporates the external sector of the economy and we now turn to the short-run equilibrium condition of the external sector of the model. It should be noted that the principal purpose of the Mundell-Fleming models is to demonstrate how domestic monetary and fiscal policies can be manipulated to secure internal and external objectives simultaneously.

To derive a BP schedule for the model we use the balance of payments identity [i.e. $Bop_t = \Delta Fr_t = (1/e_t) \cdot Ca_t - (\Delta Fp_t + \Delta Fg_t)$], where, as before, Fr is foreign exchange reserves, Ca is the current account of the balance of payments and Fp and Fg are foreign asset holdings of the private and public sector respectively. Substituting for Ca , from the current account identity [i.e. $Ca_t = Nft_t + Pt(Y_t - Da_t)$], where Nft is net factor income from abroad and Da is the domestic absorption], into the balance of payments relationship we obtain :

$$(5.18) \dots \Delta Fr_t = (1/e_t) \cdot (Nft_t + P_t(Y_t - Da_t)) - (\Delta Fp_t + \Delta Fg_t)$$

Substituting from the above relationship for ΔFr_t in the economy's foreign exchange reserves identity ($Fr_t = \Delta Fr_t + Fr_{t-1}$) and the result into the balance sheet identity ($M_t = Dc_t + e_t Fr_t$) we arrive at:

$$(5.19) \dots M_t = Dc_t + e_t Fr_{t-1} + Nft_t + P_t(Y_t - Da_t) - e_t (\Delta Fp_t + \Delta Fg_t)$$

To linearise the above equation we approximate it about the sample mean which gives a relationship as follows:

$$(5.20) \dots \log(M_t / P_t) = 2.5 \log 2 + .125 \log Dc_t - .25 \log e_t + .25 \log Fr_{t-1} + .125 \log Nft_t \\ + .125 \log Y_t - \log P_t - .125 \log Da_t - .125 \log(\Delta Fp_t) - .12 \log(\Delta Fg_t)$$

Furthermore, substituting for $\log(M_t / P_t)$ from the above equation into the estimated money market equilibrium condition (i.e. the real demand for money function eq.(4.73)) and rearranging the equation we have:

$$(5.21) \dots \log(\Delta Fp_t) = [12.5 - 6.6 \log P_{t-1} - 7.4 \log(M_{t-1} / P_{t-1}) + 2 \log Fr_{t-1}] + [\log Nft_t \\ - 2 \log e_t + \log Dc_t - .92 \log Y_t - 1.4 \log P_t - \log Da_t - \log(\Delta Fg_t) + .04 i_t]$$

With proper substitution for Nft_t and Da_t (the remaining endogenous variables in the equation) we can obtain a semi-reduced form equation for $\log(\Delta Fp_t)$ as follows:

$$(5.22) \dots \log(\Delta Fp_t) = [7.9 - 6.6 \log P_{t-1} - 7.4 \log(M_{t-1} / P_{t-1}) + 2.5 \log Fr_{t-1} + .25 \log Fp_{t-1} \\ + .25 \log Fg_{t-1} - .8 \log Y_{t-1} - .055 \log P_{t-1} - .23 \log Z_{t-1} + .32 \log X_{t-1}] + \\ [-.52 \log e_t - .48 \log P_t + \log Dc_t - 2.4 \log Y_t - 1.8 \log P_t - \log(\Delta Fg_t) \\ + .45 \log Y_t - .12 Dum + .04 i_t]$$

Therefore, changes in private sector holdings of foreign assets is expressed as a function of the interest rate (i_t), the price level (P_t) and other predetermined and exogenous variables, taking the form:

$$(5.23) \dots \Delta F_{pt} = F(i_t; P_t, D_{ct}, \dots)$$

(+) (-) (+)

This equation (eq. (5.23)) determines the magnitude of private capital flows. This latter variable is essentially a policy reaction function which gives magnitudes of capital outflows permitted by the authorities as a function of domestic and external variables affecting the degree of tightness in domestic financial markets (see Haque et al (1993)).

If we assume ΔF_p is an exogenous variable, rearranging equation (5.22) for i_t gives the models BP schedule as follows:

$$(5.24) \dots i_t = [-197.5 + 165 \log P_{t-1} + 185 \log (M_{t-1} / P_{t-1}) - 62.5 \log F_{r,t-1} - 6.25 \log F_{p,t-1} - 6.25 \log F_{g,t-1} + 20 \log Y_{t-1} + 1.37 \log P_{t-1}^* + 5.75 \log Z_{t-1} - 8 \log X_{t-1}] + [13 \log e_t + 12 \log P_t^* - 25 \log D_{ct} + 60 \log Y_t + 45 \log P_t + 25 \log (\Delta F_{gt}) + 25 \log (\Delta F_{pt}) - 11.25 \log Y_t^* + 3 \text{Dum}]$$

Assuming a fix-price condition in the short-run, we have a BP schedule with a larger slope compared to that of the LM.

The BP curve's positive slopes asserts our finding of some degree of interest sensitivity of the capital movements in the economy. Otherwise we would have evidence of a vertical BP line indicating capital immobility. The importance of this point is that in a Mundell-Fleming model, the result that internal and

external objectives can be achieved by the appropriate fiscal -monetary mix relies upon at least some degree of interest-sensitivity of capitals mobility. In what follows we briefly discuss the policy implication of the model in the short-run equilibrium condition.

5.2.4 Internal and External Balance and the Fiscal-Monetary Mix

As was noted above the key result from the Mundell-Fleming model is that it provides a solution to the problem of securing simultaneously internal and external balances, solely by means of the appropriate mix of monetary and fiscal policies and without recourse to other balance of payments policies. For example, starting from a position of external balance with domestic unemployment in figure (5.1) at Y_1 we note that as long as there is a degree of capital mobility, the IS and LM curves can be shifted by means of fiscal policy and monetary policy respectively so as to secure full employment while preserving external balance. One question which might arise here is whether a situation in which the current account is in continual deficit and the capital account is in surplus constitutes external equilibrium. On the other hand we may note that a country running a sustained current account deficit may be regarded, in international capital market markets as being diminishingly credit-worthy and therefore the capital account surplus required for overall external balance may only be secured at progressively higher domestic interest rates.

It is also worth noting that we have not taken account of the monetary consequences of the balance of payments. In other words it has been implicitly assumed that the monetary effects of the balance of payments are sterilised.

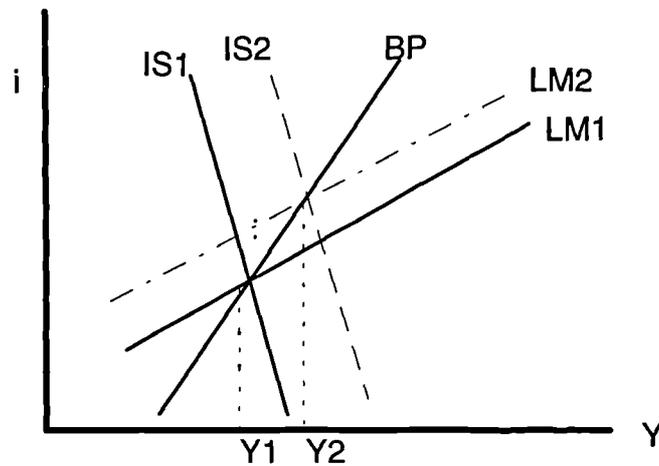


Figure 5.1 Internal and External Balance

From the structural model set out in table (4.1) we recall that a change in the money stock can be shown as:

$$(5.25) \dots \Delta M_t = \Delta D_{ct} + e_t \Delta F_{rt} + \Delta e_t \cdot F_{rt}$$

Where M is nominal money supply and D_c is domestic credit. F_r is foreign exchange reserves and e_t is the nominal exchange rate. Assuming a fixed exchange rate, $\Delta e_t = 0$, from equation (5.44) it is obvious that a net surplus or deficit in the balance of payments ($Bop_t = \Delta F_{rt}$) changes the domestic money stock, other things remaining unchanged. Of course the government may seek to change the fiscal deficit, domestic bond sales or bank lending in order to offset the balance of payments effects on the money stock. However, one might question the government's ability to offset the monetary consequences of a balance of payments surplus or deficit in the short-run. Clearly the extent of this impact will depend on the slope of the BP curve, being more significant the

greater is the interest sensitive of the capital account. In the macroeconomic model developed and estimated here the BP line is steeper than the LM curve and therefore (given the economy is an open economy) from the above discussion we can conclude that in this economy fiscal policy appears to be more effective than monetary policy except in the limiting case of zero capital mobility.

5.2.5 Price Flexibility

So far in our analysis of IS-LM -BP curves of the model , the price level is assumed constant. Because the model is an open economy model the consequence of changes in the domestic price level stem from the presence of the international relative price term (e. P_t^*/P_t), in both the IS and BP curves. An increasing domestic price level reduces competitiveness and therefore net exports, shifting the IS curve to the left. Similarly, an increase in the domestic price level means that a given real income level is associated with a larger current account deficit, requiring a greater capital inflow and therefore a higher interest rate to offset it, shifting the BP line to the left. We assume an upward sloping aggregate curve and therefore the price and real income effects operate in the same direction.

Suppose the monetary authorities increase the domestic money stock. Considering the policy change effect in Figure(5.2) this will shift the aggregate demand curve to right, increasing the income level to Y_2 and the price level to P_2 . In IS-LM space this summarises three separate effects. First the nominal money stock increase shifts the LM curve to the right. Second, the increase in the price level reduces the money stock dampening the rightward shift in the LM. These two effects taken together shift the LM curve to LM_2 . Third, the rise in price level

reduces ($e_t \cdot P_t^*/P_t$) and therefore competitiveness declines shifting the IS curve to the left to IS_2 . In addition, however, the fall in ($e_t \cdot P_t^*/P_t$) has also shifted BP line to the left, to BP_2 since decreased competitiveness dictates that for a given interest rate external balance now requires a lower domestic income. The relative size of the external deficit is unclear and depends on the relative price and income effects on net exports.

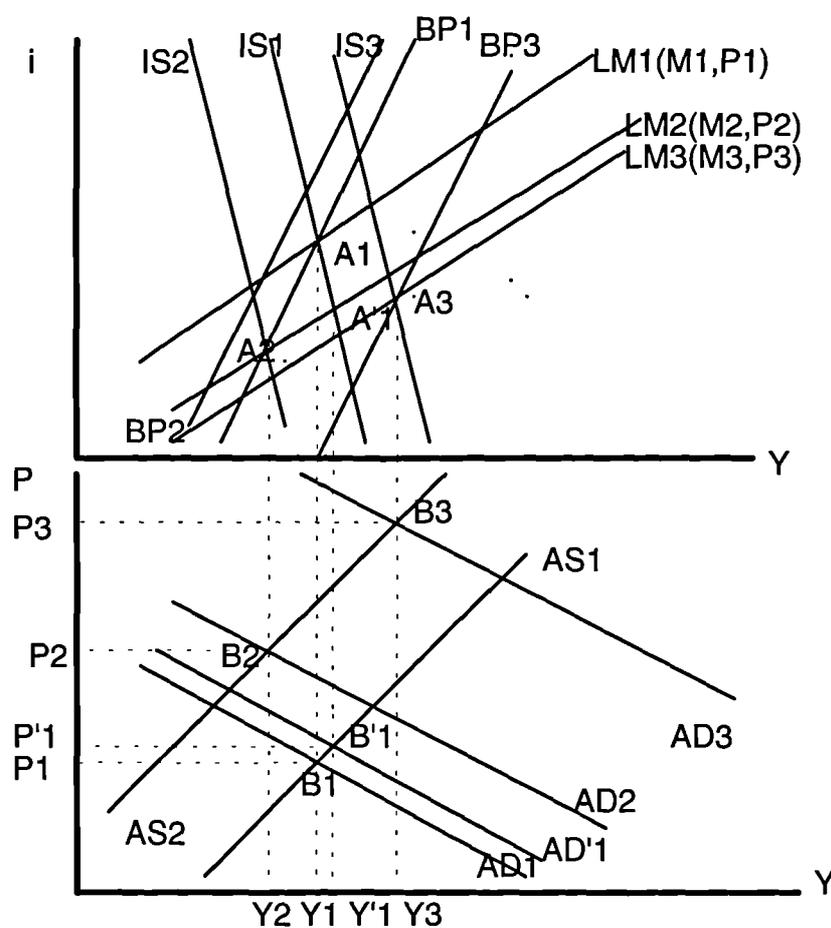


Figure 5.2 The Flex-Price and Monetary Expansion

Suppose that in order to finance public sector consumption there is a domestic credit expansion which shifts the LM curve to LM_2 . If the price level was assumed to remain constant, aggregate income would increase to Y_1' with

aggregate demand and aggregate supply adjusting at B_1 . However, assuming a flexible price an expansion of money balance would induce a price rise that will reduce the economy's competitiveness. This would shift BP and IS to BP_2 and IS_2 respectively while assuming wealth effects of the money balance aggregate demand (AD) would move to AD_2 . In the context of the Iranian economy, the government would intervene to prevent further reduction in foreign exchange reserves, for example by imposing imports compression. This in turn could lead to a fall in aggregate supply and AS shifts to AS_2 . The net outcome of the expansionary policy in this case as shown in figure (5.2) where the IS curve is steep and the LM curve is flatter than BP schedule is lower aggregate income $Y_2 < Y_1$ and higher price level $P_2 > P_1$. At this point therefore, the result of a monetary expansion is a deficit in the external sector and a decline in income level.

Suppose that in an attempt to stimulate economic growth the government increased its investment expenditure. This will have to be financed either by domestic credit or by the sale of bonds. However, it was noted that open market operations have not been a major source of finance of the public borrowing requirement in Iran so we assume the government will resort to domestic credit to finance its fiscal expansion. In this circumstances while a higher interest rate is required to increase capital inflow in order to offset the current account deficit, government credit policy would prevent rising of the domestic interest rates to attract foreign capital. On the other hand the rising price level would reduce competitiveness further deteriorating the balance of payments. A balance of payments deficit would not reduce the money stock because of the government

sterilisation policy. A combination of fiscal and monetary policy in this case therefore fails to secure both internal and external balances. It seems thus, as Meade (1951) pointed out, if monetary and fiscal policies were employed to achieve internal balances then some other policy instrument was required to attain external balance. In terms of Figure (5.2) once monetary and fiscal policies have attained Y_1 , additional policies are required to shift the BP line. Such policies might include for example exchange rate policy.

Consider an exchange rate policy of devaluation. This will increase the competitiveness of the economy and since the Marshall-Lerner condition is satisfied this will shift the BP line to the right towards BP_3 . Meanwhile government can increase its expenditure moving the IS curve to right to IS_3 . The internal and external equilibrium could attain at point A_3 on LM_3 while aggregate supply and aggregate demand meet at point B_3 . The government can assign the monetary policy to curb price increases and fiscal policy to induce income growth while the exchange rate policy is used to attain external balance thereby securing internal and external balance with higher income and albeit, higher price level.

5.3 Comparative Statics and Policy Multipliers

5.3.1 Introduction

In the previous section of this chapter we derived the IS-LM-BP curves of the macroeconomic model which provided us with a rather broad framework to compare the effectiveness of monetary and fiscal policy on the aggregate income. Although the IS-LM analysis casts some light on the structure of the model, it is

limited in that it does not measure the exact effects of the changes in policy instruments on the endogenous variables of the macro system. In what follows an attempt is made to derive the impact of monetary and fiscal policies on the economy's target variables which we consider here to consist of aggregate income (Y), the price level (P) and foreign exchange reserves (Fr).

5.3.2 The Comparative Statics Method

One of the main reasons for performing an econometric study is that of using the estimated model for structural analysis. By structural analysis, we mean an investigation of the underlying relationships in the system under consideration in order to comprehend and explain relevant economic phenomena. Structural analysis therefore involves the quantitative estimation of all the essential causalities, static as well as dynamic, implied by the model. The basic step in structural analysis is the estimation of the coefficients of the structural as well as reduced form equations of the system. In addition to the estimation of these coefficients themselves, it is also concerned with the interpretation of certain coefficients or combination of them. The macroeconomic model constructed and estimated in the previous chapters of this thesis was supposed to represent the macroeconomics of the Iranian economy. The system of equations represented in their structural form expressed the endogenous variables as functions of other endogenous variables, predetermined and exogenous variables and disturbances. On the other hand, the reduced form equations describe the endogenous variables in terms of the predetermined and exogenous variables alone.

In the macroeconomic literature the reduced form coefficients are called 'impact multipliers' since they measure the immediate response of the endogenous variables to changes in the predetermined and exogenous variables (see Rao (1987)). There exists a precise relationship between the reduced form coefficients and the structural parameters, since the reduced form parameters are obtained through the subsequent substitutions for endogenous variables. Indeed the reduced form coefficients are in fact combinations of the structural form coefficients. Impact multipliers are a special type of multiplier. The most important aspect of multiplier analysis is the validation of certain key impact multipliers of the model. Such a vindication usually forms the corner stone for policy prescription. Policy multipliers of an economic model convey extremely useful information on the magnitude and timing of influences of the instruments on the endogenous variables. To derive the policy multipliers of macroeconomic models the so called comparative static method is used which we briefly discuss below.

Comparative statics is a method used by economists to analyse changes in the equilibrium of an economic model that result from changes in exogenous variables. In terms of calculus, comparative statics is concerned with determining the derivative of each of the endogenous variables with respect to the exogenous variables when the system wide effects of the model are taken into account and equilibrium is maintained i.e. the reduced form partial derivatives (see Cuthbertson and Taylor (1987)).

The purpose of comparative statics is to examine how the equilibrium values of the variables respond to change in one or more exogenous variables. An

obvious use of the reduced-form partial derivatives, particularly in the macro context, lies in the formulation of policy prescription. Furthermore, if economic theory is to be meaningful it must have empirical content. By predicting the nature of changes in the endogenous variables resulting from a change in one or more of the exogenous variables in a model, the method of comparative statics describes features of that model that could be tested.

It will be noted that comparative statics does not say anything about the time path of the variables from the initial to final equilibrium point nor can it say whether the new equilibrium point will actually be achieved. Comparative statics involves the comparison of equilibrium positions corresponding to two set of circumstances (see Edgmand, 1982). The mathematics of comparative statics consists of two well-known theorems: the implicit function theorem and the chain rule for the differentiation of composite functions (see Gandolfo (1971)). If the economic model consists of n equations the solutions to these equations determines the equilibrium points of the model. Since the comparative static method takes the equilibrium point as given, it is assumed that this solution exists and is economically meaningful.

Generally speaking, an economic model, like the one developed and estimated in this thesis, consists of n structural equations in n endogenous variables $y_i, i = 1, \dots, n$ and m exogenous variables $x_j, j = 1, \dots, m$. Generally therefore we have:

$$(5.26) \dots f_i(y_1, y_2, \dots, y_n, x_1, x_2, \dots, x_m) = 0 \quad i = 1, \dots, n$$

In our model for example as was displayed in tables (4.1) and (4.2) $n=30$ and $m=14$. For a given vector of the exogenous variables, x , the solution of the equilibrium equations entails an equilibrium vector of the endogenous variables y . The structural equations of our model are either in linear or log linear form. These equations are differentiable in the neighbourhood of (y',x') and considering the behavioural equations of the model it can be detected that the Jacobian determinant:

$$(5.27) \dots \begin{vmatrix} \frac{\partial f_1}{\partial y_1} & \frac{\partial f_1}{\partial y_2} & \dots & \frac{\partial f_1}{\partial y_n} \\ \frac{\partial f_2}{\partial y_1} & \frac{\partial f_2}{\partial y_2} & \dots & \frac{\partial f_2}{\partial y_n} \\ \dots & \dots & \dots & \dots \\ \frac{\partial f_n}{\partial y_1} & \frac{\partial f_n}{\partial y_2} & \dots & \frac{\partial f_n}{\partial y_n} \end{vmatrix}$$

is non-zero at (y',x') . This confirms that we can apply a mathematical result, the implicit function theorem, which asserts that each of the endogenous variables can be expressed as a function of the exogenous variables that are well behaved in the neighbourhood of (y',x') , that is:

$$(5.28) \dots y_i = y_i(x_1, x_2, \dots, x_m) \quad i = 1, \dots, n$$

Equations (5.28) are referred to as the reduced form equations of the system. Now, we can solve (5.28) directly and derive our comparative static results straightaway, by calculating the matrix of the reduced-form partial derivatives:

$$(5.29) \dots \left[\frac{\partial y_i}{\partial x_j} \right] \quad i = 1, \dots, n \quad j = 1, \dots, m$$

and this we are able to do in our model.

To summarise, therefore, in order to apply the comparative static method to our model, we should solve the system for its equilibrium and differentiate with respect to exogenous variables. Here we consider the comparative statics of the policy instruments on three target variables. The target variables of the model are assumed to be the aggregate income (Y), the price level (P) and foreign exchange reserves (Fr). The first step is already done for aggregate income and the price level as we have derived these variables' reduced forms in the process of our IS-LM analysis of the model. One point should be mentioned, before embarking on the impact multiplier analysis. Since the estimation results revealed that the expected rate of inflation and the interest rate had no significant effects on the demand for money and private sector consumption and investment, in order to simplify the derivation of the reduced form and impact multipliers, we have dropped these variables from the equations.

5.3.2 The Impact Multipliers

To derive a reduced-form equation for $\log P_t$ we first obtain a relationship for $\log Y_t$ from equation (5.16) putting $i=0$. Then we substitute for $\log Y_t$ from this equation into equation (5.6). Rearranging the equation we arrive at:

$$(5.30) \dots \log P_t = [27 \log P_{t-1} - 0.05 \log Y_{t-1} + 35 \log Fr_{t-1}] + [3.3 - 0.012 \log C_{t-1} + 0.04 \log Fp_{t-1} \\ + 3.1 \log Dcp_{t-1} - 0.05 \log K_{t-1} - 0.002 \log e_{t-1} - 0.013 \log Z_{t-1} + 0.004 \log X_{t-1} \\ - 0.6 \log \tilde{M}_{t-1} + 0.006 \log] + [0.3 \log Dc_t - 0.06 \log G_t + 0.005 \log Dtax_t + 0.71 \log e_t - 0.3 \log \Delta Fg_t] \\ + [0.005 \log Y_t^* - 0.006 \log P_t^*]$$

Reduced-form equation for $\log Y_t$ is obtained by substituting for $\log P_t$ from equation (5.6) into equation (5.16) putting $i=0$, and rearranging the equation for $\log Y_t$.

$$(5.31) \dots \log Y_t = [81 \log P_t + 3 \log Y_{t-1} - 0.08 \log Fr_{t-1}] + [-2 + 0.03 \log C_{t-1} - 0.005 \log Fp_{t-1} - 0.92 \log Dcp_{t-1} \\ + 1.3 \log K_{t-1} - 0.02 \log e_{t-1} - 0.08 \log Z_{t-1} + 1.1 \log X_{t-1} + 0.08 \log \tilde{M}_{t-1} - 0.00 \log Fg_{t-1}] \\ + [-0.05 \log Dc_t + 0.19 \log G_t - 0.01 \log Dtax_t + 0.05 \log e_t + 0.04 \log \Delta Fg_t] + [0.16 \log Y_t^* + 0.17 \log P_t^*]$$

To derive a reduced form equation for $\log Fr_t$ we use the foreign exchange reserves identity i.e. $Fr_t = Fr_{t-1} + Bop_t$ and then the balance of payments identity (eq. 4.15) i.e. $Bop_t = (1/e_t) Ca_t - (\Delta Fg_t + \Delta Fp_t)$ where ΔFg_t and ΔFp_t changes to foreign assets holding of the public and private sectors respectively. After proper substitution and linearising the non-linear equations about the sample mean we end up with the following log linear approximation for $\log Fr_t$:

$$(5.32) \dots \log Fr_t = \left(\frac{29}{16}\right) \log 2 + \left(\frac{9}{16}\right) \log Fr_{t-1} + \left(\frac{1}{32}\right) \log Fg_{t-1} + \left(\frac{1}{32}\right) \log Fp_{t-1} - \left(\frac{1}{8}\right) \log \Delta Fp_t \\ - \left(\frac{1}{8}\right) \log \Delta Fg_t + \left(\frac{1}{16}\right) \log X_t - \left(\frac{1}{16}\right) \log \left(\frac{P_t^* \cdot e_t}{P_t}\right) Z_t$$

In the above equation variables $\log \Delta Fp_t$, $\log X_t$ and $\log(P_t^* e_t / P_t) Z_t$ are endogenous variables to the model. To eliminate these variables from the

equation we substitute from equation (4.41) for $\log \Delta F p_t$ and from equations (4.53) and (4.55) for $\log X_t$ and $\log(P_t^* e_t / P_t) Z_t$ respectively. The result is the following expression for $\log Fr_t$:

$$(5.33) \dots \log Fr_t = [-.30 + .24 \log Fr_{t-1} - .1 \log P_{t-1} + .92 \log M_{t-1} + .2 \log Y_{t-1} + .014 \log P_{t-1}^* + .08 \log X_{t-1}] + [.12 \log e_t + .12 \log P_t^* - .125 \log Dc_t + .175 \log Y_t + .17 \log P_t]$$

Now, substituting for $\log Y_t$ and $\log P_t$ from the reduced-form equations for these variables derived above (eq. (5.30) and eq. (5.31)) respectively we arrive at the following reduced form equation for Fr_t :

$$(5.34) \dots \log Fr_t = [.001 \log P_{t-1} + .24 \log Y_{t-1} + .29 \log Fr_{t-1}] + [.6 + .003 \log C_{t-1} - .45 \log Fp_{t-1} - .11 \log Dcp_{t-1} + .01 \log K_{t-1} - .46 \log e_{t-1} - .02 \log Z_{t-1} + .1 \log X_{t-1} + .37 \log \tilde{M}_{t-1} + .005 \log Fg_{t-1} + .014 \log P_{t-1}^*] + [-.08 \log Dc_t + .023 \log G_t - .000081 \log Dtax_t + .25 \log e_t - .04 \log \Delta Fg_t] + [.03 \log Y_t^* + .15 \log P_t^*]$$

We can put the reduced-form equations (5.30), (5.31) and (5.34) in matrix form which gives a clearer expression. The coefficients of those lagged variables which exhibited a negligible impact on all the target variables are omitted in the matrix form. Each element of the matrix (5.35), which is obtained by log-linearising the model's non-linear relationships at the point of sample means, indicates the magnitude of the direct and indirect influence of some predetermined variables, including the lagged endogenous variables, exogenous variables and policy variables upon the target variables of the macroeconomic model. For example the percentage change in the price level ($\log P_t$) induced by a

10 percent change in the domestic credit ($\log Dc_t$) is 3 percent [i.e. $\left(\frac{\partial \log P_t}{\partial \log Dc_t} = .3\right)$]

and by a 10 percent increase in the foreign exchange reserves in the pervious

year is 3.5 percent [i.e. $\left(\frac{\partial \log P_t}{\partial \log Fr_{t-1}} = .35\right)$]. The percentage change in aggregate

income caused by a 10 percent increase in government expenditure is 1.9 percent

[i.e. $\left(\frac{\partial \log Y_t}{\partial \log G_t} = .19\right)$] and by a 10 percent increase in the last period capital stock

is 1.3 percent [$\left(\frac{\partial \log Y_t}{\partial \log K_{t-1}} = .13\right)$]. This matrix also implies that elasticity

multiplier of the domestic credit on aggregate income at the point of sample

mean is -.05 or $\left(\frac{\partial \log Y_t}{\partial \log Dc_t} = -.05\right)$.

