Monetary Disequilibrium, Black Market Exchange Rate, and the Balance of Payments (The Case of Iran)

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MONETARY DISEQUILIBRIUM, BLACK MARKET EXCHANGE RATE, AND THE BALANCE OF PAYMENTS
(THE CASE OF IRAN)

by

Reza Kalantar

A dissertation submitted in partial fulfillment of the requirements for the degree
of
DOCTOR OF PHILOSOPHY
in
Economics

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1983
TO MY WIFE:

Zohreh Kalantar
ACKNOWLEDGEMENTS

I wish to express my deep appreciation to my major professor, Dr. Basudeb Biswas, not only for his invaluable assistance and advice, but also for his abundant patience throughout the duration of this study. Sincere thanks also goes to Dr. Clark A. Wiseman and Dr. Kenneth S. Lyon for their helpful suggestions at various stages in this work. I also wish to express my deep sense of gratitude to other members of my committee - Dr. Jay C. Andersen and Dr. Philip R. Swensen.

I extend to my wife, Zohreh, my expression of gratitude for the support, patience, and love that only a wife can give.

Reza Kalantar
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ABSTRACT

Monetary Disequilibrium, Black Market Exchange Rate, and the Balance of Payments

by

Reza Kalantar, Doctor of Philosophy
Utah State University, 1983

Major Professor: Dr. Basudeb Biswas
Department: Economics

The main purpose of this study is to analyze theoretically and empirically the short-run dynamics of Iranian reserve flows, black market exchange rate, and domestic rate of inflation. To achieve this purpose, a monetary approach was adopted to measure the simultaneous effect of an ex ante excess flow supply of money on the three variables.

This study also attempts to test the hypothesis that in the long run growth in output and price level is associated with a balance of payments surplus, while growth in the domestically-determined portion of the money stock tends to be associated with deficits. The empirical findings for the longrun balance of payments shows that monetary authorities in Iran cannot control the change in the stock of international reserves through domestic credit creation or destruction; rather, the authorities have a substantial control over
this variable through the money supply multiplier. In the short run, monetary imbalances do explain the flow of international reserves, whereas, domestic inflation is mainly explained by world inflation. However, changes in the black market exchange rate are solely determined by factors outside of the model.

(78 pages).
CHAPTER I

INTRODUCTION

An Overview of the Iranian Exchange System

The basic legal framework of Iran's present foreign trade policy was established under two acts during the 1930's: The Foreign Trade Monopoly Act of 1932 and the Foreign Exchange Act of 1936. The original trade act (and its amendment in 1941) gave the state a right to engage directly in, and be the sole agent for, the country's external commerce. The government could, in fact, take full charge of the country's total exports and imports. The exchange act, revised in 1958, made the state the sole legal keeper of foreign exchange balances. All export proceeds had to be sold to the state, and all imports were subject to scrutiny and "license" by the Exchange Commission.

Under Iran's present exchange regime, the rial is pegged to the International Monetary Fund's Special Drawing Rights. Special Drawing Rights were created after the introduction of a "two-price system" for gold in 1968, a system that separated official dealings from private dealing in gold. The creation of Special Drawing Rights marked the first step in the downgrading of the role of gold in International finance. Accompanying this decision of the world's major central bankers (Belgium, Germany, Italy, the Netherlands,
Switzerland, the United Kingdom, and the United States) was a decision to introduce a new reserve asset into the international monetary system, beginning in 1970. By mutual consent of its member nations, the International Monetary Fund created the Special Drawing Rights (abbreviated SDRs and often referred to as "paper gold") and distributed them among its members according to preassigned quotas, with each SDR equal to one dollar.

The new economic policy announced by the United States on August 15, 1971, closed the U.S. gold window to foreign central bankers and ushered in a three-month period of freely fluctuating exchange rates. This was followed by widespread exchange rate realignment and a devaluation of the dollar on December 18, 1971 (the Smithsonian Agreement). After fourteen months of turmoil on the international financial markets, in the first week of February 1973, the United States published its preliminary balance on merchandise trade for 1972. The balance showed a substantial deficit.

On February 12, 1973, the dollar was devalued for the second time; the immediate effect was that some major European currencies inaugurated their "joint float" against the dollar. Together with the floating yen and pound sterling, this development made the dollar a floating currency and effectively spelled the end of the Bretton Woods system.

The par value of the Iranian rial was established in 1957 at Rls. 75.75 per U.S. dollar. This rate was devalued after an 8.5 percent devaluation of the dollar in December
1971. A new par value in terms of the SDR was thereafter agreed upon with the International Monetary Fund at Rls. 82.2425 per SDR based on a gold content of .0108055 gram for the rial. With this rate intact after the second depreciation of the dollar in February 1973, the rial/dollar rate was, in fact, upvalued by ten percent to Rls. 68.1747. In June 1973, the rial's value went up again to Rls. 67.50 per dollar.

In mid-1974, the International Monetary Fund adopted a new system of valuation for the SDRs, one that is better suited for an era of fluctuating exchange rates. SDR value is calculated daily as the weighted average value of a "basket" of 16 representative currencies, rather than in terms of gold or dollars.

Since the dollar has a floating rate in financial markets and SDRs are stable in terms of the new valuation system, on February 12, 1975, the rial/dollar peg was discontinued, and the currency was directly pegged to the SDR. Another reason for the discontinuation of the rial/dollar peg was that the dollar is considered a reserve currency and thus any depreciation or appreciation of the dollar would have a direct effect on the reserve position of the Iranian economy.

Under the new exchange regime, the rial may fluctuate within 2.25 percent in either direction of its median exchange rate in terms of the SDR: i.e., Rls 82.2425. New rial/dollar exchange rates are to be fixed whenever the dollar/SDR rate moves more than 2.25 percent in either direction -- i.e., outside the rials 80.3920-84.0930 -- and remains outside
these limits for five consecutive days.

**Monetary Policy**

The principal aim of Iran's monetary policy and credit policy as of 1977 was to assist the country's overall development effort within the framework of monetary and price stability, and to provide a productive allocation of credit supply. Bank Markazi, the Central Bank of Iran, is by law charged with the formulation and implementation of overall monetary and credit policy. To secure compliance with its policies and guidelines, the bank has several specific sanctions at its disposal, including denial of rediscount and foreign exchange facilities. Direct sanctions give the bank enormous power to influence not only monetary aggregates, but also the allocation of resources in specific lines of activity. The latter is achieved essentially by determining the composition of credit through a variety of measures, including acceptance of different types of paper, rationing of credit, application of different rediscount rates and even differentiation among borrowers.

**Balance of Payments Trend**

During Iran's Fourth Development Plan (1958-1972), oil revenues increased at an annual rate of approximately 200 percent and averaged approximately 75 percent of total foreign exchange receipts on current account. Yet, until the fourfold increase in the posted price of oil under the Kuwait
and Tehran agreement (October and December 1973), and because of the undervaluation of the foreign exchange, the increase in annual petroleum revenues was not sufficient to cover faster-growing foreign exchange payments for imported goods and services. The current account was thus in perennial deficit. The annual external sector deficits were normally financed by foreign official borrowing and other sources.

In the 1973-1976 period, however, not only did the current account show a sizable surplus (thus obviating any need for external borrowing), but also many of the previous loans were repaid prior to their maturity. In 1974/75 the current account showed a hefty surplus of over $8.5 billion despite the greater than 110 percent rise in foreign payments over the previous year and the 300 percent rise during 1972-73. The capital account position also showed a dramatic reversal from a net inflow of nearly $925 million during 1973-74 to a net outflow of $3254 million during 1974-75 (including transfer payments and disbursements on bilateral and multilateral commitments for foreign aid, loans, and investments). Accordingly, the overall balance of payments registered a surplus of over $5 billion. The overall balance during 1975-76, however, showed a deficit of $991 million and there was a drawdown in foreign exchange reserves.

Petroleum revenues continue to play the predominant role in Iran's trade and economic growth. During the Fourth Plan (1968-72), oil revenues provided 52 percent of total
annual public revenues. During 1973-74, this ratio rose to 64 percent, and during 1975-76 to 80 percent. Petroleum exports accounted for 74 percent of Iran's foreign exchange earnings during the five year period ending 1972-73. During 1975-76, the share rose to approximately 85 percent.

Objective of the Study

Much of the recent work on exchange rates is labeled "monetary approach to the balance of payments" when the exchange rate is officially fixed, and "monetary approach to the exchange rate" when the exchange rate is floating. In the former case, money income (the price level) moves to equilibrate the market for domestic goods and services, and monetary policy is directed at the requirements of the foreign balance. In the latter case, the rate of exchange between two currencies moves to correct external disequilibrium, and monetary policy is aimed at the goal of internal stabilization.

The Iranian economy has been experiencing both types of parities during the last two decades. The official exchange rate is pegged, and all the importers and exporters are required to obtain and/or surrender all the foreign exchange proceeds to the monetary authorities. Because of the existence of exchange control, a black market has developed with a flexible rate of exchange for foreign currencies that has a rate higher than the official rate and is determined solely by the supply and demand for foreign money.
On the basis of these considerations, one should ask:
(1) To what extent should the central bank be concerned, in a fixed exchange rate system, about the absolute level of its reserves? and (2) To what extent can offsetting central bank actions stabilize the balance of payments which is inherently unstable because of the existence of a black market for foreign money? With these points in mind, this study:
(a) develops a model which can analyze theoretically and empirically the short-run dynamics of the Iranian balance of payments, the black market exchange rate, and the domestic rate of inflation, and (b) applies a monetary approach based on the theoretical background given by Johnson (1977), Frenkel (1978), Blejer (1977), and others who have done considerable work in these areas. The departure of this study from the analytical work of others lies in: (1) its attempt to provide a model which will test whether the monetary approach is capable of explaining the above variables in the Iranian economy and measuring the simultaneous effect of a monetary imbalance (ex ante excess flow supply of money) on the Iranian balance of payments, black market exchange rate, and domestic rate of inflation; and (2) its attempt to test the hypothesis that in the long run growth in output and price level is associated with a balance of payments surplus, while growth in the domestically-determined portion of the money stock tends to be associated with deficits and reserve outflows.
Chapter I presented an overview of the Iranian exchange system and the objectives of this study. Chapter II presents alternative approaches to the balance of payments and a review of the literature. Chapter III deals with long-run and short-run theoretical models on which this study is based.