Matrix(5.35) Impact Multipliers of the Model in Terms of Elasticity

$$(5.35) \dots \begin{bmatrix} \log P_t \\ \log Y_t \\ \log Fr_t \end{bmatrix} = \begin{bmatrix} .27 & -.05 & .35 \\ .81 & .30 & -.08 \\ .001 & .24 & .29 \end{bmatrix} \begin{bmatrix} \log P_{t-1} \\ \log Y_{t-1} \\ \log Fr_{t-1} \end{bmatrix} + \begin{bmatrix} 3.3 & .04 & .31 & -.05 & -.002 & -.004 & -.6 \\ -2 & -.005 & -.92 & .13 & -.02 & .11 & .08 \\ .63 & -.45 & -.11 & .01 & -.46 & .1 & .37 \end{bmatrix} \begin{bmatrix} 1 \\ \log Fp_{t-1} \\ \log Dc_{t-1} \\ \log K_{t-1} \\ \log e_{t-1} \\ \log X_{t-1} \\ \log \tilde{M}_{t-1} \end{bmatrix}$$

$$+ \begin{bmatrix} .3 & -.06 & .005 & .71 & -.3 \\ -.05 & .19 & -.01 & .05 & .04 \\ -.08 & .02 & .00008 & .25 & -.04 \end{bmatrix} \begin{bmatrix} \log Dc_t \\ \log G_t \\ \log Dtax_t \\ \log e_t \\ \log \Delta Fg \end{bmatrix} + \begin{bmatrix} .005 & -.006 \\ .16 & .17 \\ .03 & .15 \end{bmatrix} \begin{bmatrix} \log Y_t^* \\ \log P_t^* \end{bmatrix}$$

Also by use of the formula:

$$\frac{\partial \log Y_t}{\partial \log D_{Ct}} = \frac{\partial \log Y_t}{\partial \log \left(\frac{D_{Ct}}{P_t} \right)} \cdot \frac{\partial \log \left(\frac{D_{Ct}}{P_t} \right)}{\partial \log D_{Ct}} = \frac{\partial \log Y_t}{\partial \log \left(\frac{D_{Ct}}{P_t} \right)} \left(1 - \frac{\partial \log P_t}{\partial \log D_{Ct}} \right) \text{ we find that:}$$

$$\frac{\partial \log Y_t}{\partial \log \left(\frac{D_{Ct}}{P_t} \right)} = (1-.3) \left(\frac{\partial \log Y_t}{\partial \log D_{Ct}} \right) = -.071. \text{ In other words the proportional change}$$

of aggregate income due to a 10 percent change in real domestic credit is -.71 percent. Similarly, a 10 percent devaluation of the exchange rate increases

foreign exchange reserves by as much as 2.5 percent $\left[\left(\frac{\partial \log Fr_t}{\partial \log e_t} = .25 \right) \right]$ while

inducing a 7.1 percent rise in the price level $\left(\frac{\partial \log P_t}{\partial \log e_t} = .71 \right)$, with all other

predetermined variables held constant. We may generalise the concept of the multiplier so as to call each element of the matrix (5.35) an 'impact elasticity multiplier; (see Morishima et al (1972)).

It should be noted that expressing the comparative static results in the form of elasticities is more convenient than in the form of absolute terms. The absolute multipliers depend on the ratios of the relevant variables and multipliers which in turn depend on the structural parameters of the model. We can derive multipliers in absolute terms from the corresponding multiplier terms of elasticities. For example the absolute impact multiplier of income with respect to the government expenditure depend on (Y_t / G_t) as the following relationship shows:

$$(5.36) \dots \frac{\partial Y_t}{\partial G_t} = \frac{Y_t}{G_t} \frac{\partial \log Y_t}{\partial \log G_t} = (.19) \frac{Y_t}{G_t}. \text{ If for example } \frac{Y_t}{G_t} = 4 \text{ then } \frac{\partial Y_t}{\partial G_t} = .76$$

These absolute impact multipliers depends on the ratio of the relevant variables and elasticity multipliers which in turn depend on the structural parameters (i.e. the estimated coefficients of the behavioural equations and the coefficients of log-linearised identities). These multipliers are relevant only at the sample means because they are obtained fixing linearised relationships of the model to their sample means. If we take the actual ratios of the relevant variables (Y_t/G_t and Y_t/Dc_t) for example in each year of the sample period, contingent on linearised approximation of the model's relationships impact multipliers will vary from year to year. To illustrate this we have given impact multipliers of real domestic credit (Dc/P) and government expenditure (G) on the real aggregate income (Y) (i.e. $\frac{\partial Y_t}{\partial(Dc_t / P_t)}$ and $\frac{\partial Y_t}{\partial G_t}$ respectively) for 5 sub-periods of the time period 1959-

91 in the following table (5.2). These multipliers are calculated using the ratios of real income to real domestic bank credit and real income to real government expenditure using relationships

$$\frac{\partial Y_t}{\partial(Dc_t / P_t)} = \left(\frac{\partial \log Y_t}{\partial \log(Dc_t / P_t)} \right) \left(\frac{Y_t}{Dc_t / P_t} \right) \text{ and } \frac{\partial Y_t}{\partial G_t} = \left(\frac{\partial \log Y_t}{\partial \log G_t} \right) \left(\frac{Y_t}{G_t} \right). \text{ Table (5.2)}$$

also gives the marginal substitution rate of real domestic credit, as the main monetary policy instrument, to government expenditure, as the main fiscal policy tool in the economy $\left(\frac{\partial Y_t / (\partial Dc_t / P_t)}{\partial Y_t / G_t} \right)$ (see Morishima et al, 1972).

From table (5.2) it is apparent that the multipliers vary from period to period. It will be noted that in general real domestic credit multiplier on aggregate income $\left(\frac{\partial Y_t}{\partial(Dc_t / P_t)} \right)$ has a diminishing pattern as this multiplier

decreases from -.59 in the period 1959-62 to -.11, in absolute terms, in the period 1988-91. Government expenditure multiplier on aggregate income decreases from 1.3 in the period 1959-62 to .55 in the period 1970-78 but increases again to 1.02 in the period 1988-91. Diminishing pattern of the real domestic credit multiplier should be obvious because of decreasing ratio of income to real domestic credit. It is worth noting that domestic credit is a stock variable while aggregate income is a flow variable. This point should be noted when inspecting the marginal rate of substitution, between domestic credit and government expenditure on aggregate income, that gives a measurement of comparing the relative effectiveness of domestic credit policy vis-à-vis government expenditure policy. Table (5.2) shows that marginal substitution between real domestic credit and government expenditure is in favour of the fiscal policy instrument in its effect on aggregate income. However, we note again that while domestic credit is a stock variable, government expenditure is a flow variable.

Table 5.2 Impact multipliers and marginal rate of substitution between domestic credit and government expenditure in the selected periods

| period | $\frac{Y_t}{Dc_t / P_t}$ | $\frac{\partial Y_t}{\partial(Dc_t / P_t)}$ | $\frac{Y_t}{G_t}$ | $\frac{\partial Y_t}{\partial G_t}$ | $\frac{\left(\frac{\partial Y_t}{\partial(Dc_t / P_t)}\right)}{\left(\frac{\partial Y_t}{\partial G_t}\right)}$ |
|---------|--------------------------|---|-------------------|-------------------------------------|---|
| 1959-62 | 8.4 | -0.59 | 6.7 | 1.3 | -0.46 |
| 1963-69 | 6.3 | -0.45 | 4.3 | 0.82 | -0.56 |
| 1970-78 | 4.3 | -0.31 | 2.9 | 0.55 | -0.56 |
| 1979-87 | 1.6 | -0.11 | 3.96 | 0.75 | -0.15 |
| 1988-91 | 1.6 | -0.11 | 5.4 | 1.02 | -0.11 |

As was mentioned an advantage of impact multipliers expressed in term of elasticity is that they it provides a dimensionless measure of the sensitivity of the endogenous variable to change in the exogenous variables and do not depend upon the units in which they are measured. For this reason a measure of the relative effectiveness of policy would be the ratio of elasticities. This could provide a comparison of the relative efficacy of fiscal policy as opposed to monetary policy as far as their impact on the price level, aggregate income and foreign exchange reserves are concerned. For example the marginal rate of substitution (see Morishima (1972) and Rao, (1987)) between domestic credit as the main monetary policy instrument and government expenditure as the main fiscal policy variable upon the aggregate income can be calculated

$$\text{as: } MRS_G^{Dc} = \frac{\partial \log Y_t / \partial \log Dc_t}{\partial \log Y_t / \partial \log G_t} = \frac{-0.05}{.19} = -0.26 \text{ which clearly is in favour of fiscal}$$

policy in pursuing the aggregate income target. In table (5.3) we have presented the marginal rates of substitution of the policy instruments for the target variables in terms of elasticities. These multipliers and the rate of substitutions are useful in the sense that cast some light on the impact of different policy variables upon target variables and their relative effectiveness.

The results in table (5.3) indicate that in general the elasticity marginal rates of substitution at the point of sample mean are biased in favour of fiscal policy (government expenditure G_t) as far as aggregate income is concerned while monetary policy (Dc_t) tracks the price level target more accurately; and foreign sector policy instruments (e_t and ΔFg_t) are more effective on foreign exchange reserves. However, two points merit noting: First, tax policy appears to be almost

completely ineffective in this economy relative to the other policy instruments. In chapter II of this thesis, where we surveyed the Iranian economy for the last 40 years or so, it was noted that mainly due to the oil revenue which accrued to the government's budget, taxation was not developed as the main source of government revenues. We now find that indeed taxation exerts a relatively small effect on the different economic target variables in this economy.

**Table 5.3 The marginal rate of substitution between policy instruments
(in terms of elasticities)**

| $[MRS$ | $\log P_t$ | $\log Y_t$ | $\log Fr_t]$ |
|-------------------|------------|------------|---------------|
| MRS_G^{Dc} | -5.0 | -0.26 | -4.0 |
| MRS_{Dtax}^{Dc} | 60.0 | 5.0 | 1000.0 |
| MRS_e^{Dc} | 0.42 | -1.0 | -0.32 |
| MRS_{Fg}^{DC} | -1.0 | -1.25 | 2.0 |
| MRS_{Dtax}^G | -12.0 | -19.0 | 250.0 |
| MRS_e^G | -0.08 | 3.8 | 0.088 |
| MRS_{Fg}^G | -0.2 | 4.75 | -0.5 |
| MRS_e^{Dtax} | 0.007 | -0.2 | -0.00032 |
| MRS_{Fg}^T | -0.016 | -0.25 | -0.002 |
| MRS_{Fg}^e | -2.36 | 1.25 | -6.25 |

Secondly, exchange rate policy turns out to be more effective in general relative to the domestic credit policy, which is regarded as the main monetary policy variable in the Iranian economy. The marginal substitution rate of the domestic credit to exchange rate, at the point of sample mean, is .42 (less than unity) indicating a more effective exchange rate policy on the price level. This could be due to several factors. First, the oil revenue received by the government is

usually greater, in magnitude, than domestic credit (ΔD_{cg}) extended to the public sector (largely to finance the government budget deficit) and often even greater than total domestic credit (ΔD_c). A change in the nominal exchange rate therefore, can considerably affect on the nominal money supply. Secondly, as was discussed earlier, the lack of a sterilisation policy instrument denies the monetary authorities the means by which they could offset balance of payments or exchange rate devaluation effects on the money supply. Finally, a large percentage of the imported goods in this economy are inputs to produce final products. A change in prices of imports in the home currency terms affects a broad range of industries inducing a price increase.

To summarise the impact multiplier analysis of the model, it is fair to say that the set of impact multipliers presented in matrix (5.35) and the marginal rates of substitution between policy instruments of tables (5.2) and (5.3) help to draw a demarcation line between the economy's sectors on the basis of the policy. In general, it can be seen that monetary policy is more effective in the financial sector while fiscal policy is more influential on the real part of the economy which is in a true Mundellian fashion. However, impotence of the taxation policy and influence of the exchange rate policy should be considered as special features of this economy.

5.4 Summary and some conclusions

In the first part of this chapter Chow's first and second tests were applied to establish whether the main behavioural functions of the model have been structurally stable in the sample period. On the basis of these tests we were able

to conclude that constancy of the estimated parameters of the model, in the sample period, could not be rejected at the 5 percent level of significance. Since Chow's second test (the prediction failure test) is also considered as a powerful test of a broad range of misspecifications, these results ruled out any serious misspecification of the macroeconomic model .

Having established evidence of the model's parameter constancy for the sample period under observation, in the second part of the chapter, the structure of the model was examined through the determination of its short-run equilibrium. IS-LM-BP curves of the model were derived to constitute a setting for the purpose of policy analysis in the short-run. The IS curve of the model turned out to be quite steep reflecting the underlying interest inelastic expenditure in the economy. The LM curve also was found to be rather steep but its slope was smaller than that of the BP schedule. The relative slopes of the IS-LM-BP curves indicated that an income growth, induced for example by the private or government expenditure, would generate a balance of payments deficit.

The policy implications of the IS-LM-BP curves, that exhibited neither extreme monetary nor Keynesian cases, were discussed with some consideration given to the wealth effect and sterilisation policy. Generally speaking, assuming zero sterilisation, monetary policy was found to be impotent (if the wealth effect is disregarded). A monetary expansion will increase real income and reduce the domestic interest rate while the balance of payments is in deficit. In the longer term, as the balance of payments deficit reduces the money stock, the variables return to their original values. However, while the system is adjusting, monetary

policy is not neutral. On the other hand monetary policy could exerts some influence on the external balance. Fiscal policy can affect domestic real income even in the case of zero sterilisation. However, the financing means of the fiscal expansion and its crowding out effect should be taken into consideration. When the fixed-price condition was relaxed a combination of monetary and -fiscal policy failed to secure internal and external balance. In this case additional of the exchange rate policy to the moneatry-fiscal mix appears to be effective in persuading the economic growth with price stability and balance of payments improvement.

Finally the limitations of the IS-LM treatment of policy analysis was particularly for an economy where both the demand for money and private expenditure were found to be interest insensitive merits emphasis. On the basis of the finding that agents in the economic model were largely unresponsive to the expected rate of inflation and the interest rate, we dropped these variables from our analysis in the last section of this chapter, which was devoted to the impact multiplier analysis of the model. Derivation of the impact multipliers of the macroeconomic model enabled us to conduct a brief comparative static analysis of the Iranian economy. The marginal rates of substitution of policy variables were also calculated. These highlighted the relative effectiveness of monetary policy on the financial part of economy and fiscal policy on the real sector of the economy. Comparative static analysis, however, is limited to a comparison of steady states and is an exercise in which the effects on a change in our predetermined variables is isolated holding other variables at their previous level despite their varying nature. In chapter VI, we examine the transmission

mechanism of monetary and fiscal policies as well as some exogenous shocks to the model through dynamic simulation of the macroeconomic model where the effects of the policy variables on economic targets are studied while all the variables of the model are allowed to change.

Appendix 5.A1

The 2SLS estimation of the consumption function (as reported in table (4.5)) is:

$$(5.A1) \dots \log C_t = .13 - .02r_t + .39 \log C_{t-1} + .58 \log Y_d t$$

$$(t\text{-ratio}) \quad (.90) \quad (-1.9) \quad (2.7) \quad (4.4)$$

$$\bar{R}^2 = .99, \quad DW = 2.2, \quad \chi^2_{sc}(1) = .41, \quad \chi^2_{st}(1) = .02, \quad \chi^2_{ns}(2) = .79, \quad \chi^2_{st}(1) = 2.5$$

The following statistics were obtained estimating the equation for the two sub-periods (1959-79) and (1980-91):

$$RSS \text{ for (1959-79) or } RSS_1 = .052, \quad n_1 = 20, \quad S.E. = .042$$

$$RSS \text{ for (1980-91) or } RSS_2 = .023, \quad n_2 = 12, \quad S.E. = .05$$

$$RSS_1 + RSS_2 \text{ for (199-91) or } URSS = .075 \quad n = 32$$

$$RSS \text{ for (1959-91) or } RRSS = .090 \quad n = 32 \quad S.E. = .05, \quad k = 2$$

Analysis of variance ($F_{a.v.}$) and the predictive failure test ($F_{p.f.}$) for the 2SLS estimation can be calculated as:

$$(5.A1.2) \dots F_{a.v.} = [(RRSS - URSS)/(k+1)]/[URSS/(n_1+n_2-2k-2)] = 1.04$$

$$(5.A1.3) \dots F_{p.f.} = [(RRSS - RSS_1)/n_2]/[RSS_1/(n_1-k-1)]$$

From the F-table it can be seen that F-statistic with d.f. 12 and 17 equals 2.38 [i.e. $F(12,17) = 2.38$], and $F(3,26) = 2.95$. Therefore, we have the following results:

$$(5.A1.4) \dots F(12,17) = 2.38 > F_{a.v. \text{ OLS}} = 1.74 > F_{a.v. \text{ 2SLS}} = 1.04$$

$$(5.A1.5) \dots F(3,26) = 2.95 > F_{p.f. \text{ 2SLS}} = 1.15 > F_{p.f. \text{ OLS}} = 1.05$$

According to these results we cannot reject the structural stability of aggregate consumption in the economy in the sample period.

On the other hand 2SLS estimation of the private investment is:

$$(5.A1.6) \dots \log P_i = -10.87 + .79 \log Y_t + 1.45 \log K_{t-1} + .41 \log G_{it} - .95 \log D_{cpt-1}$$

$$\begin{array}{cccccc} \text{(t-ratio)} & (3.7) & (2.4) & (2.41) & (3.0) & (-2.4) \\ \bar{R}^2 = .91, & DW = 1.89, & \chi^2_{sc}(1) = .88, & \chi^2_{\beta}(1) = 2.03, & \chi^2_{\nu}(2) = .66, & \chi^2_{H}(1) = .002 \end{array}$$

The 2SLS estimation of the private investment for the two sub-periods have yielded the following statistics:

| | | | | |
|-------------------------------------|----|-----------------------|---------------------|----------|
| RSS for (1959-79) | or | RSS ₁ =.78 | n ₁ =20, | S.E.=.22 |
| RSS for (1980-91) | or | RSS ₂ =.14 | n ₂ =12, | S.E=.14 |
| RSS for (1959-79)+RSS for (1980-91) | or | URSS=.92 | n=32 | |
| RSS for (1959-91) | or | RRSS=1.1 | n=32, | S.E=.20 |

With the above values for the residual sum of squares, number of observations for the sample period and the two sub-periods and the corresponding degree of freedom (k=5, number of the explanatory variables), the analysis of variance and the predictive failure tests are as follow:

$$(5.A1.7) \dots F_{a.v.} = [(.18/6)] / [(.92/12)] = .39$$

$$(5.A1.8) \dots F_{p.f.} = [(.32/12)] / [(.78/16)] = .53$$

The values for the F- statistic with the corresponding degree of freedom can be found from the F-table. Comparing these statistics with those found for Chow's first and second tests for the OLS and 2SLS estimations of the private investment we have:

$$(5.A1.8) \dots F(5,22) = 2.66 > F_{a.v. 2SLS} = .39 > F_{a.v. OLS} = .32$$

$$(5.A1.9) \dots F(12,15) = 2.48 > F_{p.f. 2SLS} = .53 > F_{p.f. OLS} = .25$$

$$(5.A1.17).....F_{P.F. 2SLS} = [(.108-.071)/11]/[(.071/15)] = .69$$

From the statistics table for the F-distribution it can be seen that $F(5,21)=2.69$ and

$F(11,15)=2.50$. We therefore have the following comparisons for these statistics and Chow's first and second tests for demand for money function estimated by LOS and 2SLS.

$$(5.A1.18).....F(5,21)=2.69 > F_{a.v. 2SLS} = 1.33 > F_{a.v. OLS} = .91$$

$$(5.A1.19).....F(11,15)=2.50 > F_{P.F. 2SLS} = .69 > F_{P.F. OLS} = .53$$

These results clearly support the hypotheses that the parameters of the demand for money function have been stable in the time period (1959-91).

Chapter VI

Dynamic Simulation of the Model and Policy Analysis

6.1 Introduction

In previous parts of this study we have discussed many structural or quasi-reduced form relationships for the Iranian economy. The estimates of the parameters of these relationships are of considerable interest in themselves because of what they tell us about the structure of this economy. However, for an analysis of the consequences changes in macroeconomic policies or of changes in exogenous macroeconomic variables, examination of these parameter estimates in isolation may provide only a partial picture because there are important simultaneous and lagged interactions among the variables in the system. For example, constraints such as the government budget constraint and the balance sheet of the central bank cannot be ignored when examining the effect of policy changes on the behaviour of the economic system. This part of the thesis, therefore, integrates these relationships (discussed in chapter III) into a general dynamic simultaneous model of the Iranian economy. Given the structure of the model outlined in the previous chapter, the solution procedure and the sample performance of the model is the focus of this chapter.

6.2. The Meaning and Main purposes of Dynamic Simulation of Econometric Models

Simulation as we use the word is the mathematical solution of a simultaneous set of difference equations. It also traces movements of endogenous variables in the model over time. Given a model whose parameters have been estimated, given initial values for the endogenous variables and given time series data on the exogenous variables, the model can be solved for each period. The simultaneous solution of all equations of the model (which yields the time paths for each of the endogenous variables) is known as the simulation solution.

A dynamic econometric model which is intended to show the impact of macroeconomic policy actions on the economic system must be able to track the historical data reasonably well. This way of evaluating and validating simultaneous equations models is important because although each individual equation may pass a series of diagnostic tests, the whole model may fail to reproduce the historical time series satisfactorily. Similarly, the individual equations of a model may perform poorly on standard statistical criteria, and yet the model as a whole may be capable of reproducing the historical data. This could happen since the behaviour of the model as a dynamic system may bear little relation to the way individual equations fit the data (see Pindyck and Rubinfeld (1976)).

The first question to explore is therefore, how well the model fits known data. The model is estimated from historical data; therefore, using the same data set to test the model would appear questionable. However, if the model was estimated as a set of individual equations, as is the case in our study, it may be a relevant

test to solve the equations as a simultaneous system. For non-linear systems, such as the one that we have developed here as a macroeconometric model, there are no standard statistics, to provide criteria for judgement but we can at least compute and examine the errors. Another test for the accuracy of a non-linear simulation equation system is its forecasting power against data which were not used in the estimation process. For example this test might utilise most recent new observations.

Not only are we interested in the economy's behaviour in the future but also in gaining insight into why it behaves as it does. Verbal analysis supplemented with geometric analysis have been the traditional tools for obtaining such insight, although economists have resorted increasingly to advanced calculus and matrix algebra for deepening their comprehension of complex systems. However, when a system of equations cannot be solved analytically it is desirable to obtain a numerical solution for the system. This is the essence of simulation and its source of power.

Complex non-linear models will not in general be amenable to analytic solution. To construct a mathematical problem that can be solved analytically, extensive simplification may be required. However, using sensitivity analysis of the simulation model a great deal can be learnt about simplifications that can be made without critically affecting the behaviour of the system. The insight gained from these solutions, should, in turn help in validation of the complete model. Through simulation experiments it is possible to explore the quantitative effects of certain variables on the behaviour of the complete system: for example, it may be that some parameters can be put to zero with little impact on the system. In

this way the really important relationships stand out more precisely. For example, in our estimation of the macroeconometric model we found that the interest rate had minimal effect on consumption and investment behaviour of agents in the Iranian economy. Therefore, in simulation of the complete model, this variable was omitted (without affecting the overall performance of the model). Finally, insight into what might be referred to as critical structure can guide the complementary work on analytical solutions. The system's numerical behaviour is then determined (simulated) under different assumptions for the paths of the exogenous variables. Each simulation run is considered to be an experiment performed on the model, determining values of the endogenous variables for alternative scenarios regarding the exogenous variables. If the disturbance terms are set to zero, the simulation is referred as a deterministic simulation. In other cases it is known as a stochastic simulation (see Rao, 1987, p.101).

Simulations are usually classified as either dynamic or static simulation. A dynamic simulation is one where historical values are provided for the endogenous variables only as start values. In other words, in dynamic simulation the values of the lagged endogenous variables are themselves generated by the simulation process. Dynamic simulation therefore is a more stringent test of goodness of fit than a static simulation in which the vector of lagged endogenous variables is assumed to be predetermined. "This is because prediction errors in a dynamic simulation case can quite easily be compounded namely because a large error in any period between the actual and simulated values of the endogenous variables also affects the size of the errors in the following period" (Aghevli and

Khan (1978), p. 401). One can see that in dynamic simulation, accumulation of errors can be a major potential cause for divergence. However, by allowing the lagged endogenous variables to be determined within the simulation, the dynamic simulation can also be used as a test for stability (explained below) of the estimated model. A successful dynamic simulation is, thus, considered to be a more severe test of a model's reliability because "a static simulation by reinitialising the values of the endogenous variables at each stage, using historical records, eliminates the possibility of accumulation of errors thereby imparting a pseudo-stability to the simulated values"(M. Rao,1987, p.102).

By introducing deliberate shocks to the system it is possible to observe its characteristic dynamic responses which reveal its stability. Where the repercussions of a disturbance die out rapidly a high degree of stability is indicated. A cumulative explosion would indicate instability. However, it is worth noting that for a non-linear system the stability characteristics may therefore be functions of the region in which the system is operating (being stable in some regions and unstable in others), (see Duesenberry et al, 1965).

After the model has been validated and insight gained into its structure and behaviour we can consider its policy applications. The model can be used to make conditional forecasts by introducing a policy change and forecasting the economic outcome. At this point it may be helpful to postulate certain quantitative policy objectives in order to guide the simulation study.

When estimating individual behavioural relationships, definitional identities play a rather indirect role. For example, disposable income, an explanatory variable in the consumption function, was constructed from the private sector

disposable income identity in the macroeconomic model. However, when the complete system is assembled, definitional identities are included alongside behavioural relationships. For example, if national income is used as an explanatory variable in determining private investment a definitional identity can be used to indicate the various components that are added to obtain national income. Historical data should satisfy the identity relationships and such a test is recommended as a cross check on both data and identities (Duesenberry et al, 1965). A brief review on the methods of solution of the complete dynamic systems is provided in appendix 1 to this chapter.

6.3 Simulation Procedure

In this section we briefly introduce the Dynamo approach of simulation which is used here to simulate the macroeconomic model. Dynamo is a computer program used to simulate the behaviour of a non-linear system described by a set of simultaneous first order equations. Since non-linear systems do not, in general, have any analytical closed form solution, Dynamo, given a set of initial values for the system state variables, uses a difference equation format to compute the values of system state variables as a function of time. The two most important variable types in Dynamo are the level and rate variables, where level variables correspond to the system's state variables (i.e. variables that given their initial values, parameters of the model and the future time paths of exogenous variables, determine the state of the system at each period). Dynamo also allows the use of auxiliary variables so that complex equations can be broken up into a set of simpler equations.

As the language uses the ordinary substitution method of simulation, the equations of the system could appear in any sequence with no effect on the convergence process. The compiler performs several duties:(i) it checks the equations for logical errors; (ii) it organises the model in accordance with the structural concept of a dynamic system; (iii) it programs the model so that the equations are converted to detailed computer operating instructions and finally;(iv) it executes the step by step computation based on the control instructions and solution intervals and produces the simulated results of the system represented by the model.

In order to simulate a macroeconomic model using Dynamo the following steps have to be taken:

- (i) Formulation of the model of the system under consideration in Dynamo notation;
- (ii) Specification of the initial values of the state variables;
- (iii) Provision of the input data including time series of exogenous variables; and
- (iv) Specification of the required length of the simulation run.

The state of the system at the beginning of the simulation run is specified by the *initial values of the starting conditions included in the Dynamo equations*. Then the program determines the values of the endogenous variables of the system at the end of each time interval. Each time interval is of equal length and time can be advanced as many intervals as required. A brief description of writing the model's equations in Dynamo mode is given in appendix 2 to this chapter.

Having translated the macroeconomic model to the system dynamic, the model can be dynamically simulated. Given the parameters of the model which

are assumed to be known (estimated in the case of our econometric model), the initial values of the state variables and time series data of the exogenous variables then the system of difference equations and relationships between the level, rate and auxiliary variables of the model determine the state of the model at any period.

Table (6.1) The system dynamic version of the macroeconomic model.

note Aggregate demand

$$A \quad Ad.k = C.k + Pi.k + X.k - Z.k$$

note Domestic absorption

$$A \quad Da.k = C.k + G.k + Pi.k$$

note Private consumption

$$A \quad C.k = (2.71^{**.13}) * (Cl.k^{**.38}) * (Yd.k^{**.58})$$

$$A \quad Cl.k = Dlinf3(C.k, 1)$$

note Private investment

$$A \quad Pi.k = (2.71^{**-10.87}) * (Y.k^{**.79}) * (Ncs.k^{1.45}) * (Gi.k^{**.41}) * ((Dcp.k/P.k)^{**-99})$$

note Disposable income

$$A \quad Yd.k = Y.k - (iw.k * e.k) * (Fpl.k/Pl.k) - (i.k * (Dcpl.k/Pl.k) - Dtax.k$$

$$A \quad Fpl.k = Dlinf3(Fp.k, 1)$$

$$A \quad Dcpl.k = Dlinf3(Dcp.k, 1)$$

$$A \quad Pl.k = Dlinf3(P.k, 1)$$

note Export

$$A \quad X.k = (2.71^{**-9.2}) * ((e.k * Pw.k/P.k)^{**.94}) * (Yw.k^{**.90}) * (Xl.k^{**.40}) * (Dum.k^{**.60})$$

note Imports

$$A \quad Z.k = ((e.k * Pw.k/P.k)^{**(-.013)}) * (Yl.k^{**-1.6}) * (Y.k^{2.07}) * (el.k * Frl.k/Pl.k * Zl.k)^{**.11} * (Zl.k^{**.58}) * (Dum.k^{**-45})$$

note Aggregate production function

$$A \quad Y.k = (2.71^{**2.4}) * (Ncsl.k^{**.14}) * (Ti.k^{**.50}) * (Lab.k^{**.70})$$

note Aggregate production function in per-labour form

$$A \quad (Y.k/Lab.k) = (2.71^{**1.03}) * (Yl.k/Labl.k)^{**.68} * (Ncs.k/Lab.k)^{**.20} * (Z.k/Ncs.k)^{**.148}$$

note Net capital stock

$$L \quad Ncs.k = Ncs.j + Dt * (Ti.jk)$$

$$N \quad Ncs = 8972.9$$

$$A \quad Ncsl.k = Dlinf3(Ncs.k, 1)$$

note Total investmet

$$A \quad Ti.k = Gi.k + Pi.k$$

note Government revenues

$$A \quad T.k = Oilr.k + (Dtax.k + Indtax.k)$$

note Direct taxation

$$A \quad Dtax.k = Dtax0 + dtr * (Y.k)$$

Table (6.1) continued

note Indirect taxation

A $\text{Indtax.k} = \text{Indtax0} + \text{indtaxr} * (\text{Y.k})$

note Net factor income from abroad

A $\text{Nft.k} = \text{Ca.k} + \text{P.k} * (\text{Da.k} - \text{Y.k})$

note Current account

A $\text{Ca.k} = \text{P.k} * (\text{X.k} - \text{Z.k}) + \text{Fae.k}$

A $\text{Ca.k} = \text{Dlinf3}(\text{Ca.k}, 1)$

note Foreign asset earning

A $\text{Fae.k} = \text{iw.k} * \text{e.k} * (\text{Frl.k} + \text{Fpl.k} + \text{Fgl.k})$

note Foreign exchange reserves

L $\text{Fr.k} = \text{Fr.j} + \text{Dt} * (\text{Bop.jk})$

N $\text{Fr} = .077$

A $\text{Frl.k} = \text{Dlinf3}(\text{Fr.k}, 1)$

note Balace of payments

R $\text{Bop.kl} = (1/\text{e.k}) * \text{Ca.k} - (\text{Fpr.kl} + \text{Fgr.kl})$

note Foreign assets held by private sector

A $\text{Fp.k} = \text{Fp.j} + \text{Dt} * (\text{Fpr.jk})$

N $\text{Fp} = .02$

R $\text{Fpr.kl} = (1/\text{e}) * (\text{P.k} * (\text{Yd.k} - \text{C.k} - \text{Pi.k}) - (\text{Mr.kl} - \text{Dcpr.kl}))$

note Foreign assets held by public sector

L $\text{Fg.k} = \text{Fg.j} + \text{Dt} * (\text{Fgr.kl})$

N $\text{Fg} = -.01$

note Central bank's balance sheet (M2)

L $\text{M.k} = \text{M.j} + \text{Dt} * (\text{Mr.jk})$

N $\text{M} = 66.3$

A $\text{Ml.k} = \text{Dlinf3}(\text{M.k}, 1)$

R $\text{Mr.kl} = (\text{e.k}) * (\text{Bop.kl}) + \text{Dcr.k}$

note Domestic credit

L $\text{Dc.k} = \text{Dc.j} + \text{Dt} * (\text{Dcr.jk})$

N $\text{Dc} = 38$

R $\text{Dcr.kl} = \text{Dcpr.kl} + \text{Dcpg.kl}$

note Budget deficit

A $\text{Bd.k} = \text{G.k} - \text{T.k}$

note Demand for real money (money market equilibrium)

A $\text{Mreal.k} = (2.71^{**} - 1.3) * (\text{Y.k}^{**} .24) * (\text{P.k} - \text{Pl.k} / \text{Pl.k})^{**} (-.85) * (\text{Ml.k} / \text{Pl.k})^{**} (.91)$

note Long-run demand for money

A $\text{Lmd.k} = (\text{Mreal.k})^{**} (1/.48) * ((\text{Ml.k} / \text{Pl.k})^{**} (1 - 1/.48))$

note Excess money balance

A $\text{Emb.k} = (\text{M.k} / \text{P.k}) / (\text{Lmd.k})$

note Shadow money balance

A $\text{Msh.k} = \text{M.k} + (\text{e.k} * \text{Fpr.kl})$

note Price level

L $\text{P.k} = \text{P.j} + \text{Dt} * (\text{Inf.jk})$

Table (6.1) continued

N $P=.121$
R $Inf.k1=(Ep.k-P.k)*(Emb.k)$
A $Infl.k=Dlinf3(Inf.k,1)$
A $Ep.k=(2.71^{**}.18)*(P.k^{**}.90)*(M.k/P.k)^{**}(.125)*(Y.k^{**}-.175)$

Given the time series of the exogenous variables this system dynamic model can be used for dynamic simulation of the macroeconomic model using the computer program Dynamo. Time series data are the same used in the estimation of the macroeconometric model but the time period is extended to 1993 to examine the performance of the simulation in immediate post sample period. Data sources are given in chapter IV.

6.4 Simulation experiments

Prior to the experiments of simulation, some important characteristics of the procedure are mentioned.

- (1) The structure of the model outlined in the previous chapters of this thesis is assumed to be the true structure of the Iranian economy in the period of concern (i.e. 1959-1993). The estimated method used produces consistent estimates of the parameters.
- (2) The simulations presented in this study are non-stochastic.
- (3) All of the simulations used in this work are dynamic in the sense that in r-th simulation period, simulated lagged endogenous values from the first r-1 simulation periods are used instead of actual lagged endogenous variables. This permits the “tracing out” of the time path of the response to a given change.

(4) To examine the model's ability to track the actual time paths of the endogenous variables we first allow the exogenous variables to take their actual time series. This enables us to compare trajectories of the endogenous variables generated by dynamic simulation of the model to their actual time series. The model's performance for the main endogenous variables of the economic system are given in figures (6.1) to (6.8). Two criteria of the model's simulation performance namely the annual percentage deviation (APD) and the proportional root-mean squared errors (PRMSE) also are computed to give a more accurate assessment of the model's ability of tracking the actual time paths of the endogenous variables (see table 6.2). Having established the model's overall prediction characteristics we then use it for the purpose of policy simulation. For each policy simulation an explicitly indicated change in policy or a change in some other exogenous variable is explored. All other exogenous variables are fixed on their average growth rates, except for the nominal exchange rate which is set at its average value for the sample period; all parameters are set to their estimated values. Notice that for policy simulations, it would be inappropriate to use the actual time series of the exogenous variables. The reasons are two fold: first, due to fluctuations in the time paths of the variables in the sample period, tracing the adjustment process of the endogenous variables, induced by a policy change in the model, would be ambiguous. Secondly, since the rates of change of the variables differ within the sample period, the sign and magnitude of the impact of a policy change will depend on the time that the policy change is introduced. For example, some exogenous variables of the model have been growing in 1970-78 but declining in 1978-85.

Therefore, in the dynamic simulation generated by running the model with the exogenous variables taking their actual values the impact of a change in policy instruments in sub-period 1970-78 would be different from that of 1979-85.

(5) Because the model is basically non-linear in its structure, it cannot be solved by simple matrix inversion. Instead an ordinary substitution procedure (of the Dynamo type discussed above) is utilised to solve the model.

(6) In some simulations the indicated shocks are for the initial year only. The results therefore give the time path of the responses to such a once and for all change. In other cases the indicated shocks are maintained throughout the five year period. These alternatives will be identified in each case.

(7) In dynamic simulation of the complete model we have maintained our specification of the macroeconomic model proposed in chapter III. However, estimation results presented in chapter IV of this study indicated that in the time period under consideration, in the Iranian economy, interest rates have had no significant effect on private sector consumption and investment. We therefore have eliminated the interest rate variable from demand for money the private consumption and private investment functions in simulation experiments-as was the case for impact multiplier analysis of chapter V. The same applies to the expected rate of inflation (i.e. $\frac{EP_{t+1} - P_t}{P_t}$). No significant effect from the expected rate of inflation was found in the demand for money function or the private consumption function in estimating these functions (discussed in chapter IV). When we replaced the expected rate of inflation with the current period inflation rate the estimation results in the demand for money function were considerably

improved. Therefore, in dynamic simulation of the model the expected rate of inflation is replaced by the current rate of inflation.

(8) In dynamic simulation of the complete model, all the variables of the structural model except the exogenous and policy variables (categorised below, above section 6.6.1) are simulated within the model. In other words only the initial values of the state variables, values of the estimated parameters and assumed time series of the exogenous variables of the model (each grows at their sample average rate except the nominal exchange rate which takes its sample mean value) are given and then entire time paths of all the endogenous variables are generated by the ordinary substitution method. It should be stressed that in the dynamic simulation of a macroeconometric model, the simulation process is repeated and therefore errors are accumulated and the forecast performance gradually worsens. In our simulation model, as will be shown below, there is a good fit with the data. However, no model will fit the data (i.e. actual time paths of the endogenous variables) exactly and therefore, the time trajectories of the endogenous variables generated in the simulation process are likely to differ from their actual time series (see footnote 1 below).

(1) In one case we had to modify the equation for public holding of foreign assets and the balance of payments equations in order to prevent non-positive value for foreign exchange reserves that could stop simulation process. Magnitude of the variable foreign exchange reserves (Fr) in the model is small compared to other variables of the national accounts and a deviation of the determinant variables of Fr , from their actual time series, could reduce Fr below zero. On the other hand the lagged foreign exchange reserves appear in the (log linear) import demand function ($\log Z$). This was transferred back into the pure variable form (continued) (Z) when from (Z) when coded in the simulation model, with the estimated coefficients on the explanatory variables as the variables' power. However, in order to compute the numerical values of the difference equation in the simulation process, the simulation would stop if this variable fell to or below

6.5. Complete Model Performance in the Sample and Immediate Post-Sample Period

We first present a dynamic simulation of the main endogenous variables of the model. Notice that the purpose of this simulation is to test the model's ability to track the actual time paths of the endogenous variables. As a result, actual time series of the exogenous variables are used in these experiments. Examining these results enables us to compare simulated trajectories of these variables with their actual time paths, a process which allows us to form some judgement as to how well the model performs as an interdependent system in tracking the movements of certain economic variables. The time period of the simulation includes the entire sample period of simulation of the econometric model (i.e. 1959-1991) and the first two years after (1992-93). Thus this is a full-model full-period historical simulation of the system designed to assess its dynamic interactive behaviour. For some portion of this time period, namely between 1979 and 1987, the country experienced major shocks, most notably the 1979 revolution and a prolonged and devastating war with a neighbouring country -Iraq. In view of these facts,

Footnote 1 continued:

zero. To avoid this we had to confine foreign exchange reserves (Fr) to lie strictly above zero in the simulation process. The economic behaviour that justifies this was the government action of changing its foreign assets position to prevent total depletion of the central bank's foreign exchange reserves. In order to incorporate this constraint on Fr within the model the equation of the public holding of foreign assets (Fg which is an exogenous variable to the model) was modified to allow an equal rundown of the public sector foreign assets whenever a complete depletion of the foreign exchange reserves of the central bank was possible. The modified (Fg) has an extra component ($Gfbp$) added to its rate variable (Fgr). This variable ($Gfbp$) equals zero when $Fr > 0$ and equals Fr when $Fr < 0$. The balance of payments (Bop) in this case becomes $Bopt = (1/et) \cdot (Cat) - [Fprt + (Fgrt + Gfbpt)]$ that assures Fr be always non-negative.

simulation of the model over this period is a fairly rigorous test of the internal stability of the system.

The results of the dynamic simulation of the main endogenous variables of the model are displayed graphically on the following pages. An explanatory note on the graphs is in order. Figures (6.1) to (6.8) illustrate the behaviour of the model in tracking periods which include some turning points in the endogenous variables. This is considered to be a relatively important measure of the model's ability to capture changes in the historical data. Furthermore, at the end of these graphs two quantitative measures of the prediction accuracy of the model, for the sample period years, are presented in table (6.2). One of these quantitative measures is PRMSE (percentage root-mean squared errors). This statistic is a measure of the percentage deviation of the simulated variables from their actual paths and is defined as:

$$(6.1)...PRMSE = + \sqrt{\frac{1}{T} \sum \left(\frac{Y_a - Y_s}{Y_a} \right)^2}$$

where T is the number of periods used for simulation (number of years in our annual model), Y_a is actual values of variables and Y_s denotes the simulated values of variables. The other statistic given in the table (6.2) is the annual percentage deviation (APD) of the main variables' actual values from their simulated paths.

The important characteristics of the results presented in table (6.2) and figures (6.1) to (6.8) merit emphasis.

(1) Given the simulation period (1959-93) it seems that the 34 year dynamic simulation traces actual time series reasonably well.

(2) The percentage root-mean squared errors for the main variables in the sample period(1959-93) are .098 for consumption (C), .266 for private investment(Pi), .312 for exports (X), .263 for imports(Z), .114 for aggregate income(Y), .05 for capital stock (Ncs), .177 for real demand for money (md) and .10 for price level (P). The percentage root-mean squared errors for sample periods (1959-78) and (1959-91) are also reported in table (6.2). These results compare favourably with the similar statistics calculated from a dynamic simulation of a macroeconomic model for Chile. For example in the Chilean simulation for the period 1962-68 (i.e. only for seven years), the percentage root-mean squared errors for some of main variables are .106 for investment, .064 for exports , .071 for imports, .044 for Gdp deflator, .36 for the government deficit, .201 for production capacity and .303 for the net factor income from abroad (Behrman, (1977) pp 242-43).

(3) As expected, the discrepancy between actual and simulated values for most variables occurs around those years in which there has been a considerable fluctuation in the time paths of the variables. In 1985-86 for example, a fall in the world oil price caused a major current account deficit. The APD for exports and imports in table (6.2) for this year is larger than other years. Therefore, if the observations for these years had been excluded the mean absolute percentage errors would certainly have been smaller.

(4) The results suggest that the model is no less successful as the dynamic simulation is lengthened or as consideration is extended to the immediate post-

sample period. Observations for years 1992 and 1993 were not used in estimation of the macroeconometric model yet the results of simulations extended to 1993 suggest that the model approximates the endogenous variable paths fairly well. However, this is not to say that the model can be utilised successfully without revision for subsequent periods. Substantial structural changes such as privatisation of industries and unification of the multi-tiered exchange rate regime (developed between 1981-89) were being introduced in the later years of the period under consideration.

Table(6.2) Percentage deviation (APD) and proportional root-mean squared errors (PRMSE) for the main variables of the model for dynamic simulation

| | Annual Percentage Deviation | | | | | | | |
|----------------|-----------------------------|-------|-------|--------|--------|--------|-------|--------|
| | C | Pi | X | Z | Y | Ncs | (M/P) | P |
| 1959 | 0.0 | 0.0 | 0.0 | 0.0 | -0.01 | 0.0 | -0.5 | 0.0 |
| 1960 | 0.05 | 0.01 | 0.22 | -0.08 | -0.02 | -0.014 | -0.49 | 0.014 |
| 1961 | 0.03 | -0.29 | 0.32 | -0.19 | -0.05 | -0.006 | -0.66 | 0.039 |
| 1962 | 0.03 | -0.19 | 0.35 | -0.26 | 0.026 | -0.033 | -0.29 | 0.033 |
| 1963 | 0.04 | -0.53 | 0.36 | -0.44 | 0.021 | -0.057 | -0.16 | 0.022 |
| 1964 | 0.07 | -0.11 | 0.32 | -0.47 | 0.067 | -0.07 | -0.15 | 0.032 |
| 1965 | 0.043 | -0.21 | 0.17 | -0.24 | -0.021 | -0.07 | -0.21 | 0.025 |
| 1966 | 0.051 | -0.14 | 0.14 | -0.21 | 0.023 | -0.08 | -0.17 | -0.001 |
| 1967 | -0.014 | -0.05 | 0.16 | -0.10 | -0.027 | -0.07 | -0.13 | -0.008 |
| 1968 | -0.14 | -0.12 | 0.21 | -0.07 | -0.048 | -0.06 | -0.17 | -0.021 |
| 1969 | -0.16 | -0.21 | 0.09 | -0.14 | 0.01 | -0.07 | -0.20 | -0.011 |
| 1970 | -0.18 | 0.05 | 0.18 | 0.04 | -0.003 | -0.05 | -0.21 | -0.024 |
| 1971 | -0.14 | -0.07 | 0.25 | 0.10 | 0.022 | -0.05 | -0.20 | -0.025 |
| 1972 | -0.17 | 0.20 | 0.19 | 0.21 | 0.085 | -0.03 | -0.08 | -0.014 |
| 1973 | -0.13 | 0.04 | 0.36 | 0.09 | 0.09 | -0.03 | -0.03 | 0.013 |
| 1974 | -0.03 | 0.24 | 0.37 | 0.18 | 0.13 | -0.06 | -0.04 | 0.061 |
| 1975 | -0.03 | 0.37 | 0.10 | 0.58 | 0.14 | -0.03 | 0.02 | 0.06 |
| 1976 | 0.05 | 0.41 | 0.08 | 0.21 | 0.09 | 0.02 | -0.02 | -0.03 |
| 1977 | 0.06 | 0.25 | -0.14 | -0.04 | 0.09 | 0.02 | -0.33 | 0.037 |
| 1978 | -0.21 | -0.26 | -0.44 | -0.28 | -0.17 | 0.01 | -0.32 | 0.016 |
| 1979 | -0.13 | -0.38 | 0.09 | -0.36 | -0.04 | 0.00 | -0.05 | -0.04 |
| 1980 | -0.12 | -0.04 | -0.8 | -0.21 | -0.08 | 0.004 | 0.03 | -0.07 |
| 1981 | -0.04 | -0.05 | -0.60 | -0.12 | -0.03 | 0.007 | -0.02 | -0.12 |
| 1982 | 0.06 | -0.06 | 0.15 | -0.12 | 0.13 | 0.015 | 0.06 | -0.18 |
| 1983 | 0.15 | 0.37 | 0.23 | 0.34 | 0.19 | 0.046 | 0.09 | -0.19 |
| 1984 | 0.16 | 0.35 | 0.10 | 0.19 | 0.19 | 0.07 | 0.15 | -0.21 |
| 1985 | 0.17 | 0.26 | -0.09 | -0.08 | 0.22 | 0.08 | 0.29 | -0.28 |
| 1986 | 0.10 | 0.01 | -1.45 | -0.39 | 0.11 | 0.08 | 0.26 | -0.26 |
| 1987 | 0.02 | 0.03 | -0.54 | -0.40 | 0.17 | 0.05 | 0.14 | -0.17 |
| 1988 | -0.02 | 0.07 | -0.05 | -0.003 | 0.12 | 0.05 | 0.09 | -0.10 |
| 1989 | -0.04 | 0.18 | 0.10 | 0.34 | 0.14 | 0.05 | 0.07 | -0.07 |
| 1990 | 0.06 | 0.13 | 0.28 | 0.70 | 0.08 | 0.06 | 0.08 | -0.13 |
| 1991 | 0.05 | 0.03 | 0.22 | 0.24 | 0.01 | 0.06 | 0.04 | -0.09 |
| 1992 | -0.06 | 0.37 | 0.13 | 0.06 | -0.03 | 0.08 | -0.0 | 0.05 |
| 1993 | -0.26 | 0.11 | -0.10 | 0.11 | -0.20 | 0.09 | -0.10 | 0.17 |
| PRMSE(1959-78) | 0.083 | 0.25 | 0.338 | 0.23 | 0.070. | 0.045 | 0.185 | 0.03 |
| PRMSE(1959-91) | 0.098 | 0.25 | 0.314 | 0.268 | 0.11 | 0.049 | 0.183 | 0.10 |
| PRMSE(1959-93) | 0.098 | 0.266 | 0.312 | 0.263 | 0.114 | 0.05 | 0.177 | 0.10 |