The empirical section is presented in two parts: Chapter IV discusses the real demand for money in Iran during the period under analysis and the money supply process, including an analysis of the money multiplier; Chapter V presents an analysis of the long-run behavior of reserve flows, black market exchange rates, and prices.

In the last chapter an attempt is made to estimate the effect of domestic monetary disequilibrium on the rate of change of foreign exchange reserves, the black market exchange rate, and the domestic rate of inflation. The appendix presents a graphic manipulation of supply and demand for black market exchange rate and derivation of the three equations.
CHAPTER II

MONETARY, ELASTICITY, AND ABSORPTION APPROACHES
TO THE BALANCE OF PAYMENTS

The main feature of the monetary approach to the balance of payments, as Johnson (1977) puts it, lies in the proposition that the balance of payments is a monetary phenomenon. The term, "balance of payments," refers to the items that are below the line in the overall balance of payments, i.e., the monetary approach concentrates on the official settlement accounts and lumps everything else into a single category, "items above the line," Mussa (1977).

The rules of double entry bookkeeping require that the net sum of all items which appear above the line equal the official settlements balance, i.e., the money account. The monetary approach attempts to provide a theory of the money account, i.e., on the trend of international reserve acquisition or loss. The approach ignores the composition of the balance of payments between current account, capital account, and overall balance, as well as the question of changes in the structure of the balance of payments accounts that may occur as a country passes through various stages of economic growth. The monetary approach emphasized the direct influence of excess demand for, or excess supply of, money on the balance between income and expenditure, or more generally,
between total acquisition and disposal of funds, whether through production and consumption or through borrowing and lending -- therefore, on the overall balance of payments. Surpluses in the trade account or capital account represent, respectively, excess flow supplies of goods and of securities. Surplus in the money account reflects the excess domestic demand for money.

In analyzing the money account, or, more familiarly, the rate of increase or decrease in the country's international reserves, the monetary approach focuses on the determinants of the excess domestic flow demand for, or supply of, money. It differs from the "elasticities" and "absorption" approaches in introducing stocks as well as current expenditure flows into the adjustment process so that payment disequilibrium is transitory and is conditional on domestic monetary policy. The divergence between the monetary, elasticity, and absorption approaches lies in the following facts:

(1) The so-called "absorption approach" emphasizes the rate of accumulation or decumulation of foreign assets (security plus money). The accumulation or decumulation of assets depends on the aggregate relationship between domestic expenditure and income, and does not depend upon the composition of expenditure between exportables and importables, or between goods that, given the price structure, are classifiable into tradable and non-tradable goods. Consequently, though relative prices do influence the composition
of expenditures, they play a secondary or negligible role in the monetary approach (as in the absorption approach). The equality of the excess of domestic absorption over domestic output and the current account deficit is the essence of the absorption approach to the balance of payments.

(2) The elasticity approach implies that relative prices will cause an increase or a decrease in domestic demand for exports on the assumption that these increases or decreases are matched by equal increases or decreases in absorption. The elasticity approach views the exchange rate as the relative prices of national monies. It also assumes that the exchange rate is determined by the conditions for equilibrium in the markets for flows of funds, rather than by the conditions for equilibrium in the markets for stock of assets.

The central propositions of the "monetary approach" are, first, that the balance of payments is a monetary phenomenon that requires analysis with the tools of monetary theory, not those of barter or "real" trade theory; second, that money is a stock, whereas real theory traditionally deals with flows, so that an adequate balance of payments theory must integrate stocks and flows; and third, that the money stock can be changed in two alternative ways, through domestic credit creation or destruction and through international reserve flows, the policy choice being important to balance of payments analysis. The further purpose, particularly appropriate to balance of payments equilibrium
defined as a policy problem, is to incorporate the role of domestic monetary policy into the process of international monetary adjustment, in contrast to alternative approaches which treat monetary policy—sometimes inconsistently—as affecting the economy by setting the real price, the rate of interest, relevant to the determination of flows of consumption and investment.

The essence of the "monetary approach" is most easily understood by referring to Warla's Law, as used in contemporary theory, according to which the sum of the excess demands for goods, securities, and money is identically zero, and an excess demand for money must be matched by an excess supply somewhere else in the market system. In a closed economy, since the aggregate quantities of goods, securities, and money are fixed, excess demand and supply are "potential" and not "actual," and must be eliminated by adjustment of the two relative prices, namely the prices, in terms of money, of goods (the price level) and of bonds (the interest rate). In an open economy, however, excess demand and supply can be eliminated by net purchases or sales of goods or bonds for money in the international market. Since net international flows of bonds and money during a period alter the stocks initially available for the next period, full equilibrium is not reached until such net flows become zero (note that the analysis abstracts from
economic growth). Such equilibrium will be reached, providing the conditions for stability and uniqueness of international monetary equilibrium are fulfilled, conditions which have nothing to do with the elasticities of national excess demand for, and supply of, traded goods as functions of their real prices.

The monetary approach places emphasis on the foreign assets whose accumulation or decumulation is emphasized by the absorption approach. The main reasons for this emphasis are: (1) accumulation of foreign assets does not necessarily imply the accumulation of money through the balance of payments; it may mean the opposite; for example, when a monetary policy of lowering interest rates leads the domestic asset holders to shift their funds from domestic to foreign securities; (2) in a fixed-rate system the monetary authorities are concerned with what changes the stock of international reserves and how to prevent such changes; (3) monetary authorities control the rate of change of domestic credit, which is a component of the monetary base—the other factor is the international reserves, therefore, the flow supply of money.

The monetary approach to the balance of payments concentrates on the role of money and other assets in determining the balance of payments when the exchange rate is flexible. Because it is the relative price of two currencies, the equilibrium exchange rate is attained when the existing stock of two monies is willingly held. It is
reasonable, therefore, that a theory of the determination of
the relative price of two currencies could be stated conven-
iently in terms of supply of, and demand for, these monies.

Review of Literature

The monetary approach deals with long-run equilibrium
situations when all relative prices are fixed. This long-
run equilibrium view was studied and applied to test empir-
ically the theory for several countries, using the assump-
tion that there are no serious barriers to the international
movement of capital and that all goods are traded. These
assumptions imply that goods and capital markets are per-
fectly arbitrated, and, therefore, price level and interest
rates in all the countries always move together.

There are several studies on this subject. Donna L.
Bean (1976) (Japanese case) used quarterly data and tested
the hypothesis that reserve accumulation is positively rela-
ted to the rate of growth of domestic income and negatively
correlated with the rate of domestic credit expansion. J.
Richard Zecher (cited by Frenkel and Johnson, 1978) (Austrai-
lian case) and A. Hans Genberg (1977) (Swedish case) used
quarterly data and tested the hypothesis that there is a link
between reserve flows and the domestic money stock and showed
that this is the avenue through which monetary equilibrium is
reached in an open economy.

Manual Guitian (cited by Frenkel and Johnson,
1978) investigated the relationship between the
balance of payments and the rate of domestic
credit expansion for the Spanish economy during 1955-1971. His findings support the view that exchange rate changes are not effective unless accompanied by appropriate credit policies. The results of the tests also point out the importance of central bank credit variables in the determination of the balance of payments. These findings, if accurate, are of relevance from the policy point of view because the monetary authorities can clearly control the rate of central bank credit expansion. Their control over this variable may enable the monetary authorities, for any given demand for money, to attain their desired stock of international reserves.

The above empirical works can be found in Johnson and Frenkel's The Monetary Approach to the Balance of Payments (1977). However, as Alexander Swoboda (1977) puts it, if a country has a low degree of capital mobility and a very large proportion of non-traded to traded goods, its speed of adjustment to monetary imbalances will be reduced. Although the long-run convergence of domestic-to-world inflation and interest rates will not be prevented, the length of the disequilibrium period will be increased considerably, because, in the short run, monetary disequilibrium affects not only the balance of payments but also the level of prices. If there are restrictions or barriers to the international movement of capital, a black market for foreign currency will be developed within the economy, and since the official exchange rate is fixed below the equilibrium rate, and an excess demand for foreign money will be generated, this
would lead to a higher rate of exchange in the black market.

The essence of exchange control is rationing. In the most extreme form of rationing, the government assumes a complete monopoly of foreign exchange. There can be no legitimate free market for the national currency, although there may be a black market in which the currency is bought and sold illegally. Among those who have worked in the area of exchange restrictions is Mario I. Blejer (1978), who used the annual data for Brazil, Columbia, and Chile, and showed that the black market exchange rate appears to be significantly affected by current and one-year-lagged excess supply of money. Blejer concluded that almost all ex ante money market flow disequilibria are transmitted to the black market rate within a two-year period. The work of Blejer can be found in Frenkel and Johnson's Economics of Exchange Rates (1978).