Figure (6.1) Actual (Cac) and simulated (C) time paths of consumption

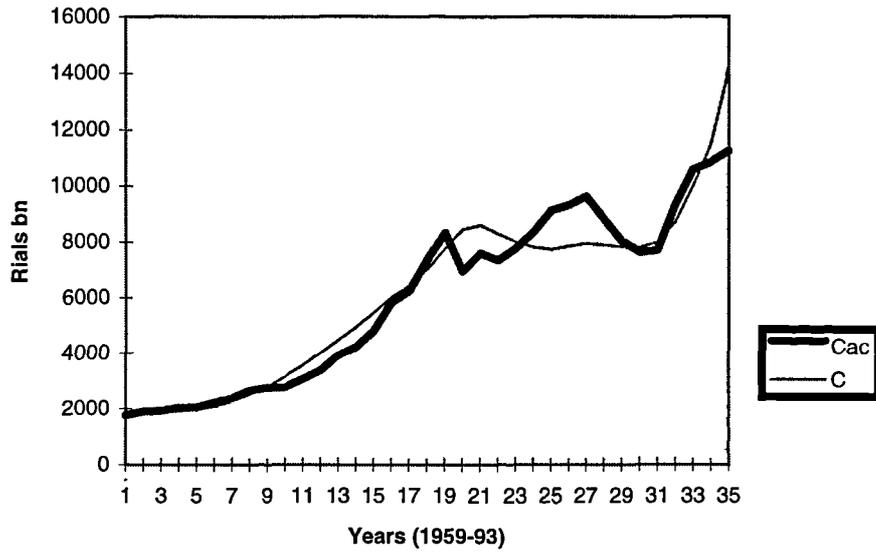


Figure (6.2) Actual (Piac) and simulated (Pi) time paths of private investment

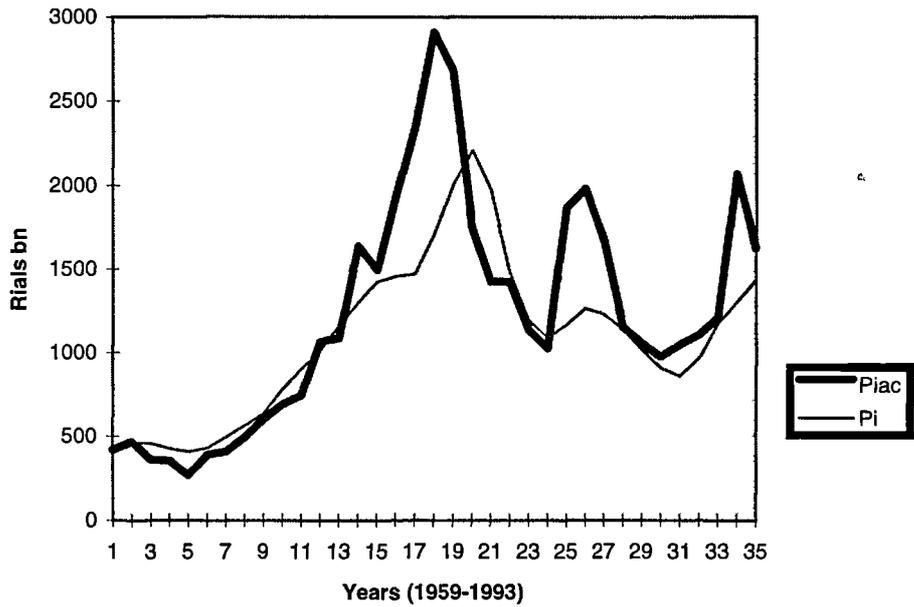


Figure (6.3) Actual (X_{ac}) and simulated (X) time paths of exports

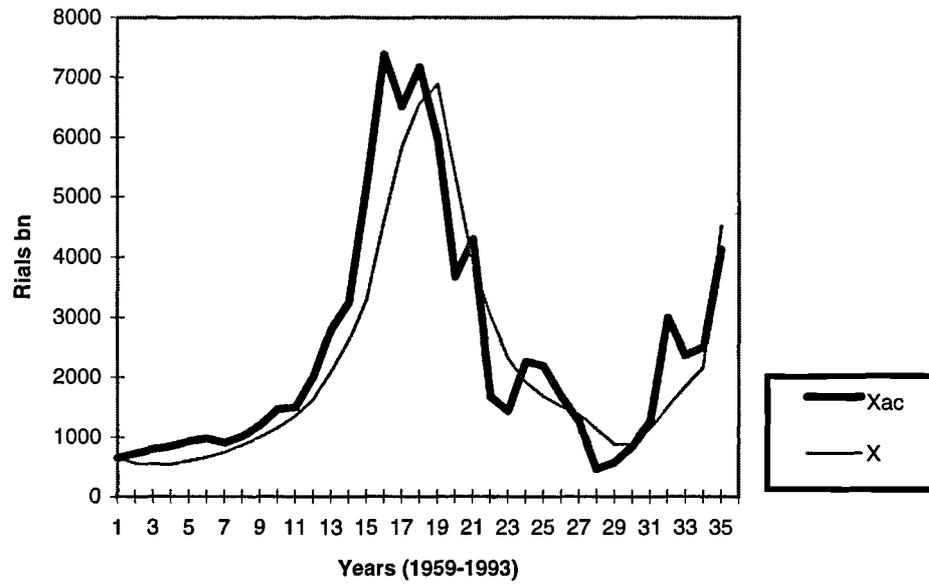


Figure (6.4) Actual (Z_{ac}) and simulated (Z) time paths of imports

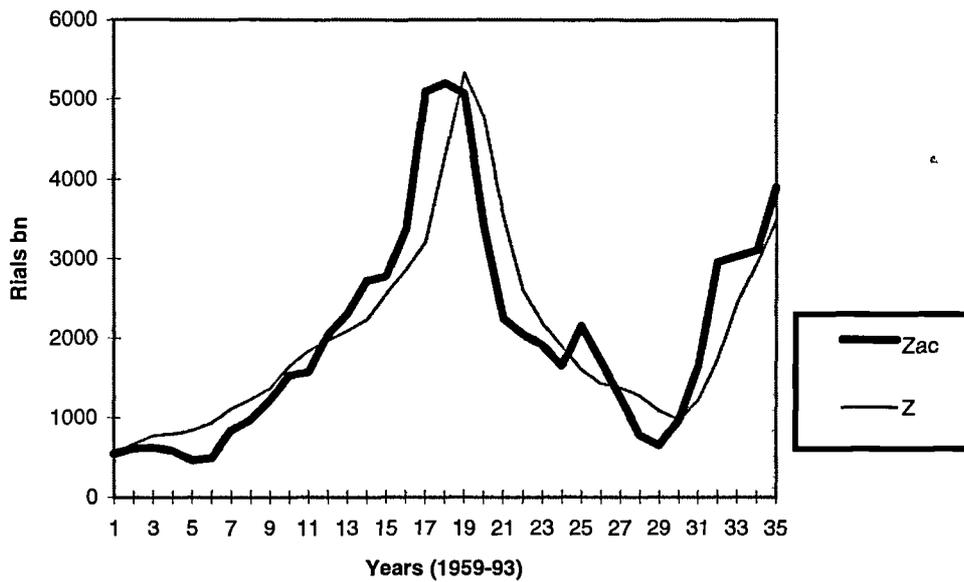


Figure (6.5) Actual (Yac) and simulate (Y) time paths of aggregate income

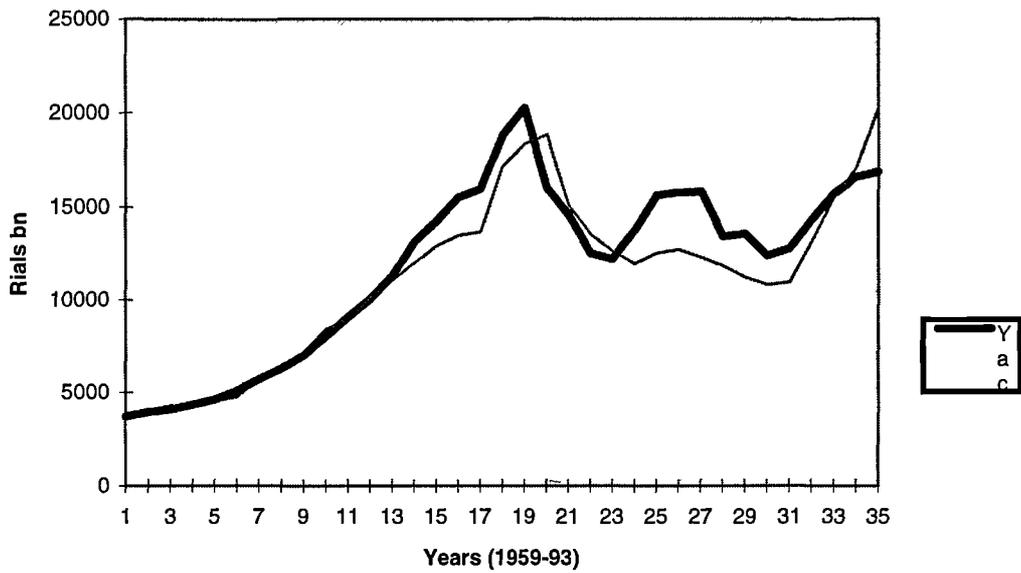


Figure (6.6) Actual (Ncsac) and simulated (Ncs) time paths of the capital stock

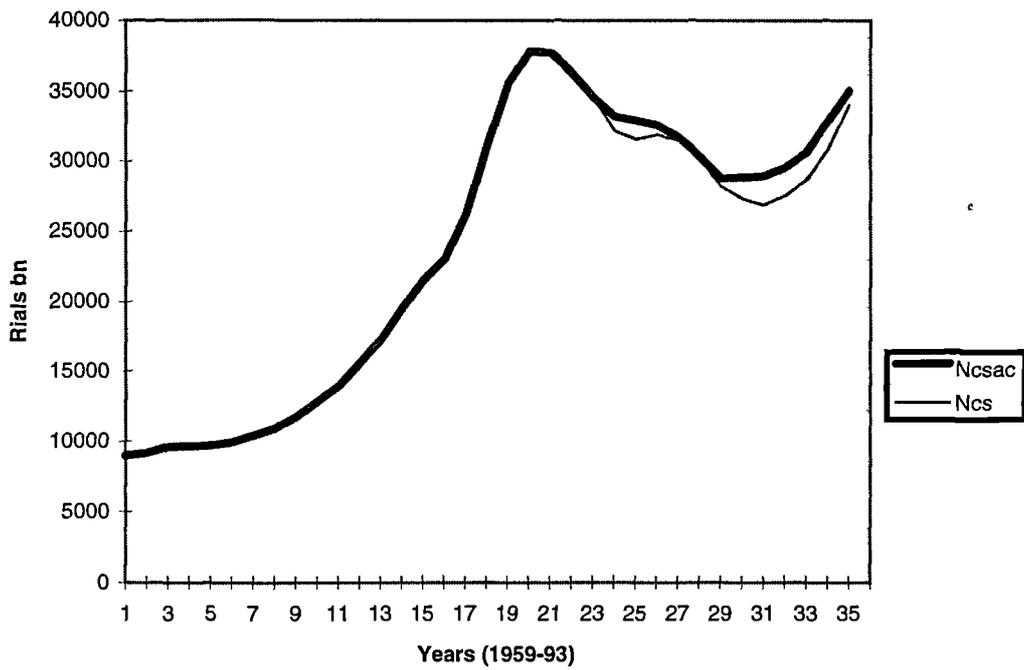


Figure (6.7) Actual [(M/P)_{ac}] and simulated (M/P) time paths of real money balance

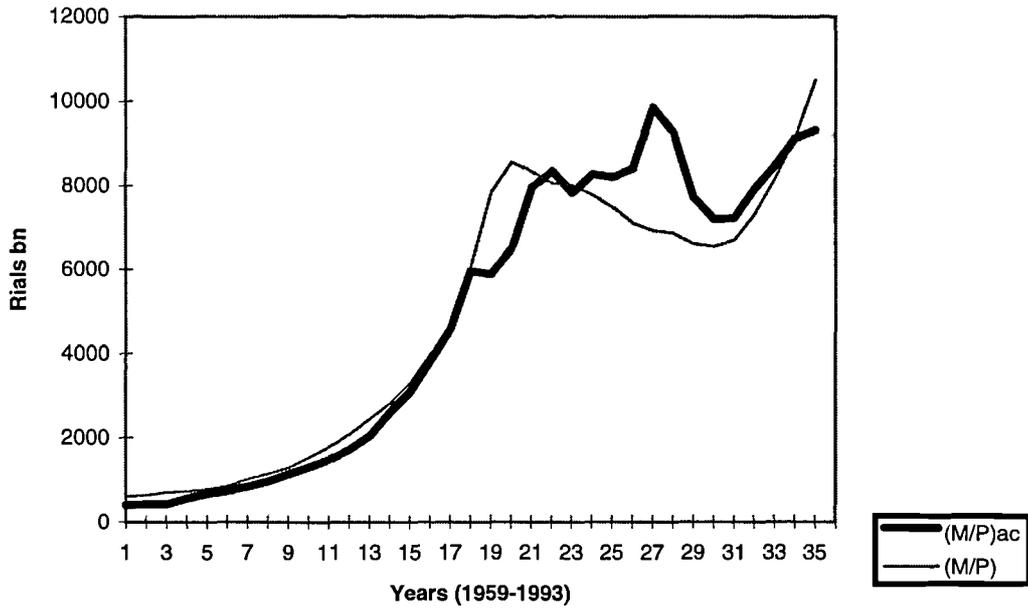
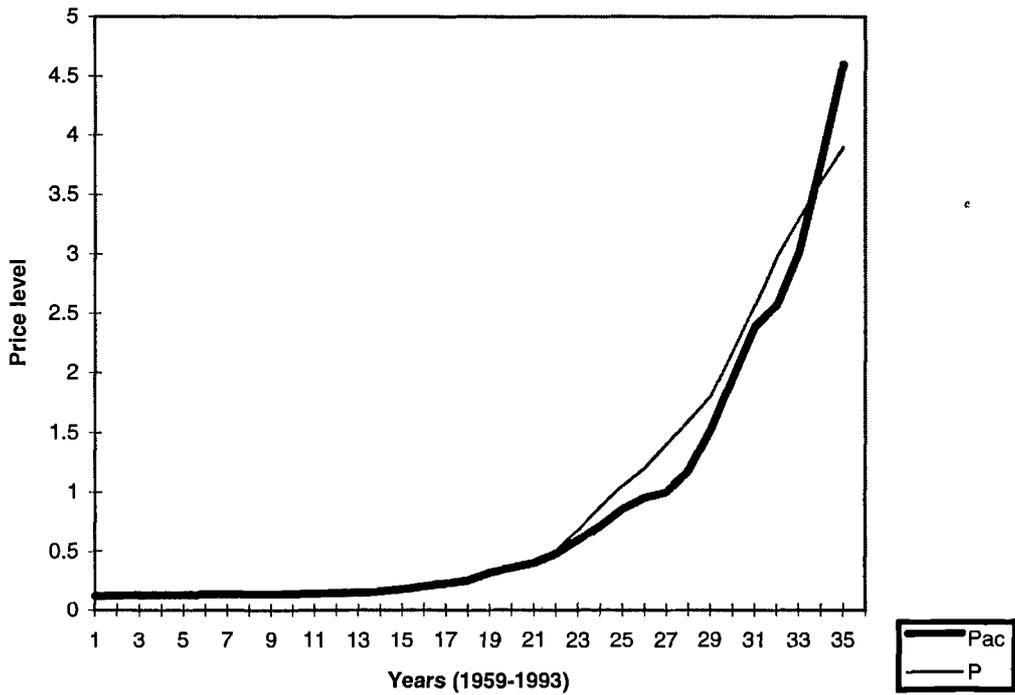


Figure (6.8) Actual (P_{ac}) and simulated (P) paths of the price level



6.6 Policy Simulation with Complete Model

The structure of a macroeconomic model determines its characteristics. The macroeconomic model developed here incorporates the well-known monetary approach to the balance of payments and a variant of the open-economy neo-classical growth model. The model provides a framework for the analysis of price movements and the balance of payments in conjunction with economic growth. In a developing country, sustained economic growth is central to any adjustment strategy intended to achieve long-run viability in the balance of payments and a permanent reduction in the rate of inflation (see Khan and Montiel, 1989).

For the reasons discussed in section (6.5) above, we have conducted our policy simulation experiments within the dynamic system which is assumed to be growing at the average rate of its exogenous variables. We have run the model for 35 time periods (the number of our observations) using the mean growth rate of the exogenous variables of the model for this period. This makes our base simulation comparable with policy simulations. Allowing the model to grow at its steady-state rate does not affect our analysis of the adjustment process in the economic model provided that the model is dynamically stable. To explore the impact of a change in a policy instrument or in some other exogenous variable of the model, we utilise a simulation of the complete model. The effects of a policy change can be evaluated by examining the percentage deviation between the base simulation and the simulated time paths of the endogenous variables of the model. The impact of such change is measured from a dynamic base simulation for 1959-93.

A prerequisite for policy simulation experiments in a dynamic model is, therefore, its stability. The system is described as stable if any divergence between the actual values of the endogenous variables and their equilibrium values disappears over time, otherwise the system is unstable. Dynamic stability of the model, therefore, appears to be a crucial measure of its structural reliability. Our experiments, which consist of introducing an impulse to the values of different exogenous variables of the model, indicate that the model is dynamically stable(see footnote 1 below).

The complete model of the Iranian economy in the previous section is now utilised to explore the consequences of various economic policy changes and external shocks. Standard fiscal and monetary policy actions along with exogenous shocks such as changes in the world oil price and OECD countries' aggregate income are examined and model's response to these changes is discussed. We have organised our policy simulation experiments around those policy and exogenous variables which are expected to have the most important impact on the economic system. These variables include a range of fiscal and monetary policy variables as well as exogenous variables such as the oil revenue and OECD aggregate income. More precisely, policy and exogenous variables in our economic system consist of:

(1). Over 300 simulation experiments have been conducted with the model. In general model adjust to its base simulation growth path within several periods of policy change and half the adjustment complete for most variables within 2 to 3 periods.

- (i) Fiscal policy variables including government investment (G_i), government consumption (G_c), rates of direct taxation (D_{tax}) and indirect taxation (Ind_{tax}).**
- (ii) Monetary policy instruments, including domestic credit to the public sector (D_{cg}), domestic credit to the private sector (D_{cp}) and public sector holdings of foreign assets (F_g).**
- (iii) The nominal exchange rate (e) as a foreign sector policy variable.**
- (iv) Exogenous variables, including oil revenue (O_{ilr}), OECD countries' income (Y_{oeed}) and the world consumer price level (P_w).**

We discuss below the model's response to changes in policy and exogenous variables, giving more detailed treatment to those policy simulations that merit emphasis. These are the policy simulations that display some considerable effects on the endogenous variables regarding either the direction of developments, after policy implementation, or the scale of the changes relative to the base simulation.

6.6.1 Fiscal Policy

Rapid increase in the government fiscal deficit has been an important source of macroeconomic imbalance in Iran, particularly in the 1980s. Because of the role the budget deficit played in fuelling inflation in this period, it has been one of the government's priorities to lower its budget deficit. In the first 5 year economic development plan (1990-94), the government committed itself to take effective measures to reduce the budget deficit to 5 percent of public expenditure by the end of the plan. A similar policy has been proposed for the second economic plan (1995-99).

The overall government budget constraint shows that a fiscal deficit can be financed in three ways: (i) by expansion of domestic credit to the public sector from the banking system, (ii) by running down foreign assets of the public sector, and (iii) by an increase in public borrowing from the private sector. In Iran, as in most developing countries, borrowing from the private sector through open market operations has not been a substantial source of financing the public borrowing requirements (due to a lack of relevant institutional arrangements). This denies the government one of its economic policy instruments and, at least in part, can be seen as a reason for governments, in developing countries, resorting to an inflation tax as the principal means of financing a budget deficit. Thus, in our model, borrowing from the private sector is not considered to be a policy option.

Financing the public borrowing requirement by internal or external sources will have different impacts on inflation, the balance of payments and output. In the case where a budget deficit is financed through foreign loans, a planned fiscal deficit can be closed with no inflationary pressures as domestic absorption does not exceed available resources. However, unless domestic production (Y) does increase within a reasonable time period of the acquisition of the loan, and exports (X) increase more than imports (Z), the current account will deteriorate as total absorption increases.

On the other hand, if the fiscal deficit was financed mainly through the expansion of domestic credit to the public sector, as has been the case in Iran for most of the sample period (1959-93), the money supply defined in our model as $M=Dc+e.Fr$ will exceed the real demand for money of the private sector with

most likely inflationary consequences. Of course not all money -financed deficits need be inflationary as some increase in the demand for money might occur because of economic growth or expansion of the monetized sector of the economy that may happen when the economy operates under its capacity limits or its capacity increases.

The effect of a fiscal deficit on the current account (Ca) might not be significant in the short-run but in the longer term if it caused any inflationary pressure the real exchange rate will appreciate assuming a fixed nominal exchange rate. This will increase the current account deficit.

The effects of government spending on income and expenditure have been the subject of considerable controversy (see Tarp 1993). It is not the direct effect of change in public spending but the indirect effect via the possible crowding out of the private sector which has generated debate.(see Stevenson et al.(1988), and Karshenas (1991)) Crowding-out concerns the effectiveness of fiscal policy in stimulating aggregate demand. Even disregarding the interest rate effects (because the interest rate in the estimated private investment and consumption functions was found to be statistically insignificant and small in magnitude), the financing of additional public spending might still affect the availability of funds for the private sector. Similarly, an increase in the price level following the government spending increase, reduces the real value of money balances which may lead to lower spending to re-establish money holdings at the desired level. Finally, some public expenditure may be a substitute for private expenditure allowing the private sector to save more (see Tarp, 1993).

Government spending can also promote private investment. The profitability of private investment can be increased by public sector activities as demand for private investment may be increased by public sector expenditure. In Iran, because of the considerable size of the government investment in the sample period (1959-93), peaking in the 1970s when the oil revenue increased considerably, there has been a large public owned capital stock as well as a backlog of investment projects that government has to finance in order to promote utilisation of the capital stock to its capacity limits. For this reason it seems that, for the foreseeable future, financing public sector investment will be given priority in the allocation of the available investable funds to the economy.

Importantly, the public sector deficit can only be used with great care as an indicator of the fiscal impact on aggregate demand because not only the size but also the composition of public sector expenditure matters. Public investment can have different effects on private sector expenditure compared with public consumption.

The above discussion of budget deficit financing assumed the government revenue to be given; however, the government could manipulate its tax policies in the medium term in order to reduce its borrowing requirements. Furthermore, a considerable part of government consumption in Iran is related to the relatively large amount of subsidies paid to keep basic commodities affordable for lower income groups of the population. As the economy grows, and the average per capita income increases, one can expect the government to allow the prices of these goods and services to move closer towards their free market prices thereby lowering the public sector borrowing requirement. This policy of reducing

subsidies was adopted in the first five year development plan (1990-94) and is also endorsed for the second five year economic plan (1995-99).

In the next section we present the results of policy simulations of the deviation of fiscal policy instruments from their base simulation trends. In general, two alternative simulations have been run for each deviation of policy variables from their base simulation path: a one year step increase and a five year increase of policy and exogenous variables above their base simulations. A number of these simulations are presented in figures and tables in the following pages. Space constraints preclude the presentation of each set of simulations so only some of the experiments, those that display most interesting characteristics of the economic system, are given.

6.6.1.1 Change in Government Investment

In this policy simulation we consider an increase of government investment. From the government budget constraint we recall that any budget deficit caused by an increase in public expenditure has to be financed either by extension of domestic credit of the banking system (Dcg) or by a change in government foreign assets (Fg). In the case of Iran both options have been adopted by the government during the sample period under study.

6.6.1.1.(a) Change in Public Investment Financed by Domestic Credit

First, consider financing an increase in government investment by an expansion of domestic credit. The main variables' responses to a 10 percent increase in government investment financed by domestic borrowing are depicted in table

(6.3). As is apparent, the time path responses vary across variables. In most cases more than five years is required to complete the adjustment process. We organise the policy change effects on four major areas of the model: (i) aggregate supply (Y);(ii) private expenditure (P_i and C), (iii) price, nominal money supply and real money demand (P, M, md); and (iv) the foreign sector of the economy (X, Z and C_a).

The percentage changes of the variables in the policy simulation discussed below are all compared to their base simulation values (i.e. values they would have taken had all the exogenous and policy variables been on their average growth paths) and are independent of their initial values in the policy experiments.

A step increase of 10 percent in government investment (G_i) induces an immediate increase of about 5.9 percent in total investment ($T_i = P_i + G_i$). However, while G_i as a policy variable resumes its base simulation trend from period 2 and onwards, total investment (T_i) continues to grow above its base simulation trend. This is obviously due to the rise of private investment, which is an increasing function of public investment and economic growth. Stimulated by the total investment increase, aggregate output (Y) increases 2.4 percent above its average growth rate in period 1. The rate of economic growth diminishes gradually towards its trend value and simulation of the model over the longer term shows that the aggregate supply adjusts to its average growth trend in period 22. However, half the adjustment process is completed in the first three years.

As aggregate income increases, private consumption and investment, (both increasing functions of aggregate income), begin to rise above their base simulations. However, there is a one period delay in the response of private expenditure following the policy change. We note that there is no evidence of a crowding-out effect of public investment on private sector behaviour. We find evidence of completion of half the full adjustment being completed in 7 and 5 periods for consumption and private investment respectively.

Turning to the monetary sector of the model, we recall that the money supply in the model is determined by domestic credit and foreign exchange reserves; while the demand for real balances is primarily determined by aggregate income. Following a 10 percent increase in public investment, and its equivalent expansion of domestic credit to the public sector, the money supply rises above its base simulation, with a one period delay, by 8.2 percent in period 2. The demand for money also changes, largely as a result of the growth of income induced by the public sector investment increase. Since in our model the demand for real balances and the money supply are determined by different factors in the economic system a short-run disequilibrium in the money market occurs following an increase in the money supply. However, the aggregate price level begins to adjust to its long-run average growth path following adjustment of the money supply and the demand for money to their corresponding trends. Simulation of the model for a longer period indicates that while half the full adjustment by the price level is completed by period 5, it takes 9 periods for the price level to reach its average growth path.