The modern revival of the monetary approach may be said to have begun in an important but indirect sense with James Meade's (1951) and Johnson's (1977) work on the generalization of the theory of the balance of payments, and with Mundell's (1968) concern with the theory of policy mix on the assumption of international capital mobility, which emphasized the monetary nature of the balance of payments disequilibrium, and in turn, led to the recognition that in a capital-mobile world, the central bank controls not the money supply and employment but the domestic credit and the balance of payments.
CHAPTER III
THEORETICAL MODEL

Long Run Model

In this section we will analyze the long-run situation of the Iranian balance of payments on the basis of the following assumptions:

1. There is long-run full employment,
2. The country being analyzed is small (in the sense that prices are exogenous.),
3. There are no barriers to the international movement of capital and all goods are traded (i.e., the domestic rate of inflation is pegged to the world),
4. The money market is always in equilibrium,
5. The exchange rate is officially fixed.

On the basis of the assumptions, the following relationships can be written:

\[ Ms = a.H \]  \hspace{1cm} (money supply equation) \hspace{1cm} (1)
\[ Md = P.L(Y, i) \]  \hspace{1cm} (money demand equation) \hspace{1cm} (2)
\[ Ms = Md \]  \hspace{1cm} (equilibrium in money market) \hspace{1cm} (3)

where \( Ms \) is the domestic stock of money, taken to be \( M_2 \) (currency plus demand deposit and time and savings accounts); \( a \) is the money supply multiplier to be calculated by the ratio of \( Ms \) over \( H \); \( H \) is high-powered money, where \( H = R+D \). \( H \) represents those funds expressly designated as reserve by

...
monetary authorities; R is international reserves. (Reserves are the foreign assets of the monetary authorities, which include Bank Markazi, the Foreign Exchange Funds, and Treasury IMF accounts; D is the domestic credit component of the money supply, which includes central bank credit to the private and government sectors as well as open market operations; Y is real income, real GNP; i is the real rate of interest -- it is a proxy for all interest rates, and changes in i reflect similar movements in domestic as well as world rates; Md is the nominal demand for money; P is the price level -- wholesale price index or GNP deflator.

According to Equation (3), \[ P(L(Y,i)) = aH, \]
by taking the natural log from both sides and assuming that the demand function is a constant elasticity function, we will get:
\[ \ln P + n_y \ln y + n_i \ln i + \ln a + \ln H \]
where \( n_y \) and \( n_i \) are the elasticities of demand for real cash balances with respect to income and interest rate, respectively. Differentiating Equation (4), with respect to time yields:
\[
\frac{dlnP}{dt} + n_y \frac{dlny}{dt} + n_i \frac{dlni}{dt} = \frac{dlna}{dt} + \frac{dlnH}{dt};
\]
\[
= \frac{dlna}{dt} + \frac{1}{H} \frac{dH}{dt};
\]
\[
= \frac{dlna}{dt} + \frac{1}{H} \frac{d(R+D)}{dt};
\]
\[
= \frac{dlna}{dt} + \frac{1}{H} \frac{dR}{dt} + \frac{1}{H} \frac{dD}{dt}.
\]
or:

\[
\frac{R/H}{dt} \frac{d\ln R}{dt} = \frac{d\ln P}{dt} + n_y \frac{d\ln y}{dt} + n_i \frac{d\ln i}{dt} - \frac{d\ln a}{dt} - \frac{D/H}{dt} \frac{d\ln D}{dt} \tag{5}
\]

Equation (5) can be written in the following way:

\[
\frac{R/H}{dt} g_R = g_p + n_y g_y + n_i g_i - g_a - \frac{D/H}{dt} g_D \tag{6}
\]

where \(g\)'s are the rates of growth of subscripted variables; notice that Equation (6) is the reduced form of the system.

For estimating Equation (6), the following endogenous and exogenous variables are used:

- exogenous variables are \(g_p, g_y, g_i\), \(D/H g_D\) and \(g_a\).
- endogenous variable is \(R/H g_R\).

Equation (6) states that the rate of growth of international reserves is determined by growth in the supply of money under the control of monetary authorities, which is represented by \(g_p\), \(g_y\), and \(g_i\).

Equation (6) will be estimated in the following form:

\[
(R/H) g_R = \beta_1 g_p + \beta_2 g_y + \beta_3 g_i + \beta_4 g_a + \beta_5 (D/H) g_D + e \tag{6'}
\]

and an OLSQ method will be applied to estimate the coefficients, where \(e\) is the stochastic disturbance.

Previous statistical work, Magee (1976) implies that \(\beta_2\) should be of the order of magnitude of unity, \(\beta_3\) should be a small negative number, and \(\beta_5\) should be negative and close to unity. However, if, for instance, \(\beta_5\) is significantly less than one, it may imply specification error rather than a refutation of the monetary approach. Magee (1976) points out that the reason that we get such good results from the quarterly data based on a long-run model with so many stringent assumptions is partly because of, rather than
in spite of, the preceding assumptions. The small country, long-run full employment assumptions allow empiricists to assume that $y$, $p$, and $i$ are exogenous and unaffected by the supply of money. But if they are not exogenous, OLSQ estimates of Equation (6) lead to a simultaneous equation bias, i.e., the true value of the parameter differs from the mean of the sampling distribution of a given estimator. This difference is, for any given parameter, a fixed value which may or may not be equal to zero. The direction of the bias is important in order to know whether we are considering that $y$, $p$, and $i$ are affected by supply or demand for money. However, since we started with the assumption that $y$, $p$, and $i$ are exogenous, we would have no problem on this subject.

Consider the causation the other way. An exogenous increase in reserves, which increases real income, should increase prices and reduce interest rates. Thus, without proper specification and estimation, it is not known whether the coefficients in Equation (6) reflect the demand for money or the effects of the supply of money on $y$, $p$, and $i$.

Second, a 1% increase in $D$ will not lead to a 1% decrease in $R$ if some money demand variables are excluded from Equation (6). For example, the increase in $D$ will lead to a depreciation of the (excluded) foreign exchange rate when the latter is within the band set by the exchange authorities. This absorbs some of the excess supply of money so that reserves do not fall by 1%. Magee continues by implying that a 1% increase in $D$ not only will not lead to a 1%
decrease in R if the central bank sterilized reserves inflows, but will also lead to a magnification effect on reserves.

If there is an exogenous increase in the home demand for money, that is caused, for example, by increases in world and hence domestic prices, then reserves will flow in. If the monetary authorities partially sterilize reserves, reducing domestic credit by some fraction of the reserve inflow, then home money demand is still unsatisfied and more reserves will flow in.

The above model represents a long-run situation in which monetary imbalances do not exist since any change in money market would be felt in the balance of payments (i.e., the reserve component of the monetary base would change). In other words, the supply of money is instantaneously adjusted to the demand for it, because the residents of the country can get rid of or acquire money either through the international market for commodities or through the international securities market. The long-run model does not include variations of the variable such as official and black market exchange rates and the domestic rate of inflation, because the long-run model assumes that domestic price level is exogenous and all goods are traded. Therefore, the domestic rate of inflation is pegged to the world, and if the official exchange rate depreciates by a rise in the world price level, it would only be temporary because the flow of reserves and proper domestic monetary policy will correct the exchange rate in the long run.
However, the theory assumes that in the short run, monetary disequilibrium affects not only the balance of payments but also the level of prices (domestic and foreign) and hence the black market exchange rate. This assumption is made on the basis that in the short run the main assumption of the theory is that the domestic price level is not pegged to the world and there is an exchange restriction in the economy which would result in a black market for foreign money. Therefore, in order to analyze the change in the above variables, and to be able to build the theoretical block for the short-run dynamic part of the model, the following assumptions are made:

1. Country is small.
2. International price of its traded goods is exogenously determined and allows for the existence of non-traded goods, defined as those whose price responds, at least in the short-run, to domestic monetary disequilibrium.
3. The exchange rate is officially fixed.
4. There is full employment.
5. Real income is exogenously determined and monetary disequilibrium does not affect the rate of growth of real income, since according to monetarists, in the short-run monetary changes primarily affect output. In the long-run, however, the rate of monetary growth primarily affects prices; therefore, there is always a lag between the effect of
monetary imbalances on output and prices, Friedman (1970). Thus, it appears that real income \( \frac{Y}{P} = Y \) is exogenous, since it takes a very long interval of time to feel the change in \( y \).

6. Domestic inflation is a geometrically weighted average of the rate of change of the price of traded and non-traded goods, where prices of traded goods are determined by the world rate of inflation and by variations in the official exchange rate. The prices of non-traded goods are determined by the prices of traded goods and monetary excess demand throughout the economy.

7. There exists an exchange control in the economy; therefore, the excess demand for foreign money created by exchange rationing has to be satisfied from the black market for foreign exchange, where the black market rate is determined solely by supply and demand.

8. The money market is always in equilibrium.

Note that in assumption #6, the higher the share of non-traded goods to traded goods in total expenditure, the slower the speed of adjustment to monetary imbalances. The following explanation clarifies this point. From equilibrium, let the monetary authorities increase the money supply; the impact effect is to create an excess supply of money and an excess demand for both foreign (traded) and domestic (non-traded) goods. The excess demand for foreign
goods is reflected in an excess demand for foreign exchange, and the money supply will tend to decrease as the authorities sell foreign exchange to stabilize the exchange rate. In the end, full equilibrium will be re-established when the money supply has returned to its original level, with international prices and domestic prices unchanged. However, there will have been a transitory increase in domestic goods prices.

The length of time it will take for the system to return to equilibrium depends partly on the extent to which the excess demand for foreign exchange and, hence, the balance of payments and the rate of change of money supply is affected. To the extent that part of the excess supply of money is absorbed by a rise in the price of domestic (non-traded) goods, the excess demand for international goods will be smaller than it otherwise would be. Therefore, we expect the rapidity with which the system adjusts to a monetary disturbance to be directly related to the ratio of traded to non-traded goods, even though the final equilibrium is not, (i.e., the following relation holds: \( \frac{P_{NT}}{P_T} + Ae^{\lambda g} \) where \( \lambda \) stands for the rate at which the relative prices respond to a monetary gap, and \( g = (\gamma D^* + a^* - M_d^*) \) where \( M_d^* = \pi + m_d^* \), i.e., the ex ante relative change in the money supply minus the relative change in money demand.