Economic growth, induced by public sector investment activity, is expected to increase the demand for imports while the (foreign) demand for exports could fall (due to an appreciation of the real rate of exchange caused by any domestic inflation alongside a fixed nominal exchange rate regime). As the policy

Table 6.3 Policy simulation using complete model: percentage deviation of the main endogenous variables* from their base simulation trend in response to a 10 Percent increase in public investment (Gi)

I-One year step increase

II-Five year increase

| periods | Ti | Y | C | Pi | M | md | P | X | Z | Ca | Fg |
|-----------|------|-----|-----|------|-------|--------|------|-------|------|-------|-------|
| I | | | | | | | | | | | |
| 1 | 5.9 | 2.4 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 2.0 | 1.1 | 1.2 | 4.8 | 8.2 | 1.9 | 0.4 | -0.08 | 3.8 | -11.7 | -0.8 |
| 3 | 1.1 | .66 | 1.0 | 2.9 | 1.4 | 4.3 | 0.8 | -0.5 | 1.0 | -5.2 | -1.8 |
| 4 | 1 | .58 | .93 | 2.6 | 0.1 | 1.2 | 0.5 | -0.6 | 0.5 | -4.0 | -2.1 |
| 5 | .93 | .55 | .8 | 2.4 | 0.005 | 0.05 | 0.3 | -0.57 | 0.4 | -3.8 | -2.3 |
| 6 | .8 | .51 | .77 | 2.2 | 0.0 | -0.05 | 0.21 | -0.5 | 0.37 | -3.5 | -2.4 |
| 7 | .75 | .47 | .7 | 2.0 | 0.0 | -0.002 | 0.12 | -0.4 | 0.32 | -3.2 | -2.4 |
| II | | | | | | | | | | | |
| 1 | 5.9 | 2.4 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 |
| 2 | 8.3 | 3.5 | 1.2 | 4.8 | 8.2 | 2.5 | 0.4 | -0.08 | 3.8 | -11.7 | -8 |
| 3 | 10.5 | 4.4 | 2.3 | 9.2 | 9.4 | 7.0 | 0.9 | -0.46 | 4.3 | -16.9 | -2.5 |
| 4 | 17.1 | 6.5 | 3.6 | 17.3 | 11.6 | 9.1 | 1.1 | -0.79 | 5.9 | -25.4 | -4.6 |
| 5 | 20.6 | 7.7 | 5.2 | 28.7 | 11.8 | 11.2 | 1.1 | -1.0 | 7.0 | -33.7 | -7.4 |
| 6 | 15.6 | 6.6 | 6.6 | 41.1 | 10.1 | 11.3 | 1.0 | -1.2 | 7.6 | -39.7 | -10.5 |
| 7 | 11.9 | 5.6 | 6.4 | 31.6 | 1.6 | 8.3 | 0.6 | -1.1 | 4.6 | -27.9 | -12.8 |

*Ti total investment, Y aggregate income, C consumption, Pi private investment, M nominal money supply and md real demand for money, P price level, X export, Z imports, Ca current account and Fg public sector holdings of foreign assets.

simulation results in table (6.3) reveal, imports increase, with a one period delay, in response to the economic growth, while exports diminish slightly. As a result, the current account of the balance of payments deteriorates. We notice the negative impact of the deterioration of the current account of the balance of

payments on the government's holding of foreign assets as the government sells these assets in order to maintain the stock of foreign exchange reserves and facilitate the foreign trade. This is important because of its implications for one aspect of the Iranian economy. As table (6.3) shows, by period 7, there is still no sign of reducing the rate of depletion of public sector foreign assets. In fact, running the model over a longer period shows that F_g continues to decline to the end of our simulation sample period(1). Although this should be obvious because of the persistence of the foreign sector deficit ($-Ca$), the important point is that, given the economy's structure, economic growth, induced for example by the government investment, could cause a sustained balance of payments deficit and that unless the problem is addressed by an effective policy (such as devaluation of the home currency) the economy could end up with an accumulation of foreign debts with no prospect of repayment in the near future.

Turning to the part II of table (6.3) the model's response to a five period increase in government investment financed by an equal increase in domestic credit to the public sector is similar to that of the one period step increase. The differences lie in the larger magnitude of changes and the longer adjustment process. However, it should be noted that part II of the table (6.3) cannot be derived as a simple summation of part I. The reason for this relates to the dynamic simulation of the model. In part II we simulate the model assuming a 10 percent increase in public investment, annually, for five successive years. The

(1) This is an illustration of how, in a non-linear dynamic system one region of the dynamic system could show no sign of converging to its steady-state path while all other variables converge to their average growth trajectories fairly fast (see section 6.2 above).

absolute size of these increases are not therefore equal. Public investment (G_i), as an exogenous variable, grows by its average rate of growth for the sample period (1959-93). Therefore G_i in period 2 is greater than in period 1 and a 10 percent increase in G_i in period 2 is larger than a 10 percent increase in G_i in period 1 and so on. The impact of a policy change shown in part II is thus greater than what would have been computed for five years from part I.

Generally speaking, the policy of raising public investment through domestic borrowing, in this economy, promotes private investment and aggregate output but on the other hand deteriorates the current account of the balance of payments and government foreign asset position and generates inflationary pressures in the economy.

6.6.1.1.(b) Change in Government Investment Financed by Foreign Assets

Suppose the public sector financed its investment by borrowing abroad rather than through the domestic banking system; table (6.4) summarises the policy simulation results. As shown in table (6.4), aggregate output immediately rises above its average growth path of the base simulation. The percentage change of Y in this simulation experiment is more or less close to the last one. Private investment and consumption also increase and the current account of the balance of payments deteriorates due to the increase in demand for imports stimulated by income growth. Despite similarities between this policy simulation and the last, there are certain differences as well. The differences are related to the price level and the foreign sector of the economy.

Since government investment (G_i) is financed by foreign borrowing (F_g) the deviation of F_g from its base simulation path is greater in this policy simulation than the previous one (-1.8 percent compared to -.8 percent in period 2 and -2.9 percent compared to -2.3 percent in period 5). The money supply deviates from its base simulation by 1.7 percent in period 2 which is much less than the 8.2 percent in the previous policy simulation. In this experiment in the first 3 period, the demand for money increases at a rate slightly less than that of the money supply and the price rises above its average growth. This reverses in the last 3 periods and the price level grows below its average growth due to the strong growth in the demand for money. Overall in this experiments the price level remains almost on its average growth path of the base simulation whereas in the previous policy simulation there was a price increase. Price stability, in turn, helps exports to increase compared to the export decline of the last experiment.

Table 6.4. Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent increase in public investment (G_i) financed by foreign assets (F_g) I-One year step increase

| periods | Ti | Y | C | Pi | M | md | P | X | Z | Ca | Fg |
|---------|------|------|------|-----|------|------|-------|-------|-----|-------|------|
| 1 | 5.9 | 2.2 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 2.0 | 1.05 | 1.2 | 4.8 | 1.7 | 0.5 | 0.0 | 0.07 | 4.1 | -11.6 | -1.8 |
| 3 | 1.05 | 0.63 | 1.0 | 2.6 | 1.8 | 1.7 | 0.04 | 0.06 | 2.1 | -6.5 | -2.0 |
| 4 | 0.73 | 0.5 | 0.77 | 1.8 | 0.6 | 1.5 | 0.05 | 0.0 | 2.0 | -7.4 | -2.4 |
| 5 | 0.64 | 0.48 | 0.70 | 1.6 | 0.2 | 0.77 | 0.0 | 0.0 | 1.9 | -7.2 | -2.9 |
| 6 | 0.58 | 0.4 | 0.56 | 1.5 | 0.05 | 0.42 | -0.07 | 0.03 | 1.5 | -6.3 | -3.3 |
| 7 | 0.5 | 0.38 | 0.5 | 1.3 | 0.0 | 0.28 | -0.14 | 0.007 | 1.1 | -5.1 | -3.5 |

In general, aggregate income growth in this policy simulation is close to the previous one while price is more stable and the current account of the balance of payments deficit is less than that of the previous experiment. However, the

expansion of foreign liabilities in this policy simulation remains a clear disadvantage of this policy.

6.6.1.1.(c) Change in Government Investment Financed by Direct Taxation

In this policy simulation, taxation policy is assumed to be used to mobilise the resources required for a 10 percent increase in public investment. This, therefore, can be considered as an exclusively fiscal policy for economic growth. The main endogenous variables' time paths, following a 10 percent step increase in government investment financed by direct taxation, are given in table (6.5) below. Space limits preclude extension of the table to the simulation results of the five year increase in public investment financed by direct taxation.

Table 6.5 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent increase in public investment (Gi) financed by direct taxation (Dtax). I-One year step increase

| periods | Ti | Y | C | Pi | M | md | P | X | Z | Ca | Fg |
|---------|------|------|------|-----|-----|------|-------|------|------|------|-------|
| 1 | 5.9 | 2.4 | 0.0 | 0.0 | 0.0 | 0.56 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1.9 | 1.05 | 0.77 | 4.8 | 0.0 | 0.5 | -0.2 | 0.07 | 3.7 | -9.8 | -0.7 |
| 3 | 1.0 | 0.56 | 0.63 | 2.5 | 0.0 | 0.4 | -0.3 | 0.2 | 0.9 | -2.1 | -1.3 |
| 4 | 0.6 | 0.35 | 0.56 | 1.6 | 0.0 | 0.4 | -0.35 | 0.35 | 0.4 | -0.4 | -1.3 |
| 5 | 0.4 | 0.28 | 0.4 | 1.1 | 0.0 | 0.4 | -0.33 | 0.4 | 0.28 | 0.14 | -1.2 |
| 6 | 0.35 | 0.26 | 0.35 | 0.9 | 0.0 | 0.39 | -0.3 | 0.47 | 0.20 | 0.56 | -1.05 |
| 7 | 0.3 | 0.24 | 0.24 | 0.7 | 0.0 | 0.37 | -0.3 | 0.49 | 0.2 | 0.84 | -0.80 |

The step increase in government investment stimulates economic growth. Aggregate income rises 2.4 percent above its average growth path, thereafter adjusting to its base simulation trend gradually. However, as comparison of these policy simulation results with the two previous cases reveals, economic

growth in this case slows-down earlier which is due to a low rate of growth in private investment. Private consumption also grows at a lower rate in this case for the obvious reason that direct taxation reduces the disposable income of the private sector. The price level in this policy simulation moves downward as the money supply remains unchanged while the demand for money grows, mainly because of the aggregate income growth. As a result exports grow and the current account of the balance of the balance of payments improves during the second part of the seven year period depicted in the table (6.5). Running the simulation for a longer period indicates that exports begin to adjust to their average growth trend from period 9 following the price level adjustment.

When a five year increase in government investment (financed by direct taxation) is implemented, the model reacts similarly. As expected, in this case, the variables rise much higher above their base simulation paths and all the adjustment processes take longer time to complete. As a general assessment we can say that income and consumption grow more slowly while on the other hand the relative price stability and ultimate improvement of the current account are considerable advantages of this policy.

One question which may arise relates to whether or not levying an indirect tax or reduction of consumer subsidies to finance public investment could have caused a significant difference in the economy. Our experimental results (not given here) indicate that except for private disposable income (Y_d) and consumption (C) (that rise higher in this case compared to the previous policy simulation and to a lesser extent for net income transferred from abroad affecting foreign asset of public sector in the model), other variables exhibit a

quite similar pattern to time paths of the last experiment, where an increase in public investment was assumed to be financed by direct taxation.

To sum up this part of the policy simulation results, we noticed that a one year step or a five year increase in public investment (G_i) would raise income and private investment and consumption with different effects on the price level and the foreign sector of the economy depending on the means of financing the extra public investment. We next examine the effects that an increase in public consumption (G_c) could have on the dynamics of the endogenous variables of the economy.

6.6.1.2 Change in Government Consumption Expenditure

Due to the importance of government investment in the Iranian economy in this study, the effects of changes in government investment and consumption are examined in separate policy simulations. Government investment affects aggregate supply via total investment and private sector investment on the one hand; and domestic absorption and budget deficit through the government total expenditure on the other. Government consumption, however, affects the endogenous variables of the through the latter two channels. For this reason an equal change in government consumption is expected to have a weaker affect on aggregate supply and private expenditure. Government consumption expenditure affect aggregate output through foreign sector and the monetary sector of the economy.

As in the case of government investment, an increase of government consumption should be financed either by domestic credit, taxation or borrowing

from abroad. For the reason discussed earlier, we do not consider the case of financing an increase in government consumption by changes in foreign asset holdings. Nevertheless, any change in the government budget deficit will, ultimately, affect the government foreign assets position through the government budget constraint.

6.6.1.2.(a) Change in the Public Consumption Financed by Domestic Credit

The main endogenous variables' response to a step and five year increase in government consumption financed by domestic credit extended by the banking system to the public sector is presented in table (6.6). The policy simulation results seem interesting. Private investment and consumption begin to rise above their average growth trend after two periods. This increase however, does not come through income growth as aggregate income starts to pick up after private investment and consumption increase and could not have affected these variables before period 2. To see the channels through which government consumption positively affect private investment and consumption notice that private investment in the model was specified to be among other variables a function of the inverse of $(D_{cp,t-1} / P_{t-1})$ where D_{cp} is domestic credit to the private sector. Extension of domestic credit to the public sector increases the money supply (6.6 percent in period 2) while the rate of growth of the real demand for money is much less (.8 percent in period 2). The price level therefore rises to equilibrate the money market. In this policy experiment, price increase .7 percent on average above the base simulation pattern. This reduces the real value of the private

sector's liabilities to the banking system encouraging private investment and consumption. In the foreign sector of the economy, exports decline because of the appreciation of the real exchange rate while imports grow slightly, which results in a deficit on the current account of the balance of payment. This in turn causes expansion of public foreign liabilities.

Table 6.6 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent increase in public investment (Gi) financed by foreign assets (Fg)

I-One year step increase

II-Five year increase

| Periods | Ti | Y | C | Pi | M | m _d | P | X | Z | Ca | Fg |
|----------|----------|--------------|--------------|-------------|------------|----------------|--------------|------------|--------------|--------------|--------------|
| ----- | | | | | | | | | | | |
| I | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2 | 0.002 | 0.001 | 0.02 | 0.0 | 6.6 | 0.8 | 0.7 | -0.1 | 0.0 | -0.9 |
| | 3 | 0.1 | 0.05 | 0.12 | 0.3 | 1.2 | 2.6 | 1.1 | -0.6 | 0.005 | -2.7 |
| | 4 | 0.32 | 0.16 | 0.2 | 0.8 | 0.08 | 0.47 | 0.9 | -0.9 | 0.06 | -3.5 |
| | 5 | 0.43 | 0.2 | 0.3 | 1.1 | 0.04 | -0.4 | 0.7 | -0.94 | 0.11 | -4.0 |
| | 6 | 0.44 | 0.2 | 0.34 | 1.1 | 0.0 | -0.45 | 0.6 | -0.9 | 0.1 | -4.2 |
| | 7 | 0.41 | 0.2 | 0.35 | 0.6 | 0.0 | -0.4 | 0.5 | -0.85 | 0.08 | -4.3 |
| ----- | | | | | | | | | | | |
| I | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2 | 0.002 | 0.001 | 0.02 | 0.0 | 6.6 | 0.8 | 0.7 | -0.1 | 0.0 | -0.9 |
| | 3 | 0.11 | 0.05 | 0.15 | 0.3 | 10.0 | 3.1 | 2.0 | -0.8 | 0.005 | -4.1 |
| | 4 | 0.43 | 0.2 | 0.4 | 1.2 | 12.5 | 4.2 | 3.2 | -1.5 | 0.08 | -9.2 |
| | 5 | 0.74 | 0.5 | 0.7 | 2.5 | 13.5 | 4.6 | 4.1 | -2.1 | 0.22 | -15.0 |
| | 6 | 1.2 | 0.8 | 1.05 | 4.1 | 13.3 | 3.7 | 4.7 | -2.6 | 0.38 | -21.7 |
| | 7 | 1.7 | 1.05 | 1.4 | 5.8 | 2.1 | 3.4 | 4.5 | -3.2 | 0.53 | -26.6 |

This policy simulation indicates an overall outcome similar to the economic crisis that the country faced in the 1980s. Confronted with the accelerating cost of the war and diminishing oil revenue, the government was forced to finance its expenditure by domestic credit of the banking system. Adoption of this policy for

several years, as part 2 of the table shows, expanded the money supply drastically with inevitable inflationary consequences.

6.6.1.2.(b) Change in the public Consumption Financed by Taxation

When the government expenditure is financed by taxation we do not expect expansion of the money supply nor an induced inflationary process. When government consumption is met by taxation there is no change in the monetary variables of the model. The only change we have in the economic system is a reallocation of economic resources from the private sector to the public sector. Private consumption therefore, is expected to be negatively affected as disposable income is reduced by taxation. Here we only report the main points and the policy simulation results are not reproduced. Simulating the model with a 10 percent increase in government consumption, met by an equal increase in direct taxation, indicates that only private consumption is affected significantly. Private consumption decreases by .66 percent in period 2 and on average there is .21 percent decline in private consumption below its average growth path. Other variables of the model do not show any significant change compared to their average growth path of the base simulation.

6.6.2 Monetary Policy

The money supply in our model is determined by domestic credit to public and private sectors together with movements in international reserves. Domestic credit to the public sector, in turn, depends on the government deficit financing obligation which was discussed earlier. Changes in foreign exchange reserves are

determined by the interaction of the current account together with changes to foreign asset holdings of the public and private sectors. The current account of the balance of payments, in turn, depends on the developments of foreign trade as well as the capital earnings of foreign assets. In our monetary sector of the model therefore domestic credit to the private sector is the main policy variable. Also, the exchange rate is a policy variable which affects the money supply and will be discussed in the context of exchange rate policy below(see section 6.6.3).

Exclusion of the interest rate from the monetary sector of the model was due to our finding in chapter IV of this thesis that the interest rate was statistically insignificant both in private investment and consumption functions as well as in the demand for money function. The official discount rate also showed no correlation with private sector borrowing from the banking system. Since other monetary policy instruments such as open market operations and the discount rate are absent or circumscribed due to the undeveloped nature of the financial market in the country the role of bank credit to private sector becomes critical in the economic system.

The role of monetary policy is twofold. Monetary policy can be seen as a stabilisation device through its impact on aggregate demand caused by the availability of credit. Monetary policy also has a role in promoting economic growth. In other words, if credit ceilings are used they must be set at levels that are consistent with balance of payments and inflation targets as well as the working capital requirement of private firms. However, when imposing a credit ceiling the government has to take account of the fact that exogenous factors, of both a negative and a positive nature, are at work. To see how exogenous factors

could be influential in the performance of the domestic economic system, recall the current account of the balance of payments identity:

$$(6.2) \dots Ca_t = P_t X_t - e_t P_t Z_t + e_t Fae_t = e_t (\Delta Fp_t - \Delta Fg_t) + e_t Bop_t$$

where all the variables have the same definition as in the structural model of chapter III. This relationship reveals that a continued real resource inflow ($PX - ePZ < 0$) is possible if a country's international resource can be run down or if borrowing in foreign markets is feasible. Therefore, for a developing country the role of foreign capital can be critical. This is the fact that the availability of foreign exchanges could ease, at least in the short-run, the costs and difficulties of economic adjustment to external shocks.

The adjustment problem becomes even more complex when the economy faces a flight of private capital. In chapter IV, in estimating the real demand for money, we found that the private sector in Iran has been able to circumvent the official barriers in moving their financial capital abroad.

The private budget constraint indicates that an increase in capital flight may be offset by a reduction either in the holding of financial assets in the form of money or in repayments of credit claimed by the banking system from the private sector. This will deepen the fiscal crisis of the government. The private sector decision to increase its foreign assets (Fp) rather than investing domestically depends on the rate of return to domestic investment compared to the opportunity cost of holding foreign assets.

From the above discussion it follows that the trade balance ($X-Z$) is related, in our model, to domestic monetary change. Recalling from equation (4.14) in table 4.1 that $Ca_t = P_t Y_t + Nft_t - P_t Da_t$ and $Bop_t = \Delta Fr_t = (1/e_t) (\Delta M_t - \Delta Dc_t)$ assuming $Y_t = Ad_t$ and substituting these two identities into the foreign sector budget constraint we have:

$$(6.3) \dots [(P_t Y_t + Nft_t - P_t Da_t) - e_t (\Delta Fg_t + \Delta Fp_t)] = (\Delta M_t - \Delta Dc_t)$$

That is the amount by which domestic absorption exceeds the availability of resources equal to the amount by which changes in the domestic credit exceeds the increase in the money balance. This leads to the interpretation that an imbalance between absorption and domestic production which causes inflation is due to credit expansion beyond the amount that the demand for money can absorb. This in turn suggests that the imposition of an overall credit ceiling may be a useful tool in re-establishing sustainable internal and external balances.

If domestic sources of credit expansion are excessive relative to growth in the money balance, spending will be stimulated and inflation will ensue until balance is restored. The important issue however, is how safe limits for credit expansion can be established and implemented taking into consideration the need for internal domestic monetary balance as well as the need for recovery of domestic production. From the relationship between external reserves and domestic monetary development we see that if domestic credit expands faster than the domestic money balance, external reserves will fall. Alternatively, if domestic credit expansion to the public sector expands faster than the net change in the

monetary system's asset position of the private sector, international reserves must fall. In what follows, we examine the model's behaviour under different credit expansion policies.

6.6.2.1 Extension of Domestic Credit to Private Sector

The model's main endogenous variables' response to a 10 percent increase in domestic credit to the private sector are given in table (6.7) below. The direction of development for most of the main endogenous variables to this policy change may seem rather surprising. While for example one expects domestic banking

Table 6.7 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent increase in domestic credit to private sector (Dcp).

I-One year step increase

II-Five year increase

| Periods | Y | C | Pi | M | ma | P | X | Z | Ca | Fg |
|---------|------|-------|-------|------|-------|------|-------|-------|-------|-------|
| ----- | | | | | | | | | | |
| I 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | -0.6 | -0.13 | -3.0 | 3.6 | 0.6 | 0.5 | -0.13 | -0.3 | 0.13 | 0.0 |
| 3 | -0.7 | -0.4 | -3.2 | 0.0 | 1.1 | 0.6 | -0.4 | -0.9 | -0.13 | 0.06 |
| 4 | -0.3 | -0.3 | -1.1 | 0.0 | -0.3 | 0.5 | -0.5 | -0.3 | -0.5 | 0.13 |
| 5 | -0.1 | -0.26 | -0.33 | 0.0 | -0.4 | 0.45 | -0.6 | -0.1 | -1.7 | 0.2 |
| 6 | 0.0 | -0.13 | -0.62 | 0.0 | -0.38 | 0.4 | -0.62 | -0.02 | -2.2 | -0.2 |
| 7 | 0.0 | 0.0 | 0.2 | 0.0 | -0.3 | 0.3 | -0.6 | 0.0 | -2.3 | -0.34 |
| ----- | | | | | | | | | | |
| II 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | -0.6 | -0.13 | -3.0 | 3.6 | 0.6 | 0.5 | -0.13 | -0.3 | 0.13 | 0.0 |
| 3 | -1.2 | -0.5 | -6.0 | 3.7 | 1.7 | 1.1 | -0.5 | -1.1 | 1.3 | 0.1 |
| 4 | -1.5 | -0.9 | -7.1 | 3.8 | 1.5 | 1.6 | -1.1 | -1.5 | 1.1 | 0.4 |
| 5 | -1.6 | -1.1 | -7.5 | 3.9 | 1.1 | 2.1 | -1.6 | -1.6 | -0.3 | 0.3 |
| 6 | -1.6 | -1.2 | -7.6 | 3.9 | 0.7 | 2.5 | -2.2 | -1.6 | -2.4 | 0.12 |
| 7 | -1.1 | -1.1 | -4.8 | 0.13 | -0.2 | 2.3 | -2.6 | -1.4 | -5.1 | -0.23 |

credit to the private sector to stimulate private investment and consumption (as more investable resources become available) the policy simulation shows a slow

down of private investment, below the trend, and consumption following the extension of bank credit to the private sector. Private investment and consumption fall 3 and .13 percent below their average growth rate in period 2. The downward movement of these variables, below the base simulation trend, only changes their direction towards the end of period 6.

The structure of the estimated private investment and consumption function could explain the adverse effect of domestic credit expansion on both private investment and consumption. We notice that in estimating private investment function domestic credit to private sector lagged one period (Dcp_{t-1} / P_{t-1}) was found (amongst other variables, namely aggregate income and capital stock), to exert a significant negative effect on private investment. This was justified on the ground that while real income and net capital stock positively influence private investment, last periods liabilities to the banking system affect it negatively as repayment of the previous period liabilities in the current period reduce the amount of investable resources. In our estimation experiments however, we did not find any evidence suggesting that current period domestic credit to the private sector has a significant (positive or negative) influence on private investment. This deserves to be noted because despite the importance attached in the literature to the considerable effect of bank credit on private investment in developing countries (see Chhibber et al (1992) and Karshenas (1991)) our model shows that this has not been significant in the Iranian economy.

With respect to the consumption function, recall that in our specification, private consumption depends on private disposable income which, in turn, is equal to aggregate income plus the earnings of the private foreign assets less

direct tax and interest of the private liabilities of the banking sector. Increasing domestic loans acquired by the private sector in the previous period affect current period disposable income and hence exert a negative effect on current consumption.

The effects of changes in domestic credit to the private sector in the model, transmit through investment to aggregate supply and from there to the current account of the balance of payments, and the real demand for money. On the other hand, extension of bank credit influences the money supply directly. Our policy simulation indicates that a 10 percent increase in domestic credit to the private sector causes a slow down in economic growth as the rate of aggregate output growth falls by .6 percent in period 2 and by .66 percent in period 3 below the average growth trend of this variable in base simulation. However, aggregate output adjusts to its base simulation average growth trend by period 6. The growth of demand for imports is also negatively affected which improves the current account as much as .13 percent in period 2 and period 3. The current account deficit rises again in the second half of the 7 year period simulation presented in table (6.7) as export demand (foreign) demand fall faster than imports which is due to the inflation and appreciation of the real rate of exchange.

When aggregate supply and private demand decline, one does not expect a steady increase in the real demand for money. Therefore, the upward movement of the real demand for money in first two years following a policy change merits consideration. The real demand for money rises .6 percent in period 2 and 1.1 percent in period 3 before falling below its average growth trend of the base

simulation. In estimating the demand for money in chapter IV we found an average period of two years for the adjustment process in the money market, which explains a brief increase in demand for money in this simulation. This could mean that private agents hold some part of the excess money balances because of adjustment costs while price increases absorb the rest of the excess money balance.