The following equations correspond to the assumptions made above:
Ms = a . (R+D)  
Md = P . md

where \( md = f(y, i) \) (real demand for money). Definitions of the variables and equations are the same as before. Continuous equilibrium in the money market implies that supply of money is equal to demand for money, hence:
\[ a . (R+D) = P . md \]

Taking the natural log from both sides and expressing the variables in terms of their percentage rate of change will yield:
\[ a^* + R/H R^* + D/H D^* = \pi + md^*; \]
or:
\[ a^* + (1 - \gamma) R^* + \gamma D^* = \pi + md^* \]

where \((*)\) is the percentage rate of change of the variable, \(\pi\) is the domestic rate of inflation, \(\gamma\) is the D/H factor of proportionality, and \(md\) is the demand for real cash balances.

According to assumption #6, the price level is a geometrically weighted average of \(P_T\), the price of traded goods and \(P_{NT}\), the price of non-traded goods, that is:
\[ P = P_T^\beta \cdot P_{NT}^{1-\beta} \]

where \(\beta\) is the share of traded goods in total expenditure.

By taking the natural log of the above equation and expressing the variables in terms of their percentage rate of change, we will get:
\[ \pi = \beta P_T^* + (1 - \beta)P_{NT}^* \]

and also:
\[ P_T^* = \pi_w + \rho_o^* \]  
(9)

where \( \rho_o \) is the official exchange rate and \( \pi_w \) is world inflation.

Now since:

\[ \frac{P_{NT}}{P_T} = Ae^{\lambda g}, \]  
and by taking the natural log from both sides:

\[ \ln P_{NT} - \ln P_T = \ln A = \lambda g \]

and differentiating it totally:

\[ d\ln P_{NT} - d\ln P_T = \lambda dg \] or:

\[ P_{NT}^* = P_T^* + \lambda d(g) \] or:

\[ P_{NT}^* = P_T^* + \lambda d(\gamma D^* + a^* - \pi - md^*) \]  
(10)

where \( \lambda \) is the elasticity of relative prices to monetary imbalances. Since the elements in \( g \) are in terms of their percentage rate of change, in order to capture the past effects of monetary imbalances we use the technique of difference operator (d) i.e., for any variable \( dx = x_t - x_{t-1} \).

Substituting Equations (9) and (10) into (8) and then replacing for \( \pi \) in Equation (7) yields:  

\[ \pi_t = \theta \pi_{w_t} + \theta \rho_o^* + (1-\theta)(\gamma D^* + a^* - md^*)_t - (1-\theta)(\gamma D^* + a^* - md^*)_t-1 (\theta)\pi_{t-1} \]

which expresses the domestic rate of inflation as a function of world inflation, percentage rate of change of the official exchange rate, current and lagged ex ante excess flow supply of money, and past rate of inflation. To derive the balance of payments equation, we substitute Equation (11) for \( \pi \) in Equation (7) which yields the following:

\[ R_t^* = \frac{\theta}{1-\gamma} \pi_{w_t} + \frac{\theta}{1-\gamma} \rho_o^* - \frac{\theta}{1-\gamma} \gamma_t - \frac{1-\theta}{1-\gamma} \gamma_{t-1} - \frac{1-\theta}{1-\gamma} \pi_{t-1} \]  
(12)
which expresses the flow of reserves (balance of payments) as a function of world inflation, changes in the rate of official exchange rate, current and lagged excess flow supply of money, and past rate of inflation. (Refer to the appendix for the derivation of the equations.)

Note that if $\beta = 1$, which implies that all goods are traded (international), then $\theta = \text{unity}$ and the domestic rate of inflation in a fixed exchange rate system is pegged to the world.

In order to analyze the black market for foreign money, we set up the following:

Supply of foreign exchange into the black market comes from two sources: (1) over-invoicing of imports and under-invoicing of exports -- the main source; (2) discrepancies between the official market and the black market, which bring the supply of foreign money to the black market from tourists. Since over-invoicing and under-invoicing play an important role in the divergence of foreign exchange from the official market to the black market, some more explanation in this area seems appropriate.

Suppose an importer whose new factory has been sanctioned, or approved officially, arranges with a foreign supplier to sell him equipment at a fictitious invoice price, higher than the price he actually pays. Presentation of the fictitious invoice to the foreign exchange authorities entitles the importer to buy the full amount of foreign exchange at the official rate to make payment. The portion
of the invoiced amount that represents overpayment is then deposited by the supplier to the importer's account in a foreign bank and, because of the disequilibrium rate (i.e., official vs. black market rate), it can be sold for rials at the higher black market rate, thus providing the importer with a profit. The deception of over-invoicing, of course, is inevitable because the government has made it illegal for anyone to trade foreign exchange openly between the official and the black markets.

The main incentive for engaging in over- and under-invoicing is provided by the differential between the official and the black market rates. The greater the differential, the larger the profit possibilities and the higher the incentive for defeating the system. This leads to a diversion of transactions from one market to the other which even a comprehensive control network may not be able to stop. Discrepancies between the official and the black-market rates also increase the supply of foreign exchange to the black market by tourists because the differential tends to spur the flow of visitors to the country.

Therefore, we can postulate the following supply function of foreign exchange to the black market:

$$\log S_{fe}^B = c_1 + \alpha \log \left( \frac{\rho_B}{\rho_o} \right)$$

(13)

where $S_{fe}^B$ is the supply of foreign exchange to the black market and $\rho_B$ is the black market exchange rate. Demand for black market exchange comes largely from illegal tourist
expenditures and transfers of capital and remittances abroad. As with the demand for domestic currency, the demand for foreign currency at a given level of income is positively related to the return derived from holding this asset, and negatively related to the return derived from holding alternative assets. Foreign exchange which is acquired through the black market may be used to buy foreign assets.

The nominal return for holding those assets, namely the foreign nominal interest rate, also has to be considered as part of the return from the purchase of foreign exchange. Since the alternative to holding foreign assets is to hold domestic ones, the "opportunity" cost of buying foreign exchange will be the nominal return on domestic assets, i.e., the domestic and foreign nominal interest rates are dominated by variations in the expected rate of inflation, the demand function for foreign exchange in the black market will be specified as follows:

$$\log_{B}^{fe} = c_2 + b \left[ (\rho_B^*)^e + \pi_w^e \right] - d\pi^e$$

(14)

where $D_B^{fe}$ is the demand for foreign exchange in the black market, $b$ is own-return elasticity, $d$ is alternative cost elasticity, and $\pi^e$ and $\pi_w^e$ are the expected domestic and world rate of inflation, respectively, and $(\rho_B^*)^e$ is the expected black market depreciation. According to assumption #7, which implies that the black market rate is determined solely by its supply and demand and that they are always in equilibrium, the following can be written:
Since \((\rho_B^*)^e\) in Equation (14) is unobservable, in order to obtain a proxy for this variable, we postulate that people form their expectations about future exchange rates by using information about the past behavior of prices and exchange rates. If the black market exchange rate is allowed to be freely determined by market forces, the rate of depreciation will probably closely follow the trend of the relative domestic inflation rate relative to foreign inflation. However, discrepancies between actual black market depreciation and relative inflation are typical. Such discrepancies may result from a variety of causes, mainly official intervention and other interference with the free functioning of the market. If, any any time, people observe that domestic prices have risen faster than foreign prices and that the increase in the relative domestic price exceeds that in the black market exchange rate, they will expect black market depreciation to equal observed discrepancy between the two variables.

Figure 1 illustrates this point. Starting from an initial ratio, let the natural log of the black market exchange rate \((\rho_B)\) at \(t_0\) be 4.30 while the natural log of the domestic price index \((P)\) is 4.37. This implies that the domestic price level has appreciated 7% more than the black market exchange rate and, and assuming for simplicity a zero rate of inflation abroad, a 7% black market depreciation is called for in order to bring both prices back to their
initial ratio. Moreover, people are apt to consider that any expected excess of domestic over foreign inflation will also be transmitted, at least partly, to the exchange rate. It follows that the expected rate of depreciation of the black market exchange rate at \( t_0 \) is 7% in addition to the expected rate of differential inflation in the coming period.

From this analysis we obtain the following formulation as the empirical proxy for the expected black market depreciation.

\[
\ln P \quad \text{lnp} \\
\ln \rho_B \quad \text{ln}\rho_B
\]

Figure 1. The time path of the domestic price level and the black market exchange rate.
\((\rho_B)^e = (\log P - \log P_W - \log \rho_B) + k(\pi^e - \pi_W^e) \) \hspace{1cm} (16)

where \(P\) and \(P_W\) are the relevant domestic and foreign price indexes, \(k\) is the proportion of expected relative inflation which people expect to be transmitted to the black market exchange rate during the coming period.

Now, by substituting Equation (16) for \((\rho_B)^e\) in Equation (14), and assuming that \(b = d\) and \(k = 1\), we come to the following relationship:

\[
\log D_{fe}^B = c + b(\log P - \log P_W - \log \rho_B) \hspace{1cm} (17)
\]

By differentiating Equations (13) and (17) and also operating upon the assumption that supply and demand for foreign exchange in the black market are in equilibrium, and manipulating the variables, the following can be derived:

\[
\rho_B^{t-1} = \sum_{i=1}^{t-1} \frac{t(-1)^i}{a+b} \pi_i^w + \sum_{i=1}^{t-1} \frac{t(-1)^i}{a+b} \pi_i + \sum_{i=1}^{t-1} \frac{t(-1)^i}{a+b} g_i
\]

which formulates the rate of change of the black market exchange rate as a function of world inflation, devaluation (revaluation) of the official exchange rate, current and lagged excess flow supply of money, and past period of domestic rate of inflation. (See appendix for the derivation of Equation 18).

Equations (11), (12) and (18) express the current rate of inflation, reserve flows, and the rate of change of the black market exchange rate as functions of world inflation, percentage rate of change of official exchange rate, current and lagged ex ante excess flow supply of money, and past inflation. By successive substitutions for \(\pi_{t-1}\) in Equations
(11), (12), and (18), we can get the following equations:

\[
\pi_t = \sum_{i=1}^{\infty} (1-\delta)^i \sum_{i=1}^{\infty} \omega_i \pi_{t-i} + \sum_{i=1}^{\infty} (1-\delta)^i \sum_{i=1}^{\infty} \omega_i \pi_{t-i} \quad (11')
\]

\[
R_t^* = \sum_{i=1}^{\infty} (1-\delta)^i \frac{1}{1-\gamma} \sum_{i=1}^{\infty} \omega_i \pi_{t-i} + \sum_{i=1}^{\infty} (1-\delta)^i \frac{1}{1-\gamma} \sum_{i=1}^{\infty} \omega_i \pi_{t-i} \quad (12')
\]

\[
\theta_t = \sum_{i=1}^{\infty} (1-\delta)^i \frac{b(1-\theta)}{a+b} \sum_{i=1}^{\infty} \omega_i \pi_{t-i} + \sum_{i=1}^{\infty} (1-\delta)^i \frac{b(1-\theta)}{a+b} \sum_{i=1}^{\infty} \omega_i \pi_{t-i} \quad (18')
\]

The above equations express three dependent variables, \( \pi_t \), \( R_t^* \), and \( \theta_t \), which are functions of the same independent (explanatory) variables in which their coefficients are distributed geometrically into the past.

Equations (11'), (12'), and (18') indicate that the current rate of domestic inflation, reserve flows, and the current rate of change of the black market exchange rate may be estimated as a weighted average of a polynomial of current and lagged rates of world inflation, official exchange rate, and ex ante excess flow supply of money. The polynomials are exponentially decreasing and the weights are functions of the elasticity of the relative prices (traded and non-traded) with respect to the ex ante excess flow supply of money (\( \lambda \)) and of the share of traded goods in the total expenditure (\( \beta \)).

As was stated above, the main purpose of this study is to measure the effect of a monetary disequilibrium on the
balance of payments, domestic rate of inflation, and the rate of change of the black market exchange rate; therefore, in order to show the importance of the ex ante excess flow supply of money in the determination of these variables, we will set up the following restrictions.

First of all we will concern ourselves only with the current world rate of inflation. Assume that past world inflation rates have already been incorporated into the current one.

Second, since the official exchange rate is fixed, the rate of change of the current exchange rate, by itself, would indicate the past behavior of the exchange rate.

Finally, since a monetary imbalance in this period would overlap into the next period, and since the main purpose of this study is to measure the effect of the monetary disequilibrium, it is reasonable to assume that there is current and lagged ex ante excess flow supply of money, and to assume that the effect of further lags are incorporated in one period of lagged monetary disequilibrium.

Given the above restrictions, the final forms of the equations are as follows:

\[ \pi_t = \beta_0 \pi_{t-1} + \beta_1 \rho_{t-1} \rho_{t-1} + \beta_2 (\gamma D' + a' - md') t + \beta_3 (\gamma D' + a' - md') t-1 + \epsilon_{t1} \] (11"

\[ R_t = \gamma_0 \pi_{t-2} + \gamma_1 (\gamma D' + a' - md') t + \gamma_2 \gamma_1 (\gamma D' + a' - md') t-1 + \epsilon_{t2} \] (12"

\[ \rho_3 = \beta_0 \pi_{t-1} + \beta_1 \rho_{t-2} + \beta_2 (\gamma D' + a' - md') t + \beta_3 (\gamma D' + a' - md') t-1 + \epsilon_{t3} \] (13"
Equations (11'''), (12'''), and (18'''') would be estimated simultaneously using ordinary least square method for estimation. Note that in Chapter V the three equations have been estimated according to their importance in this study -- first Equation (12'''), then (18'''), and last (11'''').
CHAPTER IV

EMPIRICAL RESULTS: THE CASE OF IRAN, 1968-1977

The models presented in Chapter II are tested here with quarterly data for Iran covering the period from 1968-1977. The long-run balance of payments equation is tested for the Iranian economy using three quarters of the moving average of quarterly data in order to get a smooth trend for all the variables. The estimated equation was tested on the basis of theoretical background contained in the monetary approach to the balance of payments.

During the years analyzed here, Iran passed through periods of inflation, mainly during the seventies, and its balance of payments and the black market exchange rate for foreign money had some unexplained fluctuations. The main objective of this discussion of empirical results is to make estimations of the determinations of the rate of change of the foreign reserve flows, the black market exchange rate, and the domestic rate of inflation as a function of the elements presented in the theoretical model. The principal element for those estimations is the ex ante excess flow supply of money \( g \), and its calculations will be based on the estimations of the demand for money as explained below.
The Demand-For-Money Function

The demand-for-money function needs to be investigated in order to estimate the elasticities necessary to calculate the parameters of the ex ante excess flow supply of money. The general form of the relationship is:

\[ \frac{M_j}{P} = f(y, i) \]

where \( j \) is the particular definition of the money in question. In the case of Iran, \( j \) is 2, which describes the money supply as currency plus demand deposits plus time and savings account; \( P \) is the price index, which is taken to be the wholesale price index and is used to deflate the nominal balances. The alternative cost of holding money (discount rate) is represented by \( i \). The savings and time accounts are interest bearing accounts (9 percent during the period studies), highly liquid, with no time required for withdrawal; \( y \) is real GNP.

To get a direct estimation of the elasticities, the logarithmic form of Equation I is used:

\[ \ln \left( \frac{M_2}{WPI} \right) = \ln c + \alpha_1 \ln y + \alpha_2 \ln i + e \]

As was mentioned above, \( y \) is the current gross national product deflated by the wholesale price index, and \( i \) is the nominal interest rate. The reason for using \( i \) as the discount rate is that since a good part of domestic savings and investment is diverted to unorganized markets where interest as high as 48% may be charged, and since the discount rate
represents interest on short-term bills and promissory notes which are held by the Iranian Central Bank for loans to commercial banks, it seems that \( i \) is a good proxy for the alternative cost for holding money. Table 1 reports the results of the regression estimations for the constant elasticity money demand function (Equation I') where the deflator used is the Wholesale Price Index.

\[
\ln \left( \frac{M_2}{WPI} \right) = \ln c + \alpha_1 \ln y + \alpha_2 \ln i + e
\]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.24</td>
<td>1.28</td>
</tr>
<tr>
<td>Real Income</td>
<td>1.06</td>
<td>0.096</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>-1.05</td>
<td>0.70</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>.968</td>
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</tr>
<tr>
<td>D.W.</td>
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<tr>
<td>S.E.R.</td>
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<td></td>
</tr>
<tr>
<td>Degrees of f.</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

All the coefficients are estimated by OLS method. The \( t \)-values are in parentheses below the coefficients.

In general, all of the estimated coefficients are significant at the .05 level (except the constant term) and
have the correct sign. In particular, the income elasticity is highly significant and is not different from unity at the 95% and 99% levels.

The income elasticity implies that for a given percentage increase in real income, Iranians have increased their time and saving deposits by the same percentage as they have increased their demand deposits and currency holdings.

By using the estimated elasticities we can generate observations about real cash balances demanded, so we will be able to get the main element of the previously stated equations, i.e., ex ante excess flow supply of money.

For the purpose of estimating the model, we need to analyze the money supply process in Iran. The investigation involves the determination of the relationship between high-powered money (base) and the money supply, i.e., a study of the size and the variability of the money multiplier and the relationship between the base and its source.

The monetary effect of a change in high-powered money can be predicted only if the money multiplier is stable. The money multiplier appears to be stable in Iran during a 10-year (40 quarters) analysis. Monetary authorities in Iran use measures that directly control the multiple expansion of the money supply. Two measures frequently used which affect the money multiplier are: (a) minimum reserve requirements and (b) maximum credit volume.

Bank Markazi Iran has used several types of required reserve ratios. Commercial banks have, at one time or
another, been required to maintain (1) minimum liquidity ratios on the basis of their liquid assets, (2) minimum deposits with Bank Markazi, and (3) minimum holdings of government securities as part of reserve requirements. Reserve requirements have applied to demand deposits as well as to savings and time deposits. In 1976 and 1977 the ratios ranged between 25 and 30 percent for demand deposits and 12 and 15 percent for time and savings accounts.

To support the measures described above, Bank Markazi Iran has set credit ceilings on the lending of commercial banks. This regulation has been used frequently to impose limits on the volume of credit that banks could extend to the private sector. The credit ceiling for 1975 and 1976, for example, was 40 percent above the level during 1974 and 1975. The ceiling for 1973 was 30 percent above that for the preceding period. This is perhaps the most direct measure that Bank Markazi can use to clamp down on the expansion of money, provided that enough pressure is exerted on banks not to exceed the prescribed limits.

The rate structure in the organized financial market is determined for different purposes and maturities. As of September 1976, for example, the bank's own rediscount rates were eight percent for commercial papers and seven percent for "productive" loans, loans that were supposed to make a particularly high contribution to the economic development of the country without substantially raising the total amount of credit outstanding.
The interest charges to specialized banks, as well as the interest rate on the government's own direct loans to these banks, was six percent. In turn, the interest rate on loans by specialized banks for agricultural investments was seven percent, and the interest rate on loans for industry, construction, and export was nine percent. The short-term interest rates charged by commercial banks were limited to a maximum of nine percent for export financing, 11 percent for high priority activities, and 13 percent for others.