Generally speaking, this policy simulation implies that expansion of domestic credit to the private sector on its own can only adversely affect the economy and achieves none of the policy targets. Output declines while the price level increases and the balance of payments worsens. This may appear to be a controversial result. However, it presents an example of the delicacy of economic policy design in an oil exporting developing country where the private sector is dependent to the government development policy more than its own economic initiations.

6.6.2.2 Extension of Domestic credit to Public Sector

We now consider the other monetary policy tool at the disposal of the monetary authority, namely banking credit to the public sector. Although this variable is a policy instrument in the model, it is closely connected to government fiscal policy. This is obvious because at least in the case of Iran, an extension of bank credit to the public sector is meant to finance the public sector borrowing requirement. One can of course imagine, with the government budget constraint in mind, that an expansion of credit to the public sector if it was not used for budget deficit financing should reduce government foreign liabilities. It may be

the impact effect of the policy but in dynamic simulation feedbacks running from the expansion of domestic credit to the money supply domestic price level, the balance of payments and foreign exchange reserves can worsen the public sector's foreign asset position. This is indeed what our policy simulation reveals. The direction of the dynamics of the endogenous variables were quite similar to those of the previous experiment where we considered an expansion of domestic credit to the private sector. Monetary expansion leads to price increases and the foreign sector deficit deteriorates while aggregate income and private consumption decline. Since we have discussed financing the budget deficit by extension of domestic credit to public sector we do not extend the same arguments in this section.

6.6.3 Exchange Rate Policy

We now turn to the exchange rate policy. Formally, Iran has had a managed fixed exchange rate regime in the period under consideration. However, in the main portion of the 1980s, due to the sustained inflationary pressures, despite government tight control over foreign exchange reserves a multi-tiered exchange rate regime prevailed. However, the informal foreign exchange market remained small compared to the foreign sector of the economy. This was because the country's foreign trade in this period, had been dominated by oil exports. Since foreign exchange earned by exporting oil is government revenue and on the other hand public owned or managed industries have been the main consumer of the hard currencies in this economy, the government has been able to retain a highly overvalued exchange rate for a long period (see Pesaran 1991, and Karshenas

and Pesaran 1995). However, our estimated (foreign) demand for exports function indicates that the economy's export have been responsive to the real exchange rate. In estimating the foreign trade functions we found that the Marshall-Lerner condition was satisfied in the long-run but not on impact. In what follows, we examine the effects of appreciation and devaluation of the home currency on different sectors of the economic system.

6.6.3.1 Appreciation of Home Currency

First consider a 10 percent appreciation of the nominal exchange rate. A revaluation of the exchange rate affects the economy through two channels; (i), foreign trade and (ii), money supply identity (i.e. $M=D_c+e.F_r$). The causation chain from the first channel would proceed towards the monetary sector of the economy via the current account of the balance of payments in one direction and towards aggregate supply through the imports demand function in another. On the other hand, revaluation will affect the money supply directly as any change in the exchange rate will reduce the foreign exchange reserves in domestic currency term. Table (6-8) summarises the main policy simulation results.

As was expected, appreciation of the home currency worsens the current account of the balance of payments. A 10 percent revaluation increases the foreign sector's deficit 10.5 percent above its average growth trend of the base simulation in period 2. It takes more than 6 periods for the current account to adjust to its average growth path. Deterioration of the current account is mainly due to diminishing exports. In fact imports grow in this policy simulation despite

appreciation of the home currency. This is of course because of price inelasticity and a high income elasticity of import demand in the model.

Deterioration of the balance of payments is transmitted to the public sector's foreign liabilities as it is assumed that the government takes action to retain foreign exchange reserves in its base simulation level (see section 6.4 above). Public sector holdings of foreign assets grow 2.26 percent and 2.8 percent below the average growth pattern in periods 2 and 3 respectively. However, by period 6 when the rate of deterioration of the current account of the balance of payments slows down the negative growth of public sector's holdings of foreign asset also diminishes. Revaluation of the exchange rate on the other hand, affects the money supply directly and the money supply falls .26 percent in period 2 but adjusts to its average growth rate fairly soon (in 5 periods). Aggregate income also slips below its average growth path but its deviation from the average growth trend of the base simulation is almost negligible (.014 percent in average in 7 years period). Since the change in real income is small, so is the deviation of the demand for money from its average growth rate. Also, as table (6.8) shows, any deviations of private consumption and investment from their base simulation paths are small in this policy simulation.

It seems therefore that the main effects of appreciation of the home currency, *ceteris paribus*, appear in the foreign sector of the economy and because of a rapid adjustment of money balances to their average growth rate, other parts of the economic system are not affected in a significant manner. However, when adopting this policy for 5 consecutive years the model shows that holding the home currency overvalued for a long period could have more serious

consequences on the economic system. Our experiment (not presented here) shows that assuming a 10 percent appreciation of the currency for five years results in a fall of 19 percent on average (in a 7 year period) in the current account of the balance of payments below the average growth rate, which negatively affect foreign liabilities of the public sector by 8.6 per cent a year on average.

Aggregate income and private investment fall about .1 percent on average below their base simulation trend while the demand for money and private consumption decrease .14 percent and .05 percent on average respectively. The Iranian economy experienced a similar state of foreign sector imbalances in the 1980s. This was mainly because of holding the formal rate of exchange unchanged for a long period while the real rate of exchange was appreciating due to inflation. To address the balance of payments problem, the government imposed restrictions on imports in an attempt to reduce the trade deficit but this in turn led to the economic recession.

Table 6.8 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent appreciation of the home currency .
I-One year step increase

| Periods | Y | C | Pi | M | ma | P | X | Z | Ca | Fg |
|---------|--------|--------|--------|--------|-------|-------|------|-------|-------|-------|
| I 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | -0.02 | -0.004 | -0.003 | -0.26 | -0.06 | -0.03 | -5.9 | -0.33 | -10.5 | -2.26 |
| 3 | -0.03 | -0.02 | -0.003 | -0.02 | -0.13 | -0.03 | -2.8 | -0.5 | -4.9 | -2.8 |
| 4 | -0.02 | -0.02 | -0.05 | -0.01 | -0.02 | -0.02 | -2.0 | -0.3 | -3.8 | -3.0 |
| 5 | -0.01 | -0.02 | -0.05 | -0.01 | -0.01 | -0.01 | -1.8 | -0.2 | -2.9 | -3.0 |
| 6 | -0.01 | -0.02 | -0.04 | -0.006 | 0.0 | 0.0 | -1.2 | -0.13 | -2.3 | -3.0 |
| 7 | -0.006 | -0.01 | -0.03 | 0.0 | 0.0 | 0.0 | -0.7 | -0.06 | -1.8 | -2.8 |

6.6.3.2 Devaluation of Home Currency

In a country with sustained balance of payments problems it is more likely that the government will finally succumb to growing foreign sector pressures and devalue the home currency. In Iran, the government eventually recognised the irreversible gap between the formal and real exchange rate and devalued the currency in the early 1990s. Since then, non-oil exports have been growing in response to a more realistic exchange rate. However, any devaluation increases the money supply in the absence of a sterilisation policy and economic growth in a developing country like Iran will induce a strong demand for imports as well. To see the transmission mechanism of the exchange rate policy we examine the model's behaviour under a 10 percent appreciation of the exchange rate. Policy simulation results are presented in table (6.9) below.

Devaluation policy seems to have produced a mirror image of results of the above revaluation policy simulation. Almost all the main endogenous variables move in the opposite direction with more or less the same absolute magnitude of the previous policy simulation results where we examined a 10 percent revaluation of the exchange rate.

In the estimated macroeconomic model, the Marshall-Lerner condition was found to be satisfied in the economy in the medium term but not on impact. An exchange rate devaluation therefore is expected to move exports upwards in proportion to the price elasticity of (foreign) demand for exports (allowing the necessary time to elapse). As table (6.9) indicates exports rise 5.8 percent above

Table 6.9 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent devaluation of home currency.

I-One year step increase

II-Five year increase

| Periods | Y | C | Pi | M | m_a | P | X | Z | Ca | Fg | |
|-----------|---|-------|-------|-------|-------|-------|-------|------|------|------|------|
| I | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 2 | 0.013 | 0.003 | 0.003 | 0.26 | 0.06 | 0.03 | 5.8 | 0.3 | 10.5 | 1.6 |
| | 3 | 0.026 | 0.002 | 0.02 | 0.02 | 0.13 | 0.03 | 2.8 | 0.4 | 4.9 | 2.3 |
| | 4 | 0.02 | 0.01 | 0.04 | 0.013 | 0.02 | 0.02 | 1.8 | 0.26 | 3.8 | 2.6 |
| | 5 | 0.02 | 0.02 | 0.04 | 0.013 | 0.005 | 0.013 | 1.2 | 0.2 | 2.8 | 2.7 |
| | 6 | 0.013 | 0.025 | 0.04 | 0.01 | 0.002 | 0.01 | 0.7 | 0.13 | 2.2 | 2.7 |
| | 7 | 0.01 | 0.02 | 0.03 | 0.01 | 0.0 | 0.0 | 0.5 | 0.06 | 1.7 | 2.5 |
| II | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 2 | 0.013 | 0.003 | 0.003 | 0.26 | 0.06 | 0.03 | 5.8 | 0.3 | 10.5 | 1.6 |
| | 3 | 0.04 | 0.02 | 0.026 | 0.3 | 0.2 | 0.06 | 8.8 | 0.7 | 16.8 | 4.0 |
| | 4 | 0.07 | 0.05 | 0.07 | 0.3 | 0.2 | 0.08 | 10.9 | 1.0 | 23.1 | 5.9 |
| | 5 | 0.08 | 0.07 | 0.12 | 0.3 | 0.2 | 0.1 | 12.3 | 1.2 | 29.4 | 9.2 |
| | 6 | 0.09 | 0.9 | 0.16 | 0.3 | 0.2 | 0.1 | 13.2 | 1.3 | 36.0 | 12.1 |
| | 7 | 0.086 | 0.1 | 0.18 | 0.06 | 0.13 | 0.08 | 7.4 | 1.1 | 22.4 | 13.3 |

their average growth trend in period 2 before beginning to adjust to the average growth rate which takes more than 12 periods to complete.

The current account of the balance of payments improves despite a small increase in imports which is due to economic growth. Recall that import demand in the model was found to be almost unresponsive to the real exchange rate while depending strongly on aggregate income therefore the net effect of the devaluation of home currency on imports appears to be positive.

Examining the results of the devaluation policy for 5 years, given in part II of table (6.9), confirms that the devaluation policy alone, even in the medium term, cannot take the economy much above its average growth pattern. Devaluation

therefore could only yield a considerable economic growth if adopted together with a set of consistent monetary and fiscal policies.

6.6.4 External Shocks

In this section we examine the effects that external shocks can exert on the economic system. Regarding the vulnerability of developing countries to dramatic changes in their foreign sectors, policy simulations of this section could cast some light on the likely consequences of such events in the Iranian economy. First we will examine the model's dynamics following changes in oil revenue in conjunction with government fiscal and monetary policy. Next we discuss the transmission of a change to OECD aggregate income to different sectors of the economic system.

Oil revenue in our model enters the economic system through the government budget and the export demand function which affect the balance of payments. The government sets a formal budget for public investment and consumption. This annual plan is based on the government prediction of its revenue which, in the case of Iran, includes oil revenue- a substantial portion of government total revenue. Should the oil revenue change (in either direction) dramatically, as a result of factors outside government control, the government fiscal position will be subject to inevitable reconsideration.

Whether oil revenues fall or rise will determine the government budget deficit position. A major fall or rise of the oil revenue will force the government to take measures to minimise its budget deficit or maximise the extra oil income

effect on the economy. We will consider these changes in conjunction with government policies.

6.6.4.1 An Increase in Oil Revenue and Government Investment

Suppose oil revenue went up 10 percent for one year. Assuming the budget deficit moves on its planned trend, government may raise its investment by an amount equal to the extra oil revenue to help the economy's growth. Table (6.10) shows the adjustment process of the main endogenous variables of the model for this experiment. The results of simulation are interesting. Obviously we expect the policy to enhance economic growth through government investment without causing a budget deficit. This is reflected by the simulation results. As the economy grows so does import demand, private investment, real demand for money and private consumption. Aggregate income rise 8.4 percent above its average growth rate which induces an increase of 27 percent in import demand in period 2. Since exports in this period increase only by 8 percent above the average growth trend, the current account of the balance of payments deteriorates in this period. Money demand also increases[^] which, because of an unchanged money supply, reduces the price level. For this reason, the exchange rate appreciates and export growth exceeds that of import from period 3 onwards. The foreign sector therefore secures a surplus that improves the government foreign asset position towards the end of the 7 years period of this experiment.

The reason why the money supply remains on its base simulation path is that foreign exchange reserves are assumed to remain on their average growth trend.

Therefore, any change in the balance of payments is transmitted to the public sector's holding of foreign assets. Meanwhile, the demand for money grows 2.9

Table 6.10 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 Percent increase in oil revenue and an equal increase in public investment (Gi).

I-One year step increase

II-Five year increase

| Periods | Y | C | Pi | M | m_d | P | X | Z | Ca | Fg |
|----------|-----|-----|------|-----|-------|------|------|------|-------|------|
| I | | | | | | | | | | |
| 1 | 8.4 | 0.0 | 0.0 | 0.0 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 7.5 | 7.5 | 3.2 | 0.0 | 3.6 | -1.9 | 8.0 | 27.0 | -58.0 | -3.6 |
| 3 | 3.9 | 4.2 | 17.0 | 0.0 | 3.3 | -2.4 | 12.0 | 14.0 | 9.4 | -5.4 |
| 4 | 2.5 | 3.6 | 10.0 | 0.0 | 3.0 | -2.5 | 8.6 | 2.2 | 14.5 | -3.2 |
| 5 | 1.9 | 2.8 | 7.0 | 0.0 | 2.9 | -2.5 | 7.1 | 1.5 | 15.0 | 1.5 |
| 6 | 1.6 | 2.2 | 5.5 | 0.0 | 2.7 | -2.4 | 6.0 | 1.2 | 15.0 | 0.5 |
| 7 | 1.4 | 1.7 | 4.8 | 0.0 | 2.6 | -2.3 | 5.2 | 1.1 | 14.8 | 0.2 |

percent more than its base simulation pattern mainly because economic growth promotes private consumption and investment. This, in turn, stimulates economic growth further.

Simulating the model, assuming a five year increase in oil revenue and an equal increase in public investment (not presented here) yields similar results regarding the direction of endogenous variables. Deviations of the endogenous variables' paths from their average trend in the base simulation are of course larger which makes the adjustment process longer. This experiment shows that had government investment been extended over a longer period without causing budget deficits, the economy would achieve all three target variables. Economic growth increases to 5.2 percent compared to 4.5 percent in the base simulation. The current account of the balance of payments eventually moves into the black

and the economy enjoys a lower inflation rate (7 percent in average compared to 9 percent in the base simulation).

However, in a developing country such as Iran non-economic considerations may prevent turning a the revenues of a non-renewable wealth like oil to other source of income i.e. capital. Indeed it has been a common practice for governments in Iran to extend their consumption expenditure following a considerable increase in oil revenue. For example, when oil revenue picked up in the second half of the 1960s and 1970s, the government extended its social welfare programmes by channelling a considerable portion of its oil income to its consumption expenditure budget. But it was after the 1979 revolution that the government's social welfare commitments expanded due to the government's political and ideological stance. This required a very rapid rate of economic growth to finance them. We summarise below simulation results of the model's behaviour following a 10 percent change in oil income and an equal expansion of government consumption expenditure.

The external deficit reduces in this experiment due to a 10 percent increase in oil revenue. The current account rises 15.4 percent above its average growth pattern in period 2 and 22 percent in period 3, before starting to adjust to its trend value which takes more than 6 years to complete. Since foreign exchange reserves are assumed to be held on their average growth trend, an improvement in the balance of payments lends itself to an increase in public sector holdings of foreign assets-on average government foreign liabilities fall by 3.8 percent annually between period 1 and 7. Aggregate income however, shows a very small change as there is no considerable increase in total investment. Public investment

is assumed to remain unchanged as an exogenous variable. Private investment also does not rise much above its average growth rate in the base simulation as there is no income growth stimulated, for example, by government investment. The demand for money increases at an average rate close to its base simulation trend. Private consumption however, decreases slightly. This could be rationalised on the grounds that increasing public sector expenditure provides public goods and services that allow the private sector to spend less and save more.

6.6.4.2 A Decrease in Oil Revenue

A considerable decline in oil revenue would cause severe difficulties in a major oil exporting country in which the oil industry is the main provider of foreign currency. Iran is no exception in this respect. Balance of payments problems, following a decline in oil revenue, would force the government to take painful measures such as cutting public investment or consumption, increasing taxation or borrowing in domestic or foreign monetary markets. In the real world, usually a combination of these policies is adopted. In the time period 1959-93. at least on three occasions. falling oil revenue had severe consequences on the Iranian economy. In 1985-86 when the oil price fell from \$ 28 per barrel to \$ 6 within eight months, the country faced an economic crisis. On one hand government was forced to reduce its expenditure and on the other hand it had to mobilise more resources to finance the inevitable budget deficit. Tighter measures had to be taken to depress imports in order to prevent total depletion of foreign exchange reserves. In the remainder of this section we examine the

model's response to policy changes when the government is assumed to implement fiscal and monetary policies at its disposal when confronted with a major slump of oil income.

6.6.4.2.(a) Financing a Fall in Oil Income by Domestic Borrowing

It was discussed earlier that expansion of domestic credit to the public sector to finance a budget deficit has been frequently adopted in Iran. Table (6.12) summarises the main endogenous variables' time paths following a 10 percent drop in oil revenue and an equivalent expansion of domestic credit to public sector.

A decline in oil revenue immediately deteriorates the current account of the balance of payments. The foreign sector's deficit expands by 5.6 percent in period 2 compared to its base simulation trend. Because of the lagged variables and integration of the state variables within the model, the current account deficit worsens further in period 3 to 10.6 percent thereafter adjusting to the average growth pattern of the base simulation. Full adjustment for this variable takes about 11 years in this experiment. It is interesting to note that this one period drop of 10 percent in oil revenue with an equal expansion in public credit would cause a long-run deterioration in the balance of payments.

To explain this long-run adjustment process for the balance of payments it can be noted that extension of domestic credit to the public sector in this experiment induces an expansion of the money supply by as much as 7.8 percent in period 2 and 3.6 percent in period 3 while the demand for money is increased by .65 percent in period 2 and 2.7 percent in period 3. As a result of the excess

supply of money the price level rises to equilibrate the money market. The inflationary process causes an appreciation of the real exchange rate which reduces export demand, further deteriorating the foreign sector balance. Although the deviation of import demand from its base simulation trend in this case is quite small trade deficits continue to the end of the seven year period shown in table (6.11). Thus the public sector's foreign liabilities increase by a rate of 2.5 percent on average above its average growth pattern.

Table 6.11 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 percent fall in oil revenue (Oilr) and an equal increase in domestic credit to public sector (Dcg).

I-One year step increase

II-Five year increase

| Periods | Y | C | Pi | M | m _a | P | X | Z | Ca | Fg |
|-----------|---|------|------|------|----------------|------|------|-------|------|------------------------|
| ----- | | | | | | | | | | |
| I | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2 | 0.0 | 0.35 | 0.0 | 7.8 | 0.6 | 0.6 | -2.5 | 0.0 | -5.6 -0.13 |
| | 3 | 0.4 | 0.6 | 0.2 | 1.5 | 2.7 | 1.15 | -4.25 | 0.0 | -10.6 -1.4 |
| | 4 | 0.25 | 0.5 | 0.75 | 0.1 | 0.9 | 0.8 | -3.1 | 0.05 | -8.6 -2.3 |
| | 5 | 0.2 | 0.45 | 1.0 | 0.0 | -0.3 | 0.6 | -2.4 | 0.2 | -7.8 -3.0 |
| | 6 | 0.2 | 0.4 | 1.4 | 0.0 | -0.4 | 0.5 | -1.9 | 0.1 | -7.0 -3.4 |
| | 7 | 0.15 | 0.4 | 0.9 | 0.0 | -0.3 | 0.4 | -1.5 | 0.05 | -6.0 -3.5 ^e |
| ----- | | | | | | | | | | |
| II | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2 | 0.0 | 0.35 | 0.0 | 7.8 | 0.6 | 0.6 | -2.5 | 0.0 | -5.6 -0.15 |
| | 3 | 0.05 | 1.3 | 0.2 | 12.3 | 5.2 | 2.25 | -10.0 | 0.0 | -25.1 -1.9 |
| | 4 | 0.2 | 2.0 | 1.2 | 12.0 | 7.35 | 3.4 | -14.0 | 0.05 | -39.7 -5.4 |
| | 5 | 0.5 | 2.6 | 2.7 | 10.5 | 6.7 | 4.2 | -16.3 | 0.2 | -52.2 -9.9 |
| | 6 | 0.7 | 2.9 | 4.0 | 7.4 | 5.2 | 4.4 | -16.2 | 0.35 | -59.3 -14.8 |
| | 7 | 0.9 | 2.7 | 5.0 | 10.0 | 2.3 | 3.8 | -13.2 | 0.4 | -56.3 -19.3 |

Private investment and consumption also rise in this experiment. This is partly because of economic growth but also as a result of inflation. When prices rise, private liabilities to the banking system decrease in real terms affecting

positively the private sector's disposable income which lends itself to higher investment and consumption growth.

Continuation of the slump in oil revenue and expansion of bank credit to the public sector could end in high inflation and a larger foreign sector deficit as is shown in part II of table (6.11). The relevance of these simulation results to the Iranian economy arises from the country's experiments of the second half of the 1980s and early 1990s when years of diminishing oil revenues and domestic borrowing of the banking system created a sustained inflationary environment with foreign sector imbalances that eventually forced the government to devalue the home currency and acquire foreign loans to overcome the external and internal pressures.

6.6.4.2.(b) Taxation Policy

Like most developing countries, the taxation system and tax policy in Iran has not been sufficiently well developed to finance the public sector borrowing requirement in the event of an unprecedented budget deficit caused by a fall in oil revenue. However, here we have examined the model's response to a possible taxation policy. The simulation results can be summarised as follows. The budget deficit is assumed to remain the same as the base simulation because taxation is designed to offset the loss of oil revenue. Since neither domestic credit nor the exchange rate has been changed and because the net balance of payments is transmitted to the public sector holdings of foreign assets, there would be no expansion in the money supply. Aggregate supply does not change, in a significant manner compared to its base simulation trend, because there is no

increase either in public or private investment. Public investment is an exogenous variable and is not changed in this policy simulation. Private investment on the other hand is a function of aggregate output, capital stock, government investment and private liabilities to the banking system. None of these variables deviates from their base simulation trend. The price level also does not change because there is no expansion in the money supply or any considerable change in the demand for money, hence real domestic credit to the private sector also remains at the base simulation. Private consumption however, falls .5 percent below its average growth rate of base simulation in period 2 because of the negative effect of taxation on disposable income but it recovers in the next period and even rises slightly over its average growth trend in periods 4 and 5 before adjusting toward its trend in the following periods.

The current account of the balance of payments increases by 4.7 percent in period 2 due to a 2.5 percent fall in exports. Although domestic absorption slips slightly because of a .5 percent decrease in consumption in period 2, this is outweighed by the current account deficit and as a result public sector liabilities increase by 1.3 percent in period 2 and remain below the base simulation trend for a long period (9 years).

Generally speaking, although assuming taxation could finance the budget deficit caused by a decline in oil revenue, this policy negatively affects private consumption. However, provided that this is a one off increase in taxation, the economy's performance does not change in the medium term in a significant way. Nevertheless, the current account deteriorates leading to more public sector foreign liabilities.

6.6.4.2.(C) Reduction in Public Expenditure

A more realistic assumption about the government's behaviour when facing a decline in oil revenue is a reduction of public expenditure. In this policy simulation we assume that the government reduces its total expenditure by an amount equal to the 10 percent fall in oil revenue in order to avoid a change in budget deficit position. We further assume that 25 percent of this reduction falls on public consumption expenditure and the remaining 75 percent is taken from public investment. The model's response to this policy change is presented in table (6.13).

The public sector's dominant role in the Iranian economy once again becomes apparent in this policy simulation as a change in public sector consumption and investment induce significant changes in the time path of the main endogenous variables time paths. According to these results, cutting down public expenditure has the consequence that economic growth diminishes while the price level rises above its average growth trend in the base simulation. The foreign sector deficit increases despite a decreasing demand for imports caused by the economic slow down. If the reduction of public expenditure was short lived the economy adjusts to its average growth trend in 12 years. However, in the case where the reduction in public sector expenditure continued for a longer time (e.g. 5 years as part II of table (6.12)), it takes quite a long time (19 years) for different endogenous variables to adjust to their average base simulation growth rate although half of the full adjustment for all the variables is completed within ten years of the policy change.

Table 6.12 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 percent decrease in oil revenue (oilr) and equal reduction in public expenditure (G).