As mentioned earlier in this chapter, the monetary effects of changes in high-powered money can be predicted only if there is a stable relationship between the base and the money supply. One way of testing this relationship is to estimate statistically a regression of the high-powered money and currency deposit ratio on the money supply.

In order to get a direct estimate of the elasticities, the log-linear form of the equation is used. It includes claims on foreign assets, on government, on official entities, and on commercial banks. CP is currency over demand deposit of the non-bank public. This regression equation would be estimated by the OLS method.

The estimated regression is:

\[
\ln M_2 = 1.33 + .798H - .292CP \\
(4.62) (15.49) (-.625)
\]

\[R^2 = .97 \quad D.W. = 1.58 \quad S.E.R. = .137\]

In parentheses are t-values. H is high-powered money and CP is currency-deposit ratio.
The estimated elasticity of money supply with respect to high-powered money is highly significant and close to unity, implying a stable relationship between the money supply and high-powered money, which further implies a stable multiplier. The t-value for the currency-deposit ratio indicates that this variable does not significantly explain the variations in money supply.

The results show only that the monetary changes of high-powered money can be predicted. However, it does not in any way affect the outcome of the final estimation. On the other hand, since these results are not going to be used anywhere else, it would not have made any difference if the above equation had not been estimated.

The Sources of Monetary Base

The main sources of the monetary base are (a) the foreign assets of the Bank Markazi: gold, foreign exchange, subscription, and shares in international agencies, including the IMF quota subscription minus drawings, and (b) the claims of the Bank Markazi on the treasury, the publicly owned financial institutions, and the private banking sector. These claims are the majority of the domestic assets of the Bank Markazi Iran, and are defined as "domestic credit" in the estimates in the next chapter. Included in the claims of the Bank Markazi on the government are government securities, loans, and credit granted by Bank Markazi to commercial and specialized banks which are government sponsored
banks.

Bank Markazi issued several types of securities over the period studied, short-term securities for a three-month to one-year period, with an interest of 8.74 to 9.07 percent; intermediate securities for two to four years, with a rate of return ranging from 9.67 to 10.48 percent; and long-term securities for five to seven years with an interest of 10.73 to 11.23 percent.

In the next chapter, Equations (6'), (11'''), (12'''), and (18'''') are estimated using the estimated money demand equation for the generation of ex ante excess flow supply of money. Equation (6') is estimated by the OLS method. Equations (11'''), (12'''), and (18'''') are estimated simultaneously by using the OLS method.
CHAPTER V

BALANCE OF PAYMENTS, BLACK MARKET EXCHANGE RATE, AND DOMESTIC RATE OF INFLATION

The main objective of this chapter is to present an analysis of the long-run Iranian balance of payments and of the dynamic responses of reserve flows, black market exchange rate, and domestic rate of inflation to changes in the variables considered to be important in the theoretical considerations discussed in Chapter II. Specifically, the main purpose will be to estimate Equations (6'), (12''), (18''), and (11'').

Long-Run Balance of Payments

The estimated long-run equation for the balance of payments Equation 6', Table 2, shows that growth in the domestic price level increases the reserve inflows with respect to the monetary base. The sign of the estimated coefficient for the rate of interest (elasticity of demand for real cash balances with respect to rate of interest) is negative as it becomes, as expected, the sign of the money supply multiplier coefficient. The sign of the elasticity of demand for real cash balances with respect to income is positive, as was expected and as the theory predicts; however, it does not seem to be close to unity even though it is not signi-
significantly different from zero.*

* A permanent income series should produce a larger magnitude.
TABLE 2
LONG-RUN ESTIMATED BALANCE OF PAYMENTS EQUATION
USING THREE QUARTERS MOVING AVERAGE* OF
QUARTERLY DATA FROM 1968-1977

Equation (6')

\[ R/H g_R = \beta_1 g_p + \beta_2 g_y + \beta_3 g_i + \beta_4 g_a + D/Hg_D + e \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient**</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>1.02</td>
<td>.391</td>
</tr>
<tr>
<td></td>
<td>(2.62)</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>.266</td>
<td>.214</td>
</tr>
<tr>
<td></td>
<td>(1.24)</td>
<td></td>
</tr>
<tr>
<td>Interest Rate</td>
<td>-.314</td>
<td>.187</td>
</tr>
<tr>
<td></td>
<td>(-1.67)</td>
<td></td>
</tr>
<tr>
<td>Money Supply Multiplier</td>
<td>-.573</td>
<td>.157</td>
</tr>
<tr>
<td></td>
<td>(-1.64)</td>
<td></td>
</tr>
<tr>
<td>Domestic Component of the Money Base</td>
<td>.021</td>
<td>.183</td>
</tr>
<tr>
<td></td>
<td>(1.19)</td>
<td></td>
</tr>
</tbody>
</table>

\[ R^2 = .385 \]
\[ D.W. = 1.095 \]
\[ S.E.R. = .039 \]
\[ Degrees of f. = 33 \]

* By implying moving averages, an attempt may be made to eliminate passing fluctuations and to arrive at values that define the influence of the steady operating secular factor. When a trend is to be determined by the method of moving averages, the average value for a number of years, quarters, or months is secured, and this average is taken as the normal trend value for the unit of time falling at the middle of the period covered in the calculations of the average. Mills (1956)

** The t-values of estimates are given in parentheses below the coefficients.
In order to check the significance of the income elasticity coefficient, two tests of the hypothesis have been conducted, one for the magnitude of the income elasticity and one for the sign of it. In the first case we failed to reject the null hypothesis that income elasticity is in the magnitude of unity at 5% level of significance; however, in the second case we rejected the null hypothesis that income elasticity is negative.

The coefficient of the domestic component of the monetary base, as can be seen, is positive and is not significant. This implies that domestic credit creation, contrary to the theory, does not have any significant effect on the balance of payments. However, this might be interpreted to mean that while changes in domestic assets can be controlled by Bank Markazi, effective control of the public sector's share is dependent on government fiscal policy. Substantial foreign exchanges received by the treasury through increased oil revenues and deposited in Bank Markazi would have the immediate effect of increasing the net foreign assets of the banking system. If the government converts these assets into local currency for domestic use, the assets will have the double-barreled effect of increasing domestic liquidity and setting the stage for multiple expansion of the money supply. The monetary authorities have a limited ability to halt these exogenous increases in the supply of
money. The significance of the coefficients of the rate of interest and money supply multiplier implies that these do have significant power in explaining the variations in the Iranian balance of payments.

Dynamics of the Iranian Reserve Flows, Black Market Exchange Rate, and Domestic Inflation

Equations (12''), (18''), and (11'') in Chapter II have been simultaneously estimated using the method of two-stage least square for estimation.

The estimated reserve flows equation (Equation 12'', Table 3) implies that an increase in the world rate of inflation is associated with reserve inflows, so does an exchange rate depreciation even though they are insignificant. However, the current ex ante excess flow supply of money would result in a deterioration in the balance of payments. The past value of monetary imbalances have little effect on current values of the reserve flows. The coefficient of $q_t$ is highly significant at .05 level, but coefficients of $p_o$ and $\pi_w$ are not significant. This would mean that current values of monetary disequilibrium do explain the current

---

* This phenomenon, which is a recent feature of the oil producing economies also occurs in certain developed countries as they experience massive inflows of dislodged short-term funds (i.e., "hot" money).
monetary situation, as do the past values of the variable, but less significantly. A fixed official exchange rate could affect the balance of payments only temporarily after it depreciates or appreciates.
## Table 3

Short-run Estimated Reserve Flow Equation with One Quarter Lagged Ex Ante Excess Flow Supply of Money Using Quarterly Data for 1968-1977

Equation (12'')

\[ R_t^* = \beta_0 \pi_t^* + \beta_1 p_t^* + \beta_2 (\gamma D_t + a^* - md^*)_t + \beta_3 (\gamma D_t + a^* - md^*)_{t-1} + \epsilon_t \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient*</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Inflation</td>
<td>.712</td>
<td>.769</td>
</tr>
<tr>
<td></td>
<td>(.926)</td>
<td></td>
</tr>
<tr>
<td>Official Exchange Rate</td>
<td>1.55</td>
<td>2.01</td>
</tr>
<tr>
<td></td>
<td>(1.768)</td>
<td></td>
</tr>
<tr>
<td>Ex Ante Excess Supply of Money ((g_t))</td>
<td>-1.20</td>
<td>.238</td>
</tr>
<tr>
<td></td>
<td>(-5.07)</td>
<td></td>
</tr>
<tr>
<td>(g_{t-1})</td>
<td>-.354</td>
<td>.233</td>
</tr>
<tr>
<td></td>
<td>(-1.52)</td>
<td></td>
</tr>
<tr>
<td>(R^2) = .508</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.W. = 1.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.R. = .124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degrees of f. = 35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The t-values of the estimates are given in parentheses below the coefficients.
The black market exchange rate equation (Equation 18', Table 4) makes it obvious that none of the coefficients are significant. This implies that variations in $\rho_B$ are not explained by the variables in the model. That is to say, the monetary approach is incapable of explaining the changes in the black market exchange rate.
TABLE 4

SHORT-RUN ESTIMATED BLACK MARKET EXCHANGE RATE EQUATION WITH ONE QUARTER LAGGED EX ANTE EXCESS FLOW SUPPLY OF MONEY USING QUARTERLY DATA FOR 1968-1977

Equation (18"

\[ \rho_{Bt} = \beta_0 \pi_{wt} + \beta_1 \rho_{t-1} + \beta_2 (\gamma D^* + a* - md^*)_t + \beta_3 (\gamma D^* + a* - md^*)_{t-1} + \epsilon_t \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient*</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Inflation</td>
<td>-.151</td>
<td>.128</td>
</tr>
<tr>
<td></td>
<td>(-1.17)</td>
<td></td>
</tr>
<tr>
<td>Official Exchange Rate</td>
<td>.154</td>
<td>.337</td>
</tr>
<tr>
<td></td>
<td>(.456)</td>
<td></td>
</tr>
<tr>
<td>( g_t )</td>
<td>-.022</td>
<td>.039</td>
</tr>
<tr>
<td></td>
<td>(-.525)</td>
<td></td>
</tr>
<tr>
<td>( g_{t-1} )</td>
<td>.063</td>
<td>.039</td>
</tr>
<tr>
<td></td>
<td>(1.61)</td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>.270</td>
<td></td>
</tr>
<tr>
<td>D.W.</td>
<td>2.40</td>
<td></td>
</tr>
<tr>
<td>S.E.R.</td>
<td>.020</td>
<td></td>
</tr>
<tr>
<td>Degrees of f.</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

* The t-values of the estimates are given in parentheses below the coefficients.
None of the coefficients except \( q_{t-1} \) are significant at .05 level; however, the coefficient of \( \pi_w \) becomes significant at .1 level.

By looking at \( R^2 \), we see that it is low. This further implies that 70% of the change in the black market exchange rate is due to the factors outside the model and that only 30% of the variations in \( \rho_B \) can be explained by the stated variables. Another factor which contributes to the low significance of coefficients and lower \( R^2 \) is that \( M_2 \) definition of money is used.

The last of the three simultaneously estimated equations is the domestic rate of inflation (Equation 11'', Table 5). The coefficient of world inflation is positive, highly significant, and close to unity, further justifying the assumption that Iran is a price taker in the international market. The coefficient of the official exchange rate is positive and significant, which implies that any depreciation of the exchange rate would result in a higher rate of inflation; however, the current and one quarter lagged ex ante excess flow supply of money would have an upward pressure on the level of prices. As can be seen, the coefficients of monetary disequilibrium are again not significant at .05 level, implying that monetary imbalances do not explain much of the price variations in this case as opposed to the explanatory power of the official exchange rate and of world inflation.
TABLE 5

SHORT-RUN ESTIMATED DOMESTIC INFLATION EQUATION WITH ONE QUARTER LAGGED EX ANTE EXCESS FLOW SUPPLY OF MONEY USING QUARTERLY DATA FOR 1968-1977

Equation (11'')

\[ \pi_t = \beta_0 \pi_{wt} + \beta_1 p_{ot} + \beta_2 g_t + \beta_3 g_{t-1} + \epsilon_t \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Inflation</td>
<td>.934</td>
<td>.169</td>
</tr>
<tr>
<td></td>
<td>(5.51)</td>
<td></td>
</tr>
<tr>
<td>Official Exchange Rate</td>
<td>1.31</td>
<td>.444</td>
</tr>
<tr>
<td></td>
<td>(2.98)</td>
<td></td>
</tr>
<tr>
<td>( g_t )</td>
<td>.002</td>
<td>.052</td>
</tr>
<tr>
<td></td>
<td>(.046)</td>
<td></td>
</tr>
<tr>
<td>( g_{t-1} )</td>
<td>.025</td>
<td>.051</td>
</tr>
<tr>
<td></td>
<td>(.434)</td>
<td></td>
</tr>
</tbody>
</table>

\( R^2 = .55 \)
\( D.W. = 2.15 \)
\( S.E.R. = .027 \)
Degrees of f. 35

According to the monetary approach to the balance of payments theory, the short-run effect of monetary disequilibrium will fall more heavily on the domestic price level and less on the balance of payments, the higher is \( \lambda \) (the elasticity of relative prices to monetary imbalances) and the lower is the share of traded goods, \( \beta \). However, as can be
seen from the estimated coefficients, the short-run effect of monetary disequilibrium has fallen more heavily on the balance of payments and less on the price level and on the black market exchange rate, implying that $\lambda$ is low and $\beta$ is high. The theory also implies that the lower is $\lambda$ and the higher is $\beta$, the lighter is the effect of world inflation on the balance of payments and the heavier on the domestic rate of inflation.

This hypothesis is justified by the estimated coefficients and their significance for world inflation in both the balance of payments and the domestic inflation equation. Since $\lambda$ is low, the implication is that the domestic rate of inflation is less affected by domestic monetary imbalances, as is the price of non-traded goods. However, a low $\lambda$ also implies that part of the ex ante excess flow supply of money created by the domestic expansionary monetary policies is absorbed by a rise in the prices of domestic (non-traded) goods; therefore, the speed at which the system adjusts to monetary imbalances is directly related to the share of traded and non-traded goods in the total expenditure. We thus expect a higher coefficient for world inflation than ex ante excess flow supply of money in the equation for domestic inflation.

In the short run, the government can reduce the impact on the balance of payments of a given monetary policy by imposing heavy restrictions on international transactions of
goods - reducing $\beta$ and reducing the impact of monetary disequilibrium on the balance of payments during the transition period. These measures, however, can only delay the full impact of the monetary changes on the balance of payments until the adjustment process is completed, and the delay of the impact will undoubtedly be accomplished at the cost of a higher rate of inflation during this adjustment period.

Blejer (1977) suggests that for a given change in the ex ante excess flow supply of money, countries with high $\lambda$ and low $\beta$ at the same time may experience a higher rate of inflation and a stronger balance of payments. This implication of the theory, however, applies only to industrialized countries, since in a small country like Iran with a higher share of traded goods to non-traded goods (high $\beta$), and less response of the relative price level to monetary imbalances (low $\lambda$), the effect of monetary imbalances falls more heavily on the balance of payments, and the effect of world inflation falls more heavily on domestic inflation. On the basis of this explanation, we expect countries like Iran to have a higher domestic rate of inflation and a weak balance of payments. Note that the preceding analysis does not hold fully for the changes in the black market exchange rate, since as was noted earlier, much of the variation in $p_B$ in Iran are due to the factors outside the model, such as unlicensed transactions of "hand" payments which cannot be traced.
Now consider an exchange rate devaluation; when the exchange rate is devalued (for example the rial/dollar rate in December 1971 by 8.5%), the equilibrium in the goods market is altered as the relative prices of traded goods increase (Equation 9). At the same time, a stock disequilibrium is created in the money market as a result of a decline in the real value of the cash balances held by the public.

Equation 12 states that as a result of devaluation and a state of disequilibrium, there would be an inflow of reserves and, according to Equation 11, a higher domestic rate of inflation. These results are only transitory and short-run. When substitutions in production and consumption equilibrates the goods market, and the inflow of reserves restores the stock equilibrium in the money market, the effects of the devaluation are completed and prices will continue to rise at the world rate while the rate of change of foreign exchange reserves will return to its previous level.

Devaluation of the official exchange rate narrows the gap between the demand for and the supply of foreign reserves. Because the domestic price level rises as a response to the official exchange rate depreciation, the narrowing of the gap ultimately results in an increase in the black market exchange rate by a smaller percentage.
CHAPTER VI
SUMMARY AND CONCLUSIONS

It is obvious from the reported results that there are deficiencies in some of the empirical findings of this study as far as the significance of some of the estimated coefficients is concerned. Nevertheless, this should not imply that the model is incompatible with the analysis, since some of the results were expected prior to the testing because of the unavailability and lack of reliable data. Also, because of the small sample properties, the insignificance of some of the coefficients at .05 level does not reduce the explanatory power of the theory and the models that have been adopted, and further indicates that the main purpose of this study has been accomplished and that the findings are compatible with the real situation of the economy under consideration.

In the next few pages a brief summary and some concluding remarks are presented which analyze the accuracy of the obtained results.

In the theoretical part of this study, a model is presented to analyze the impact of external influences and of domestic monetary disequilibrium on the balance of payments, black market exchange rate, and domestic rate of inflation of a small economy (Iran) operating under a system of fixed exchange rate. The main departure of this model from other
presentations of the monetary approach to the balance of payments is the analysis of the simultaneous effect of an ex ante excess flow supply of money (monetary imbalances) on these endogenous variables.

The central emphasis of the theoretical inquiry is that in a small economy with a fixed exchange rate, increasing the domestic credit component of the monetary base at a rate that is too fast in relation to the growth of its demand for money will result, in the short-run, in a rate of inflation higher than that of the rest of the world. In the longer run, however, if the difference between the supply and the demand for money is kept at a constant rate, the complete excess supply of money created ex ante by the monetary authorities will be eliminated through the balance of payments, and domestic inflation will converge to the world rate.

If the exchange authorities devalue the domestic currency, the result will be a higher rate of inflation in relation to the rest of the world. The balance of payments will improve, but only after a transitional period of adjustment. The price level will continue to rise again at the rate of the outside world and the flow of reserves will revert to its previous direction and rate. The exact path and length of the adjustment will depend on the assumptions about the behavior of the monetary authorities following the devaluation, but in all cases the transitional character of the effect of a one-time devaluation are preserved.
In the empirical part of this study, the experience of Iran between 1968 and 1977 is evaluated. Two kinds of models (long-run model and short-run dynamic model) are presented. The estimated long-run balance-of-payments equation justifies the hypothesis that is based on the theoretical model, in which \( P, y, \) and \( i \) are exogenous. The long-run reserve flow equation was estimated with three quarters of the moving averages of quarterly data, which shows the expected results except for the positive sign of the coefficient for domestic credit. This should not imply, however, the refutation of the monetary approach, but rather that the assumption that changes in the Iranian balance of payments occur because of factors outside the model, and that monetary authorities do not have substantial control over the flow of their international reserves.