I-One year step increase

II-Five year increase

| Periods | Y | C | Pi | M | m _a | P | X | Z | Ca | Fg |
|-----------|-------|-------|-------|-----|----------------|------|-------|-------|-------|------|
| I | | | | | | | | | | |
| 1 | -1.6 | 0.0 | 0.0 | 0.0 | -0.45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | -1.5 | -1.7 | -6.2 | 0.0 | -0.85 | 0.55 | -2.6 | -5.4 | 9.7 | 0.65 |
| 3 | -0.7 | -0.8 | -3.1 | 0.0 | -0.75 | 0.65 | -4.1 | -0.6 | -7.3 | 0.4 |
| 4 | -0.45 | -0.7 | -1.7 | 0.0 | -0.70 | 0.65 | -2.8 | -0.05 | -7.1 | -0.5 |
| 5 | -0.30 | -0.5 | -1.1 | 0.0 | -0.65 | 0.60 | -2.2 | -0.01 | -6.0 | -1.2 |
| 6 | -0.25 | -0.35 | -0.85 | 0.0 | -0.60 | 0.55 | -1.8 | 0.0 | -5.9 | -1.7 |
| 7 | -0.20 | -0.25 | -0.7 | 0.0 | -0.55 | 0.5 | -1.4 | 0.0 | -5.4 | -2.0 |
| II | | | | | | | | | | |
| 1 | -1.6 | 0.0 | 0.0 | 0.0 | -0.45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | -7.2 | -1.7 | -6.2 | 0.0 | -2.45 | 0.55 | -2.6 | -5.4 | 9.7 | 0.65 |
| 3 | -7.8 | -3.1 | -11.6 | 0.0 | -3.40 | 1.6 | -10.2 | -8.2 | 1.9 | 1.6 |
| 4 | -8.1 | -4.05 | -13.5 | 0.0 | -4.4 | 2.7 | -13.8 | -7.9 | -9.5 | 0.9 |
| 5 | -7.0 | -4.4 | -13.7 | 0.0 | -4.8 | 3.5 | -15.8 | -6.9 | -21.8 | -0.8 |
| 6 | -3.0 | -4.1 | -12.0 | 0.0 | -4.1 | 4.0 | -15.7 | -4.8 | -34.5 | -3.7 |
| 7 | -1.8 | -2.8 | -7.3 | 0.0 | -3.8 | 3.8 | -12.8 | -0.7 | -47.9 | -7.7 |

It was mentioned earlier that public consumption affects the endogenous variables of the model only through domestic absorption and the budget deficit while a change in public investment is transmitted through private sector investment and total investment in addition to the above two channels. A reduction in public investment and consumption therefore affects aggregate supply and aggregate demand at the same time. Following a reduction of government investment to offset 75 percent of the slump in oil revenue, aggregate output grows 3.3 percent less than its average growth trend. As economic growth slows down so does the real demand for money, private investment and consumption and import demand.

Private investment, both because of diminishing aggregate income and government investment falls 6.2 percent below its base simulation trend in period 2 while the decrease in private consumption and import demand is 1.7 percent and 5.4 percent respectively. Lower private investment and imports in the model feed back to aggregate supply through the capital stock and induce a further slow down in economic growth. There is, therefore, a process of diminishing economic growth with foreign sector deficit and inflation. The longer this policy persists the higher is inflation rate and the larger is the external deficit. Again there are some similarities between this policy simulation and the economic situation of the mid 1980s and early 1990s in Iran. In these periods, following a fall in oil revenue the government reduced its expenditure in real terms. However, this did not resolve the budget deficit problem and the government still had to borrow from the central bank which expanded the money supply. As a result, cutting public investment affected aggregate output negatively, and inflation rose because of excess money balances in the economy leading to the balance of payment deficit.

6.6.4.3 Change in the World Income

Our simulation experiments so far have been concerned with the effects of policy variables and oil revenue changes on the economic system. In what follows we examine the likely effects of changes in the OECD country's income (as a proxy for world income) on the Iranian economy. It goes without saying that any change in the rest of the world's economy could only influence the home

economy through the foreign sector of the economy that means via the current account of the balance of payments or capital movements.

Suppose that in a period of boom in the world economy, the OECD's aggregate income grew by 10 percent annually for five successive years. This would increase the demand for Iranian exports. Our policy simulation shows that the world economy's 10 percent growth increases Iran's exports by almost 4.5 percent. Export growth improves the current account position and the foreign sector deficit reduces 12 percent on average in this period. In our base simulation the economy was in a sustained current account deficit. Assuming that foreign exchange reserves are left on their base simulation time path, the net surplus in the balance of payments will reduce the public sector's foreign liabilities. In fact public sector foreign debt reduces 3 percent on average in the 7 year period of running the simulation.

There is no significant change in aggregate supply compared to its average growth trend. This is because despite growing exports, the excess foreign exchange is used to reduce the foreign debt of the public sector and therefore exchange reserves do not increase considerably. Imports, mainly a function of aggregate income and foreign exchange reserves, therefore do not deviate from their average growth path. The money supply also remain the same since domestic credit has not been extended in this policy simulation and neither the exchange rate nor foreign exchange reserves have changed. The demand for money, private consumption and investment also do not rise above their average growth paths as these variables are mainly a function of aggregate income.

This clearly reveals how an accumulation of foreign debt would adversely affect economic growth. Had the foreign liabilities position allowed the economy to allocate some part of its foreign exchange proceeds from export growth to private or public investment, there could have been an export led economic growth. Increasing foreign exchange reserves on the one hand could expand the money supply but on the other hand would lead to an increase in imports and new investments leading to the aggregate income growth. Assuming the policy of foreign debt repayment in this experiment, therefore, an improvement in the foreign sector and foreign assets held by the public sector could benefit the economy after all the economy's foreign liabilities were paid.

To summarise this part of the policy simulations, where the effects of external changes on the economy were discussed, we notice that the model's responses to these changes were convincing in the sense that the policy simulation results on occasions seem to resemble the realities of the Iranian economy. Once more this can be attributed to the structure of the macroeconomics model as a good proxy for the Iranian economy. In this section simulation experiments showed that, as one might expect, a sustained increase in oil revenue would induce a healthy economic growth provided the government increased its investment accordingly. On the contrary, an oil revenue slump would force the government to reduce its expenditure and borrow from the domestic banking sector or abroad. In the first case, economic recession would develop while the most probable consequence of financing the drop in oil revenue by borrowing domestically would be inflation and a balance of payments deficit. A period of world economic growth can reduce the economy's foreign liabilities. If the opportunity was seized to

accumulate foreign exchange and increase public and private investment, economic growth would follow. In the next section we attempt to answer the question of whether a combination of fiscal and monetary policies could be implemented to improve the position of all three target variables of the economic system, (aggregate income, the price level and the balance of payments) through the time.

6.6.5 Monetary, Fiscal and Exchange Rate Policy Mix

In this part we consider the question of whether, in the assumed macroeconomic system, the government can achieve its long-run objectives of sustained economic growth, price stability and the balance of payments together by adopting a combination of policies. From our policy simulation experiments, discussed above, we could draw some broad observations that could be helpful in policy analysis.

(i) Government investment in this economic system appeared to have a stimulating effect on economic growth. More public investment increases private investment as well as total investment and leads to economic growth.

(ii) Expansion of domestic credit to finance a government budget deficit would create inflationary pressures that oppose a government stabilisation policy. Borrowing in foreign markets also undermines future economic prosperity because with already high foreign liabilities, foreign loans cannot be acquired on favourable terms. The remaining option for financing public investment is direct and/or indirect taxation. It should be noted that the taxation ratio to GDP in the economy has been very low (6 percent on average) suggesting that further

taxation would not have a strong crowding out effect on private sector expenditure.

(iii) In our structural model the Marshall-Lerner condition was satisfied in the medium term. On the other hand, the home currency has been kept overvalued for a considerable period of time despite a higher rate of inflation at home compared to the rest of the world. This leads to the fact that a more reasonable exchange rate (that means devaluation of home currency to close to its market determined value) will be consistent with the overall policy targets.

(iv) Although the main stimuli for private investment in the economic system were found to be aggregate income growth, the capital stock of the economy and public investment, an extension of domestic credit to the private sector, accompanied by economic growth and public investment, could facilitate private investment.

In this policy simulation we consider a 10 percent increase in government expenditure financed by a taxation policy. Home currency is devaluated by 10 percent and domestic credit to the private sector is extended by 10 percent. The other policy variables remain on their base simulation time paths. The policy mix is assumed to be implemented for 5 successive years. The policy simulation results are given in table (6.13)

Almost all variables behave in the way that was desired. Aggregate output grows 9.5 percent on average above its trend in the base simulation. The price level slows down 1.6 percent below its base simulation pattern. The inflation rate is 6.5 percent in this policy simulation compared to 8.6 percent in the base simulation. The current account of the balance of payments also eventually

begins to improve as exports grow faster than imports towards the end of the economic policy plan- in period 5.

Table 6.13 Policy simulation using complete model: percentage deviation of the main endogenous variables from their base simulation trend in response to a 10 percent increase in public expenditure (G), 10 percent increase in domestic credit to private sector (Dcp) and 10 percent devaluation of home currency (e) for five years.

| Periods | Y | C | Pi | M | m _a | P | X | Z | Ca | Fg |
|---------|------|-----|------|-----|----------------|------|------|------|-------|-------|
| 1 | 6.9 | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 8.3 | 2.1 | 8.0 | 3.3 | 3.5 | -2.1 | 6.1 | 10.7 | -17.4 | -0.2 |
| 3 | 10.4 | 3.4 | 10.7 | 3.9 | 6.5 | -0.8 | 9.8 | 11.6 | -12.5 | -0.6 |
| 4 | 14.8 | 5.0 | 16.9 | 4.9 | 9.1 | -1.3 | 13.2 | 15.1 | -15.3 | -0.8 |
| 5 | 15.3 | 6.5 | 23.1 | 5.5 | 11.0 | -1.9 | 16.1 | 16.6 | -12.6 | -1.2 |
| 6 | 6.3 | 7.9 | 26.9 | 5.5 | 10.1 | -2.4 | 18.8 | 15.8 | -2.2 | -0.98 |
| 7 | 4.5 | 5.9 | 12.2 | 0.8 | 7.9 | -2.6 | 12.2 | 4.4 | 21.7 | 0.2 |

The transmission mechanism of changes in policy variables to the endogenous variables is similar to that already discussed in various simulation experiments above. As increasing public investment stimulate economic growth through the increase in the capital stock, new investment captures the new technology effect on aggregate output. As aggregate income grows above its base simulation path, the real demand for money, disposable income, private investment and import demand are all positively affected. Growing private investment in turn increases total investment and the capital stock thereby accelerating aggregate output growth. The growth oriented policy thus appears to work effectively.

Regarding the price level, we notice that the respectable rate of economic growth (9.5 percent on average) induces a strong demand for money amounting almost 7.1 percent on average. The money supply on the other hand increases

only by 3.4 percent on average and, as a result, the price level in this policy simulation is lower than the base simulation pattern.

The current account of the balance of payments deteriorates in the first 3 years of the policy simulation. This, as could be expected, is because of a higher rate of growth for imports encouraged by the economic growth in the first half of the 7 year simulation period. The demand for imports in our economic system is heavily dependant on aggregate income while the price elasticity of demand for imports is quite low. On the other hand, the price elasticity of demand (foreign) for exports is quite large. In this policy simulation, aggregate income rises steadily affecting imports while price changes affect exports with a one period delay. For this reason, imports grow faster at the beginning of the policy simulation period. Nevertheless as relative price falls, due to the slow down in inflation and the 10 percent devaluation of the home currency, in the second half of the policy simulation period, export growth catches up and the current account turns to surplus.

The above description of the macroeconomic model's dynamics under economic policy suggest that the economic system could achieve all its policy targets provided a suitable set of policies were adopted. However, the suggested policy may prove difficult, if not impossible, to implement in reality. Direct taxation has not been the main source of government revenue in Iran in the time period (1959-93). Excluding petroleum revenues, government tax receipts have not been more than 7.5 percent of GDP and on average have been near to 5.5-6 percent, probably one of the world's lowest ratios (see Amuzegar, 1993). Regarding the magnitude of public investment in the country in order to

finance a 10 percent increase in public investment taxation should have been increased by almost 25 percent a year. Although this is still a rather low rate of taxation but raising taxation as much as 125 percent in a 5 year economic plan cannot be without some social and political disapproval.

Suppose the government, because of the difficulties in raising the taxation rate, decided to finance its extra investment by domestic borrowing. The other elements of the economic policy are retained as above. Our simulation experiments show that, in this case, aggregate output above its base simulation path compared to the previous policy simulation (11.2 percent on average). However, due to the expansion of the money supply, caused by domestic credit to public sector, the price level in this policy simulation rises above its average growth trend in the base simulation (1.5 percent annually on average) and is much higher than the inflation rate in the previous case. The target of net positive balance of payments also is not achieved in this policy simulation. Because of a growing price level at home and a higher rate of growth for imports, induced by economic growth, despite a 10 percent devaluation of the home currency foreign trade remains in deficit leading to larger foreign liabilities for public sector. In this case therefore economic objects of external balance and the price stability are not achieved although the rate of economic growth is higher.

6.7. Summary and Conclusion Remarks

In this chapter, following a brief discussion on the meaning and the main purpose of dynamic simulation of economic models, the procedure adopted in

this thesis to simulate the macroeconomic model estimated in chapter IV, were introduced. Two characteristics of the estimated macroeconomic model were examined before utilising it for policy simulation. It was established that the model could track the actual time series of the endogenous variables fairly well. Proportional root-mean-squared errors (PRMSE) and annual percentage deviation (APD) of the simulated values of the main endogenous variables from their actual values were computed and compared to some other simulations results. Also the model was found to be dynamically stable in the sense that divergence caused by a shock in one or a set of exogenous or policy variables tended to disappear over time.

Policy simulation results in this chapter are organised around fiscal, monetary and exchange rate policy. Likely consequences of the external shocks to the model were also examined through changes in some of the external variables of the model, namely oil revenues and world income. In most cases, two alternative simulations have been run for each change in policy or the external variables from their base simulation paths: a one year step increase and a five year increase of policy and exogenous variables.

The model's response to fiscal policy changes were inspected in conjunction with the means of financing the fiscal expansion. The model indicates that an expansion in public investment would raise income and private investment with different effects on the price level and the foreign sector of the economy, depending on the means of financing the extra public investment. Raising public investment through the extension of domestic credit to the public sector promotes private investment and aggregate output but on the other hand

increases the money supply thereby inducing a price increase that eventually deteriorates the foreign sector deficit. Financing public investment by borrowing abroad yields a similar result regarding aggregate output. However, while the price level is more stable in this case, expansion of public sector foreign liabilities is a clear disadvantage of this policy. It is worth noting that due to the economy's sustained current account deficit it would take a long time to repay an accumulated foreign debt without jeopardising economic growth. Financing public investment through the taxation produce weaker economic growth but, on the other hand, curbs the price and improves the balance of payments.

The model exhibited different behaviour when the fiscal expansion is devoted to public consumption rather than public investment. Expansion of domestic credit to finance public sector consumption increases the money supply without much effect on aggregate output. The money demand therefore remains close to the base simulation path. As a result, the price level increases and this reduces the real value of the private sector's liabilities to the domestic banking system. This increases private consumption and investment but this level of private investment is not capable of inducing strong economic growth. On the other hand because of the price increase, the current account of the balance of payments deteriorates leading to a further expansion of public sector foreign liabilities. Therefore, while economic growth is weaker the price level rises higher in this case compared to the previous experiment where fiscal expansion was allocated for public investment.

When government consumption is met by taxation there is no change in the money supply. The only change we have in the economic system is a reallocation

of economic resources from the private sector to the public sector. Private consumption decreases by .21 percent on average below its average growth path. Other variables do not show any considerable change compared to their trends in the base simulation.

With respect to monetary policy, it was argued that because of the absence of open market operations and the irrelevance of the interest rate to the behaviour of economic agents within the economic system, credit policy is the main monetary policy variable in the model. The model's response to an expansion of domestic credit to the private sector may seem rather surprising because of its negative effect on economic growth. Following an extension of domestic credit to the private sector, aggregate output declines while the price level increases and the balance of payments worsens. We note that an expansion of domestic credit to the private sector increases the money supply inducing the price rise. On the other hand, expansion of domestic credit to the private sector increases private liabilities to the banking system adversely affecting private investment and aggregate output. Our policy simulation indicates that following a 10 percent increase in domestic credit to the private sector aggregate output falls by .2 percent annually on average. Although the growth of the demand for imports is negatively affected by the economic slow down, however, as the demand for exports falls faster than the demand for imports, the current account deficit rises by 1.15 percent on average, mainly because of the inflationary pressures created by the expansion of the money supply. This policy simulation, therefore, reveals that in the economic system under examination, expansion of domestic credit to the private sector on its own can only adversely affect the economy- increasing

the price level, while negatively affecting economic growth and the foreign sector balances.

Expansion of domestic credit to the public sector, at least in the case of Iran is meant to finance the public sector borrowing requirement. The monetary policy action of expanding the domestic credit to the government is, therefore, closely related to the government's fiscal policy and financing its budget deficit. This was examined in the section on fiscal policy. However, with the government budget constraint in mind, it should be noted that an expansion of credit to public sector, if it was not used for budget deficit financing, should reduce government foreign liabilities. This may be the impact effect of the policy but in a dynamic simulation of the complete model, feedbacks running from the expansion of domestic credit to the money supply, domestic price level, the balance of payments and foreign exchange reserves implies worsening of the public sector's foreign assets position- again an adverse effect from monetary policy on economic system as a whole.

Turning to the exchange rate policy, recall that the Marshall-Lerner condition was found to be satisfied in the economic system in the medium term but not on impact. An exchange rate policy is therefore expected to affect the economic system in the medium term. Our policy simulation indicates that a 10 percent devaluation of the home currency would raise exports by 1.8 percent annually on average. This improves the current account of the balance of payments despite a growing demand for imports. However, the one period devaluation effect on aggregate output is quite small (.015 percent on average). The price level also is slightly higher than the base simulation path. Continuation

of the devaluation policy for 5 successive years reveals that the exchange rate policy alone could not affect aggregate output in a considerable manner and might be considered in a combination of consistent monetary and fiscal policies.

The model was subjected to external shocks through changes in oil revenue and a five year increase in world income. An increase in oil revenue with an equal increase in government investment would enhance economic growth without causing a budget deficit. Our simulation results suggest that a 10 percent increase in oil revenue and an equal increase in public investment raises aggregate income 6.8 percent above its base simulation trend on average. This induces an increase of 27 percent in import demand in period 2. However, on average, exports increase by about 8 percent which is higher than imports increase and as a result the current account of the balance of payments improves, leading to a fall in the public sector's foreign liabilities. Simulating the model, assuming a five year increase in oil revenue and an equal increase in public investment, shows that had government investment been extended over a longer period without causing budget deficits the economy would have achieved all three targets of economic growth, price stability and foreign sector balance.

A fall in the oil revenue would cause a budget deficit. Alternative government policies for financing the budget deficit, in the wake of an oil revenue slump, will have different effects on the economic system. Simulation results suggest that a 10 percent decrease in the oil revenue financed by domestic borrowing will deteriorate the current account of the balance of payments expanding the foreign sector deficit by 5.6 percent in period 2 and 10.6 percent in period 3. Full adjustment of the current balance of payments in this experiment takes about 11

years. To explain this long-run adjustment process for the balance of payments it can be noted that extension of domestic credit to the public sector increase the money supply by as much as 7.8 percent in period 2 and 3.6 percent in period 3 while the demand for money is increased only .65 percent in period 2 and 2.7 percent in period 3. As a result, the real rate of exchange appreciates, further deteriorating the foreign sector balances. Private investment and consumption rise in this experiment. This is partly because of economic growth but also as a result of inflation.

Continuation of the slump in oil revenue and expansion of bank credit to the public sector could end in high inflation and a larger foreign sector deficit. The country experienced a similar economic situation in the second half of the 1980s when the government facing years of diminishing oil revenues financed the budget deficit by domestic borrowing.

A more realistic assumption about the government's reaction to a decline in the oil revenue would be a reduction of public expenditure. The complete model simulation suggests that cutting down public expenditure has a consequence that economic growth falls while the price level rises and the foreign sector deficit increases. The price level increases because of a diminishing demand for money which exceeds a fall in the money supply due to the reduction in the balance of payments. The balance of payments deteriorates despite a decreasing demand for imports. This is because of the slump in the oil revenue and appreciation of the real exchange rate. Aggregate output falls because of the reduction in public investment.

The complete model simulation suggests that a world economy boom in which world output grows 10 percent per year for 5 successive year would increase Iran's exports by almost 4.5 percent a year. Export growth improves the current account and the foreign sector deficit reduces 3 percent on average in the 7 years of simulation. However, since the net balance of payments surplus is used to reduce the foreign debt of the public sector and therefore foreign exchange reserves do not increase, the money supply and aggregate output are not affected. The demand for money, private investment and private consumption, mainly dependant on aggregate income, also show relatively negligible changes compared to their base simulation patterns.

Finally, we considered the question of whether in the context of Iranian economy approximated by the economic model, the government can achieve its long-run policy objectives of economic growth, price stability and foreign sector balance together. From policy simulation results discussed in this chapter we expect that a combination of economic policy which consisted of: (i) expansion of government investment financed by taxation; (ii) rationalisation of the exchange rate by *devaluation of the overvalued home currency*; and (iii) *extension of bank credit to private sector*, would stimulate economic growth without jeopardising foreign sector balance and without fuelling the inflationary pressures. The complete model simulation assuming a 10 percent increase in the government investment financed by taxation, a 10 percent devaluation of the home currency and a 10 percent increase in domestic credit to the private sector suggest the following outcomes. Aggregate output grows 9.5 percent on average above its base simulation path while the price level slows down 1.6 percent below its base

simulation trend and grows by 6.5 percent compared to 8.6 percent in the base simulation. The current account of the balance of payments also eventually improves as exports grow faster than imports on average. However, financing an increase in public investment by taxation may prove difficult in reality as in Iran taxation has not been the main means of the financing government expenditure in the sample period under consideration 1959-93. Simulation results suggest that if in this combined economic policy, government investment was financed by domestic borrowing instead of taxation, although aggregate output grows higher (11.2 percent on average), the price level rises 1.5 percent above its base simulation time path and the balance of payments deteriorated due to the inflationary pressures.

Appendix VI.I Solution Methods of the Non-linear Dynamic Systems

Given the difficulties of solving large economic models which are both simultaneous and non-linear in structure it is common practice to make use of a numerical algorithm for model solving. There are in general two main categories of algorithms :the Newton and Substitution methods.

The main idea in Newton's method is to expand the non-linear system's function linearly in a Taylor's series around a starting value of the system's variables. Consider the general non-linear system:

$$(6A.1) \dots f_i(x_1, \dots, x_n) = 0 \quad i = 1, \dots, n$$

where x_i are variables of the system.

Expanding these functions linearly in a Taylor's series about a starting value, say x_{0j} , we have:

$$(6A.2) \dots f_i(x_{01}, \dots, x_{0n}) - \sum_{j=1}^n \left(\frac{\partial f_i}{\partial x_j} \right) \Big|_{x=x_0} (x_j - x_{0j}) = 0 \quad i = 1, \dots, n$$

These are linear equations in x_j with coefficient $\left(\frac{\partial f_i}{\partial x_j} \right) \Big|_{x=x_0}$ and constant terms:

$$(6A.3) \dots f_i(x_{01}, \dots, x_{0n}) - \sum_{j=1}^n \left(\frac{\partial f_i}{\partial x_j} \right) \Big|_{x=x_0} x_{0j}$$

From the solution for these linear equations x_{1j} is found. Next we could form linear expansions around x_{1j} and proceed as before to find x_{2j} .

From the iterative solution method, the simulated time paths of the system's equations can be developed. If we normalise the equation system (6-1) as:

$$(6A.4) \dots x_i = g_i(x_1, \dots, x_n)$$

and the r-th iteration solution values are evaluated from:

$$(6A.5) \dots x_{r,i} = g_i(x_{r-1,1}, \dots, x_{r-1,n})$$

an alternative solution algorithm known as the substitution method results. Its relation to Newton's method can be seen from a consideration of

$$(6A.6) \dots x_{r,i} = g_i(x_{r-1,1}, \dots, x_{r-1,n}) + \sum_{j=1}^n \left(\frac{\partial g_i}{\partial x_j} \right) \Big|_{x=x_{r-1}} (x_{r,j} - x_{r-1,j})$$

As is apparent the Newton's method would involve successive (iterative) solution of linear equations in the above expression (6.6). In solving this set of equations, large scale matrix inversions are required at each stage. These calculations involve a large number of arithmetic operations. The algorithm defined by (6-5) on the other hand entails fewer calculations, because it avoids matrix inversion (see Fromm and Klein (1969)).

Newton's method applied to econometric models has been found to converge rapidly. The block recursive method also appears to converge rapidly to a solution. However, there is no assurance that the substitution method always converges to a correct solution, if any solution at all (Fromm and Klein, 1969). In the linear case we know that if a solution exists it will be unique and that a solution will exist if all the equations are linearly independent. In the Gauss-Seidel method, which is a variant of the substitution approach known to be sensitive to the normalisation of variables, there is no guarantee of finding such a solution even when it exists and is unique. Crucial factors in the success of the Gauss-Seidel method are the normalisation (i.e. having obtained a parameter

with unit value for the variable at the left hand side of the equation) and ordering of the equations in the system. There are a number of variants on the Gauss-Seidel technique which have received attention. A survey of the literature in these methods and their solution techniques can be found in Hughes-Hallett (1981).

Here we use Fromm and Klein's (1969) example to illustrate the Gauss-Seidel convergence process. Consider a two equation system where:

$$(6A.7.1) \dots x_{r,1} = g_1(x_{r-1,2}) \quad i = 1, \dots, r, \dots, n$$

$$(6A.7.2) \dots x_{r,2} = g_2(x_{r,1})$$

where x_1 and x_2 are endogenous variables of the system to be evaluated at r -th iteration. Suppose we are at the first iteration, namely $r=1$. The Gauss-Seidel approach proceeds as follows:

$$(6A.8.1) \dots x_{1,1} = g_1(x_{0,2})$$

That gives the first iteration values of x_1 from the initial value of x_2 . From the second equation:

$$(6A.8.2) \dots x_{1,2} = g_2(x_{1,1})$$

That is, the first iteration values of x_1 is used to obtain the first iteration value of x_2 . So the next steps are:

$$(6A.9.1) \dots x_{2,1} = g_1(x_{1,2})$$

$$(6A.9.2) \dots x_{2,2} = g_2(x_{2,1})$$

Finally a terminal solution is achieved at the $v + h$ iteration :

$$(6A.10.1) \dots x_{v,1} = g_1(x_{v-1,2})$$

$$(6A.10.2) \dots x_{v,2} = g_2(x_{v,1})$$

We noted earlier that in the ordinary substitution method the right-hand side variables are maintained fixed at the immediate last period values in any particular iteration period until all the left hand side variables are evaluated. The effect of using ordinary substitution iteration can also be shown easily. Considering our example of the two-equation system, the solution process in ordinary substitution is:

$$(6A.11.1) \dots x_{r,1} = g_1(x_{r-1,2})$$

$$(6A.11.2) \dots x_{r,2} = g_2(x_{r-1,1})$$

Equation (6-11-1) is identical to (6-9-1) but equation (6-11-2) uses $x_{r-1,1}$ instead of $x_{r,1}$ as in (6-9-2). The solution in this case proceeds as following:

$$(6A.12.1) \dots x_{r,1} = g_1(g_2(x_{r-2,1}))$$

$$(6A.12.2) \dots x_{r,2} = g_2(g_1(x_{r-2,2}))$$

which in its explicit form can be expressed as a function of $x_{0,1}$ and $x_{0,2}$ respectively, by successive substitutions. The time path of the real system to convergence in this case is substantially slower than with the Gauss-Seidel procedure but for an economic model of the size we are concerned with here, this would cause no problem. With the ordinary substitution method the ordering of equations has no effect on convergence. In this study we have used a version of the ordinary substitution approach known as MIT Dynamo substitution method. This technique is used in different disciplines to simulate system dynamic models

(see Naylor, 1971). An early application of this method in economics is that of L. Erdman who programmed a solution for the Brookings Institute Macroeconomic model using this method (see Duesenberry et al, 1969).

Appendix VI.II Writing the Model's Equations in Dynamo Mode

As was mentioned, using Dynamo language to simulate a dynamic model requires translating the entire model to a system of difference equations. This system of equations basically consists of the state or level variables, the rate variables and the auxiliary variables of the model. Here we briefly describe these variables in order to clarify the system dynamic version of the estimated macroeconomic model, given in table (6.1) below. It will be noted that level variables represent accumulation of material or information (such as the capital or exchange stock or the price level). Level equations are identified by L in the list of equations of a system dynamic model. Consider for example foreign exchange reserves equation in the model. This is a state or level variable and its equation as is appeared in table (6.1) is given as

$$(6A2.1) \text{ L } \text{Fr.k} = \text{Fr.j} + \text{Dt} * (\text{Bop.jk}).$$

By this, it is meant that at time k, foreign exchange reserves is equal to the amount at time j plus the change in foreign exchange reserves determined by Bop.jk, in the interval from j to k times the length of that interval. Dt denotes the length of the interval over which changes in foreign exchange reserves occur, which is one year in our model. The j, k and jk in the above equation are referred to as timescripts and are used to indicate relative timing. Initial values of level variables are shown by N and must be specified for all level variables. For example foreign exchange reserves has been \$.077 bn in year 1959 which is the beginning year of our sample period, 1959-93. Rate equations in system

dynamic models can be determined by a wide variety of factors in a wide variety of ways. An example of rate equation in our model is the balance of payments equation which changes the state or level variable foreign exchange reserves.

$$(6A2.2) R \quad Bop.kl=(1/e.k)*(Ca.k)-(Fpr.kl+Fgr.kl)$$

Notice that R is required in front of the equation. Also notice that the rate variable is timescripted .kl, indicating that the calculated value of a rate is used to determine further value of the level variable (Fr in this case).

Levels and rates form the fundamental building blocks for a system dynamic model. But it is rarely feasible or desirable to specify all rates variables solely in terms of the levels. To make the definition of rate variables clearer and easier, a class of variables known as auxiliary are used. In terms of the feed back structure of a system dynamic model, auxiliary variables simply bridge the gap between levels and the rates changing other levels. In practice however, auxiliary variables tend to be most numerous and to represent important concepts in the system dynamic models. An example of an auxiliary variable in our model is the current account of the balance of payments:

$$(6A2.3) A \quad Ca.k=P.k*(X.k-Z.k)+Fae.k$$

where as before X and Z are exports and imports respectively and Fae denotes the economy's foreign assets earnings. Auxiliary equations represent information processing and actions based on information in the dynamic system. Finally we used two built in functions for the lagged variables and the exogenous variables of the model. Dynamic simulation program *Dynamo* considers information and material delays. For example in the equation

$$(6A2.4) A \quad Fae.k=iw.k*e.k*(Frl.k+Fpl.k+Fgl.k)$$

the lagged foreign exchange reserves and foreign assets held by the private and the public sectors are shown by Frl.k and Fpl.k and Fgl.k respectively. To introduce the value of foreign exchange reserves delayed one period the function $A \quad Frl.k=Dlinf3(Fr.k,1)$ is used. The first argument is input variable- the variable

to which we are delaying response. The second argument is the average length of the delay (one year in our model). Time series data for the exogenous variables of the model are introduced to the simulation process using table functions which are another type of built in function in Dynamo (see Pugh-Roberts 1986)

Chapter VII

Overview and Summary

7.1 Major Results of the Study

This study provides considerable knowledge about the structure of the Iranian economy in 1950s-93 and about the impact of macroeconomic policy both in the short-run and in the medium-term within the economy. Some of this knowledge might appropriately be generalised to other developing countries particularly to the oil exporting countries of the Middle-East where oil revenues construct a substantial part of their government revenues. The detailed findings are numerous and discussed throughout the thesis, the following points, however, capture the more general major implications.

(1) Our survey of the Iran's economic development in 1950s-1993 (chapter II) suggests that: (i) because of the oil revenues, government expenditure has not been constrained by the tax effort and oil revenue increases the multiplier effects of government expenditure; (ii) that government budget deficit (after oil revenue received) have largely been financed by domestic credit but public expenditure has not had a considerable crowding-out effect; (iii) that the official interest rate has not been an effective measure regarding demand for credit from the banking

system and bank loans have been largely allocated through legal reserve requirements and credit ceiling on commercial banks; (iv) that open market operations were not used as a major source of finance for the public sector borrowing requirement; and (v) that foreign exchange shortages have been a genuine constraint on economic growth, except for a short period- the oil boom era 1964-76 (see chapter II).

(2) The resultant model that emerges in our study, on the basis of our observations of the Iranian economy, theoretical considerations and literature review, is basically a variant of the traditional flexible-price Mundell-Fleming model with specific modification designed to take account of the particular characteristics of the Iranian economy. The model includes 14 exogenous variables and 30 endogenous variables. The behavioural equations of the model consist of aggregate consumption, private investment, exports, imports, aggregate output and the demand for money.

The specification of private consumption is conventional and takes account of the effect of the real rate of interest, disposable income and the lagged dependent variable. In private investment, we have considered government investment and bank credit in addition to the real rate of interest, aggregate income and the capital stock of the economy as explanatory variables to test the empirical significance of these variables on private investment. All agents in the economy are assumed to be price takers for imports while exerting some monopoly power over the price of exports in the world markets. In the import demand function, the variable “lagged reserves to imports ratio” is included to measure the effects of exchange controls on import demand. Two alternative aggregate supply

functions have been derived: one, in the Keynesian macroeconomic tradition, allows actual output to deviate from its long-run trend, and the other is a neo-classical full employment production function. It was left to empirical evidence to indicate which production function best explains aggregate output in Iran.

On the financial side, the absence of a market for domestic securities, the presence of capital controls and officially determined interest rates on bank assets and liabilities are integrated in the model by appropriate assumptions. We formulate the market determined interest rate as a linear combination of the international interest rate and a domestic 'shadow' interest rate. This domestic 'shadow' interest rate is the interest rate that would clear the domestic money market in the absence of capital mobility (see chapter III). Formulation of market determined interest rate allows us to estimate an index of the effective degree of capital control through the revised demand for money function.

(3) The estimated model appears to be a reasonable proxy for the Iranian economy in the sample period under observation. Goodness of fit for all the estimated equations is above 92 percent except for the export demand function which is 86 percent. Aggregate consumption in the sample period has been mainly responsive to real disposable income. No evidence could be found of a significant effect of the real rate of interest on consumption expenditure. We found a marginal propensity to consume of about .41. The short-run and long-run income elasticity of consumption turned out to be 58 and 95 percent respectively. Our results therefore reject the Hall(1978) specification of the permanent income hypothesis of consumption in the Iranian economy in this period.

(4) The most influential explanatory variables on private investment were real aggregate income and the capital stock of the economy. Our estimates also reveal that public sector investment exerts a significant and positive effect on private capital formation. No significant relation was found between the real rate of interest and private investment.

(5) Export demand was found to be responsive to relative prices but import demand appeared quite price inelastic. Considering the immense necessity of imported capital and intermediary goods in the economy a price inelastic demand for imports is a reflection of the dependency of the Iranian economy to the wider international economy. The income elasticity of demand for imports on the other hand is quite large (2.07) suggesting that in Iran, as in most developing countries, the major difficulties lie on the supply side of the economy-demand appears to be quite strong for home and imported goods and is largely dependent on aggregate income. Also our estimates show that the coefficient on the lagged reserves-import ratio is significant and positive reflecting the foreign exchange constraint in the economy. The Marshall-Lerner condition is satisfied in our model in the medium term but not on impact.

(6) The capital stock and labour force both appeared to exert a significant and positive influence on aggregate output. Current investment was also found to have a strong effect on aggregate supply. This could be interpreted as the technological changes effect embedded in new investments. The estimated production function exhibited constants return to scale. The output elasticity with respect to the capital stock and labour inputs were estimated to be about .30 and .70 respectively

(7) The coefficients in the estimated demand for money function are all significant and of the expected sign except for that on the real rate of interest which was not found to be significant statistically at the 5 percent level. The estimated income elasticities of the demand for money are .23 and 2.8 in short-run and long-run respectively. The coefficient on the inflation rate in the demand for money function was found to be negative and highly significant. One interpretation of this is that the inflation rate should be regarded as the opportunity cost of holding money in this economy over the sample period for most of which Iran experienced high inflation. Our modelling approach allowed us to estimate the effective degree of capital mobility. The estimate of parameter ϕ (index of capital mobility) turned out to be about .62 indicating a relatively high degree of capital mobility in this economy. This finding implies that economic agents find ways to get around official barriers adopted to curb private capital transfers.

(8) These findings have a number of policy implications. For example the existence of capital mobility aggravates the destabilising potential of exchange rate overvaluation. At the same time it underlines the futility of financial repression as a means of keeping domestic interest rates low to stimulate investment. However, while correction of an existing exchange rate misalignment will move the economy in the right direction, it is worth noting that this will only happen slowly due to the satisfaction of the Marshall-Lerner condition in the medium term and the sustained balance of payments deficit. Therefore, complementary demand management policies are needed to correct external balances in the short-run.

(9) On the basis of Chow tests applied to the estimated equations of the model, we were able to conclude that the constancy of the estimated parameters could not be rejected at the 5 percent level of significance. Since Chow tests are also considered as powerful tests against a broad range of the misspecifications, these results precluded any serious misspecification of the macroeconomic model.

(10) Having established the model's parameter constancy over the entire sample period, the structure of the model was examined through the determination of the short-run equilibrium conditional on the expected values of the exchange rate and the price level one period ahead. Linearising the model by approximating the model's identities around their sample mean and solving for $\log P$ we were able to derive an (approximate) aggregate demand function with the domestic price level expressed as a function of the nominal interest (i_t), the price level expected next period (EP_{t+1}) and exogenous variables such as government spending (G_t), taxation (T_t) as well as predetermined variables. Assuming the price level remains constant in the short-run with aggregate income and interest rates as the main variables of the system, this gave a fairly standard IS curve for the model.

(11) To derive the LM portion of the model the 'shadow' money and the 'shadow' interest rate relationships were used. With proper substitution for the endogenous variables we ended up with the 'shadow' interest rate as a function of price level, exchange rate and domestic credit. Accordingly the monetary aggregate controlled by the authorities in this setting is the stock of domestic credit (D_c). The 'shadow' interest rate depends on credit policy, government borrowing, the exchange rate policy, the current account and money demand

variables. From there we derive the LM curve of the model as a function of the domestic price level, domestic credit and other exogenous and predetermined variables of the model.

(12) The BP schedule of the model was derived using the balance of payments identity, linearising the resulting expression, and proper substitution for the endogenous variables. First an expression is derived for the changes in foreign assets held by the private sector ($\Delta \log F_p$), in which changes in the private sector holding of foreign assets is expressed as a function of the interest rate, the price level and other predetermined and exogenous variables. This equation determines the magnitude of private capital flows. This latter variable is essentially a policy reaction function which express as the magnitude of capital outflows permitted by the authorities as a function of domestic credit and external variables affecting the degree of tightness in domestic financial markets. If we assume $\Delta \log F_p$ is an exogenous variable to the model, rearranging the expression gives the model the BP schedule (see chapter V).

(13) Comparing IS-LM-BP curves derived from the estimated model indicates that in the nominal interest rate (on vertical axis) and real income plane slope of IS curve is steeper than that of BP and this latter schedule has steeper slope compared to the LM curve. This implies that an income growth, induced for example by the private or government expenditure, would generate a balance of payments deficit. The policy implication of the IS-LM-BP curves, which applies only to the point of sample mean of these functions, are that: fiscal policy is far more effective in inducing an income growth while monetary policy appears impotent in this respect. In short-run an expansion monetary policy will

increase real income and reduce the domestic interest rate while the balance of payments is in deficit. In the longer term as the balance of payments deficit reduce the money stock, the variables turn to their original values. However, the financing means of the fiscal expansion should be taken into consideration. When the fixed price condition was relaxed, combinations of monetary -fiscal policy failed to secure both internal and external balances. In this case addition of exchange rate policy to the monetary-fiscal mix appears to be effective in providing economic growth with price stability and balance of payments.

(14) Derivation of the impact multipliers of the macroeconomic model enables us to conduct a brief comparative static analysis of the Iranian economy. The marginal rates of substitution of policy variables were also calculated at the point of sample mean. These marginal rates underline the relative effectiveness of monetary policy on the financial part and fiscal policy on the real part of the economy in a true Mundellian fashion. The set of impact multipliers and the marginal rates of substitution between policy instruments help to draw a demarcation line between the economy's sectors on the basis of the policy. In general it can be seen that monetary policy is more effective in the financial sector of the economy while fiscal policy is more influential on the real part of the economy. However, this analysis also reveals the impotence of taxation policy and the short-run influence of the exchange rate policy in the Iranian economy.

(15) The complete model was transferred to a system dynamic model for policy simulation purpose (see chapter VI). The complete system simulation results suggest that the model could track the actual time series of the endogenous variables reasonably well. Proportional root-mean-squared errors

(PRMSE) and the annual percentage deviation (APD) for the main variables of the model also were computed. The system dynamic model was found to be dynamically stable in the sense that a divergence caused by a shock to one or a set of exogenous variables would disappear over time. This means that the model could usefully be utilised for policy simulation purposes.

(16) The complete model simulation suggests that an expansion in public investment would raise income and private investment with different effects on the price level and the foreign sector of the economy depending on the means of financing the public sector investment. Extension of domestic credit to finance public investment promotes private investment and aggregate income but on the other hand generates inflationary pressures and balance of payments deficits. Financing public investment through foreign borrowing yields a similar result regarding aggregate output. However, while the price level is more stable in this case, expansion of public sector foreign liabilities is a clear disadvantage of this policy. Raising taxation to finance extra public investment curbs the price level and eventually improves the balance of payments but economic growth in this case is lower.

(17) In the absence of open market operations and the market determined interest rate, credit policy is the main monetary policy instrument. The complete model simulation changing the credit policy yields interesting results. An extension of domestic credit to the private sector adversely affects the economy. Aggregate output declines while the price level increases and the balance of payments worsens. This may appear to be a controversial result. To explain the transmission mechanism by which an extension of credit to private sector

negatively affects aggregate output while increasing the price level it will be noted that the variable, domestic credit to private sector lagged one period, appears with a negative coefficient in the estimated private investment function. This means that an increase in domestic credit to the private sector will have a negative effect on private investment, and thereby on total investment and aggregate output with a one year delay. On the other hand an expansion of domestic credit increases the money supply, but since the demand for money does not catch up due to the fall in aggregate income, the price level has to rise to equalise the demand for and supply of money. Our policy simulation results show that a 10 percent increase in domestic credit to the private sector decreases the growth of aggregate output by .2 percent on average. Although the demand for imports also diminishes compared to the base simulation trend, however, because exports fall faster in the second half of the 7 year simulation period the deficit of the current account of the balance of payments increases by 1.15 percent on average mainly due to inflationary pressures.

(18) The complete model simulation suggests that an exchange rate devaluation would promote exports in the medium term. Recall that the Marshall-Lerner condition was found to be satisfied in our model in the medium term but not on impact. A devaluation therefore, improves the balance of payments. Our policy simulations indicate a 10 percent devaluation of the home currency would raise exports by 1.8 percent on average which improves the current account of the balance of payments despite a growing demand for imports. However, the one period devaluation effect on aggregate output is quite small (.015 percent on average). On the other hand, simulation results of a 5 year

period devaluation reveal that exchange rate policy on its own could not promote economic growth considerably. This indicates that the exchange rate policy should only be adopted in combination with the other fiscal and monetary policies in order to deliver a considerable result on the economy.

(19) The economy was subject to external shocks including changes in oil revenues and an increase in world income. Simulation results suggest that a 10 percent increase in the oil income with an equal increase in public investment would raise aggregate income 6.8 percent above its base simulation trend on average. This induces an increase of 27 percent in imports in period 2, but because of faster growing exports, eventually the current account of the balance of payments improves leading to a reduction in public sector foreign liabilities. The complete model's simulation results (assuming a five year increase in oil revenue and an equal increase in public investment) show that had the government investment been extended over a longer period without creating budget deficits in the economy the government would have achieved its targets of economic growth, price stability and the balance of payments surplus.

(20) Our simulation results suggest that a 10 percent decrease in oil revenue financed by domestic borrowing will deteriorate the current account of the balance of payments, expanding foreign sector deficit by 5.6 percent in period 2 and 10.6 percent in period 3. Full adjustment of the current account of the balance of payments in these experiments takes about 11 periods. To explain this long term adjustment process it can be noted that extension of domestic credit to the public sector induces an expansion of the money supply by as much as 7.8 percent in period 2 and 2.7 percent in period 3 while demand for money only

increases by .65 percent in period 2 and 2.7 percent in period 3. As a result, the real rate of exchange appreciates further deteriorating the balance of payments. Continuation of the slump in the oil revenue and expansion of bank credit to the public sector could end in high inflation and larger foreign sector deficits. The country experienced a similar situation in the second half of the 1980s when the government resorted to finance its budget deficits caused by reducing oil revenue, mainly through domestic borrowing. This fuelled inflation while the foreign sector deficit increased.

(21) The complete model simulation indicates that a reduction of public expenditure in the wake of a major oil revenue decline would diminish economic growth while the price level would rise and the foreign sector deficit increases despite a decline in the demand for imports caused by economy's slow down.

(22) The simulation results suggest that a world economy boom in which world output grows by 10 percent a year for five successive years, would increase Iran's exports by almost 4.5 percent a year on average. Export growth improves the current account of the balance of payments leading to a reduction of public sector foreign liabilities by 3 percent on average. Assuming that a net surplus of the balance of payments is used for the repayment of the foreign liabilities, foreign exchange reserves of the economy do not increase considerably in spite of a net surplus in the foreign sector of the economy. As a result, money supply and imports also remain unchanged and therefore, changes to aggregate output and the price level are small. These results are similar to the country's economic position in the period 1992-95 during which, despite the increase in the oil price,

compared to the second half of the 1980s, economic growth was not high enough given that the country had to repay its accumulated foreign debts

(23) The complete model simulations suggest that adoption of a proper combination of economic policies would steer the economic system in the right direction towards its targets (considered here to be economic growth, price stability and balance of payments) but it could be difficult to implement in reality. Policy simulation results indicate that an economic policy consisting of (i) expansion of public investment by 10 percent financed by taxation; (ii) rationalisation of the overvalued home currency by 10 percent devaluation of the exchange rate; and (iii) extension of domestic credit to the private sector by 10 percent for five successive years would yield the following results. Aggregate output would grow by 9.5 percent on average above its base simulation trend, while the price level increase slows down 1.5 percent on average. The price level increases by 6.5 percent on average in this experiment compared to 8.6 percent in the base simulation. The current account of the balance of payments also eventually improves as exports grow faster than imports in the second half of the 7 year policy simulation period. However, implementation of this policy might be quite difficult if not impossible due to the undeveloped taxation system in the country. This is because, in Iran, the direct taxation rate has been about 6 percent of GDP on average over the period 1959-93. Financing a 10 percent increase in public investment will require an increase in direct taxation as much as 25 percent a year which cannot be without social disapproval. Suppose in this economic policy the increase in public investment was financed by expansion of the domestic credit to the public sector. Our policy simulation suggest that in this

case although aggregate output would grow higher (11.2 percent on average), however, price level also would increase higher than the base simulation and the balance of payments would worsen.

(24) The complete model simulation results suggest that policies can have a significant impact. Fiscal, monetary and exchange rate policies can have quite substantial effects on most areas of policy concern. Fiscal policy has a greater impact on the real part of the economy while exchange rate policy appears influential to the foreign sector and the balance of payments; and monetary policy seems to have greater impact on the price level.

(25) In some respects, the complete model simulation results support some of the prevailing beliefs concerning Iranian policy choices. For example, government investment exerts a positive effect on private investment, an increase in imports affects aggregate output but the import demand responsiveness to a devaluation is quite limited. The price level increases significantly following an expansion of the money supply through domestic credit policy with negative effects on foreign trade and the balance of payments. Taxation policy is rigid in the sense that it cannot be manipulated to finance a public sector borrowing requirement in the case of an unprecedented slump in the oil revenue. In other respects however, the simulations illustrate ways in which historical policies have caused results opposite to those intended. Expansion of domestic credit to the private sector, for example, produced a negative effect on aggregate supply while causing inflationary pressures.

(26) The complete model analysis suggests that there exist substantial trade-offs among various macroeconomic objectives. For example, due to the structure

of the economy, economic growth causes balance of payments problems; and financing government investment by domestic credit generates inflationary pressures. The complete model simulations reveal that to some extent, the partial equilibrium analysis provides poor predictions of the magnitude of the medium term effects. On the other hand, policy tools are limited by such realities as the absence of an integrated capital market, the lack of a market determined interest rate and open market operations, making successful 'fine-tuning' of the economy even more difficult.

(27) The partial equilibrium and complete model simulation results of this study do not exclusively support one side or the other in the extreme monetarist or Keynesian controversy. While excess money balances induce inflationary pressure, a fiscal expansion is effective in promoting real income and the exchange rate policy appears to be effective in the foreign sector of the economy.

7.2 Further Extension of the Study

The nature of this study confined our analysis to an aggregate macroeconomic model with a conventional specification and the application of standard econometric techniques for estimation and dynamic simulation of the model. Time and space limits prevent us from embarking on an attempt to enlarge the model, to incorporate aspects such as informal markets to the model and/or to apply vigorous techniques for policy analysis.

However, the study can be extended in the future to enrich our analysis of the Iranian economy . Some possible directions in which this study can be advanced without losing its original characteristics are as follows:

(i) At such a level of aggregation of our macroeconomic model, it is impossible to capture the impact of policies on relative prices. Some economists have argued that policies in developing countries have primarily reflected on altered relative prices. Enlarging the model to include the main sectors of the economy such as the oil and gas industry, machinery, agriculture, services and so on would allow an examination of the impact of policies concerning relative price changes on the reallocation of resources between the sectors and intersectoral flows.

(ii) In the last decade or so, curb market for informal foreign exchange transactions, in Iran, have expanded enormously as a result of the government policy of retaining a highly overvalued Rial. This makes a devaluation of the home currency, which is a key component of the macroeconomic adjustment programme recommended by the IMF, inevitable in the future. There is wide agreement that the structure of the financial markets play a crucial role in determining the nature of the devaluation effects and in transmitting them to the real economy. The macroeconomic role of parallel markets for foreign exchanges in Iran is ambiguous and requires further investigation. Since the stocks of assets traded in informal markets, their current prices, and the expected future paths of these prices can all be expected to affect the current spending decisions of private agents, the economy's dynamic response to devaluation can be quite complex. The simultaneous existence of rationing in official markets and informal markets for both credit and foreign exchange are a key feature of the developing economy financial context. Integration of these aspects of the exchange rate policy into the model would help to enhance our understanding of the foreign sector of the economy and make our analysis more robust.

(iii) In our study, the policy implication of the model were discussed by straightforward simulation comparison between baseline projections (without policy change) and policy induced projections. A further expansion of the policy application of the model would be to use the technique of optimal control. In this mode a loss function is constructed as a function of principal targets (aggregate income, the price level and foreign exchange reserves in our case), and instruments (a subset of our policy variables) that are relevant for decision makers. The loss function is to be minimised subject to our macroeconomic model, given in table (6.1) over the time horizon $T+1, \dots, T+H$, with respect to instrument variables, where T is the terminal time of the sample period in which the model is estimated. Numbers of targets and instruments should be a proportion of the endogenous and policy variables respectively. Numbers of instruments also should be less than target variables.

Control theory develops very specific policy proposals. It is a formal method and is optimal only in the sense of existing for a given loss function and the simplest of policies. It is useful in bringing out a system's properties and is an excellent device for working out medium or long range projections. The control theory approach can be worked out in terms of a comparison between two dynamic simulations over the horizon period, one being a base line projection and the other being that which follows from the solution of the first-order condition for control. The control simulation can be deterministic with all error terms put at their sample mean values- say zero. It can be stochastic by choosing replicated random drawings that conform to the moment structure of the

computed residual. Allowance can also be made for the sampling distributions of the parameter estimates in the economic model(see Klein, 1993)

Optimal control procedures are both interesting and useful, but the results are optimal in only a limited sense. However, economic policy making is not yet at a stage whereby purely formal computational methods can be used in the same way that they are applied to highly restrictive engineering systems. They are certainly not ready for global economic policy formation. However, in the circumstances that the policy makers have to decide upon a trade off between the various targets, the formal theory underlying such policy trade-offs and the necessary adjustment that has to be made to the control variables is the subject matter of optimal control theory and its application to our study would further illuminate our policy analysis of the economy.

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