In the short-run, three equations (reserve flows, black market exchange rate, and domestic rate of inflation) were evaluated. In the first part of the estimation, a distributed lag model with ex ante excess flow supply of money having one lag period (quarter) was used. This lag structure was used in order to see the effect of the previous monetary imbalances on the balance of payments, the black market exchange rate, and domestic inflation. The estimated coefficients and elasticities show that domestic monetary disequilibrium has fallen more heavily on the balance of payments and less on the price level (and thus on the black
market exchange rate) because of the reduced responsiveness of the relative prices to domestic monetary imbalances (low \( \lambda \)) and a high ratio of traded to non-traded goods (high \( \beta \)).

Estimated Equation (12') implies that if the monetary authorities increase the domestic component of the monetary base (to create an ex ante excess flow supply of money) too quickly in relation to the growth of the demand for money, a balance of payments deficit will result.

The behavior of the rate of inflation and the black market exchange rate was analyzed in the framework of the theoretical model. The inflation rate, as measured by the wholesale price index, is significantly explained by external inflation (as measured by the rate of price change in the United States) and by variations in the official exchange rate. In both cases (rate of inflation and the black market exchange rate), the results indicate that the adjustment of prices to internal monetary imbalances is completed in a shorter period than is the adjustment to external influences. Another finding is that, since the fixity of the official exchange rate has created a black market for international reserves, much of the variations in the black market rate is explained by factors outside the model. This indicates that the monetary approach is incapable of explaining the variations in the rate of the black market exchange.
BIBLIOGRAPHY


Appendix A

A Graphical Interpretation of Supply and Demand

For the Black Market Exchange Rate

If there are not controls on dealings in foreign currencies, the free market for foreign exchange will absorb all the demands and supplies of foreign exchange. In this particular case, the imposition of, for example, a tariff in the absence of exchange controls creates incentive for smuggling, but does not create incentives for the creation of a black market for foreign exchange. However, the following geometric analysis deals with the creation of a black market and the respective supply and demand functions.

In Figure 2, the amount of foreign exchange supplied and demanded per period (FX) is represented on the horizontal axis and the exchange rate is the number of units of domestic currency (rial) per unit of foreign exchange (dollar). $S_1$ is the total supply curve of foreign exchange, including both the capital and current account supplies, in the absence of any exchange control. $D_1$ is the demand curve for foreign exchange. It is derived by a horizontal summation of the curves $D$ and $D^k$, representing the current account, and a constant capital outflow demand in terms of local currency (rial), respectively (assuming that capital outflows local currency are independent of the exchange rate). Equilibrium in the foreign exchange market in the absence of exchange control and government intervention occurs at E,
and the equilibrium exchange rate is $p^e$ (for detailed assumptions on the elasticities of supply and demand, see Sheikh (1976).

Suppose the government now follows a fixed exchange-rate policy and sets the exchange rate officially below $p^e$, such as $p^c_0$ in Figure 2. Monetary authorities are thus drawing down foreign exchange reserves to meet the excess demand (ab). At $p^c_0$ the government has two options to correct the disequilibrium: (1) devalue the currency, or (2) to retain the pegged parity and impose strict exchange control. Under such an exchange control system, the monetary authorities are assumed to ban all capital outflows and distribute whatever foreign exchange supplies are available to those who demand foreign exchange for current account transactions at the pegged rate. The excess demand for foreign exchange for capital outflow may seek out another source of supply (black market).

In the presence of a black market for foreign exchange, there would be two foreign exchange rates: $p^c_0$, which is officially pegged and $p_B$, which is the black market rate. In Figure 2, $S_2$ is the supply of foreign exchange showing total supplies, official as well as black market, as a function of the black market rate $p_B$. This curve is everywhere to the left of $S_1$, because with exchange control, capital inflow in the form of direct investment may be discouraged since foreign investors are uncertain about whether they can take their profits or principal out of the country. Thus, even
Figure 2. Derivation of the supply curve of foreign exchange in the black market.
if the official exchange rate after the establishment of exchange control remains at $p_0^c$, the existence of exchange control may decrease total supplies of foreign exchange from $a$ to $d$ in Figure 2 due to a decrease in capital inflow. $S^0$ shows the supplies of foreign exchange for the official market as a function of the black market rate. It is negatively sloped because as the black market rate, $p_B^c$, rises, given the official rate $p_0^c$, exporters will be tempted to divert more and more of their foreign exchange earnings from the official to the black market.

There is another source of supply of foreign exchange for the black market, and that is from over invoicing of imports by domestic residents, due to the overvaluation of the exchange rate (for further discussion of over-invoicing and under-invoicing of exports and imports and smuggling, see Bhagwati (1974). This is indicated by the curve TNd, which is drawn to show that if the black market rate is the same as the official rate, i.e., $p_0^c$, the proportion of total official supplies over-invoiced is zero, but the proportion rises as the black market rate rises relative to the official rate. When the black market exchange rate rises to $T$, over-invoicing is again zero, because officially distributed foreign exchange for imports is zero. Thus, at any black market exchange rate, given the official rate pegged at $p_0^c$, the supply of foreign exchange to the black market is equal to the total supply of foreign exchange at that rate (given
Figure 3. Derivation of the demand curve for foreign exchange in the black market.
by the curve, $S_2$) minus the supply of foreign exchange to the official market (given by $S^O$) plus the supply to the black market from over-invoiced imports (given by $S^O$ minus TNd curves). By subtracting TNd from $S_2$ at every black market rate we will get $S^B$, the black market supply curve of foreign exchange, which gives us the supply of foreign exchange in the black market as a function of the black market rate, given that the official rate is pegged at $p^o_c$.

Because of exchange control, and in the absence of any risks in dealing on the black market, the demand for capital outflow now blocked by exchange control ($D^K$ in Figure 2) is the potential demand for foreign exchange shifted to the black market. Before the imposition of exchange control, the total foreign exchange supplied was enough to satisfy current account demand for foreign exchange ($p^{ca}c$ Figure 2).

With exchange control, however, official supplies are not enough to satisfy current account demand for foreign exchange.

In the black market, there is an additional potential demand for foreign exchange. Given $p^o_c$ as the officially pegged exchange rate, at the same black market rate the total supply of foreign exchange in the official market determined from $S^O$ curve is $p^o cd$ (Figure 3), which is less than $p^o ca$, the amount demanded of foreign exchange from exchange control authorities. Given the black market rate, $p^b = p^o_c$, the potential demand for FX in the black market for current account transactions is $p^o cf$ (which is equal to da), the
demand left unsatisfied in the official market. If, because of the risk involved in dealing in the black market, not all the unsatisfied (excess) demand turns up in the black market (assuming that the exchange control does not change consumer behavior so that the supply and demand curves do not shift) and if the proportion which turns up is given by $\frac{\rho_o f'}{\rho_o f}$, $f'$ would be a point on the demand curve for FX in black market for current account transactions.

Now assume that the black market rate is given by $\rho_B$. Then, $\rho_o c g$ of FX is supplied to the official market. Out of this, $gg'$ is received by demanders for over-invoicing imports, thus leaving $\rho_o c g'$ to satisfy the demand for foreign exchange for current account transactions. The amount, $ag'$, is the potential demand in the black market. To determine the point on the black market demand curve for the rate $\rho_B$, we have to know the demand at the market rate. From the point, $\rho_o c'$, let $ag' = \rho_o c m$; $ag'$ decreases as a function of the black market exchange rate.

How this unsatisfied demand, $\rho_o c m$, decreases in the black market for higher black market rates depends upon the behavior of those operating in the black market. This, in turn, depends upon who is turned away from the official market because of limited supplies of FX there. There are two factors which determine this: (1) the form of rationing of the limited amount of foreign exchange in the official market, and (2) the possibility of resale of the FX acquired from the exchange control authorities. Let us assume for
simplicity that there is no resale of FX. If we assume that there is a neutral distribution of the limited amount of FX among applicants, then the response of those left unsatisfied in the official market to the black market is a proper fraction of the demand curve D (Figure 3), at every black market price of foreign exchange. The locus of those points would be curve km (Figure 3) -- at every price of FX, this neutrality assumption means that the elasticity of demand on this curve, km, will be the same as the corresponding elasticity on the D curve, given the assumption of no resale.

In the absence of any risks, the demand for foreign exchange in the black market at the black market rate \( \rho_B' \) will then be \( \rho_B'y \). If there is risk involved in dealing on the black market, the demand for FX appearing in the black market at rate \( \rho_B'y \) will be a fraction of \( \rho_B'y \) which is given by \( km' \), the fraction given by \( \rho_o'c_f' / \rho_o'c_f \), so that \( \rho_B'y \), the black market demand for FX, is \( \rho_B'y' \) (i.e., \( \rho_B'y' / \rho_B'y = \rho_o'c_f' / \rho_o'c_f \)). By joining the points, k, y', and f', we get black market demand curve ky'f' for current account transactions. Curve ky'f' is positively sloped at a range because an increase in the black market rate has two effects. First, it decreases the official supplies of foreign exchange, thus diverting greater excess demand to the black market; second, the higher black market rate directly decreases demand for foreign exchange. As long as the first effect is stronger than the second, an increase in the black market rate will,
by increasing the black market demand, make the demand curve positively sloped.

We know that $D^k$ in Figure 2 represents the potential demand for capital outflows in the black market. If a fraction of the demand that appears in the black market is represented by $D^k_1$ (Figure 4), the total demand curve for FX in the black market is derived (Figure 4) by adding $k'y'f'$ to $D^k_1$, which is $D^B$. The equilibrium in the black market occurs at $E^B$ and the equilibrium black market rate is $\rho^e_B$. 
Figure 4. Supply and demand curves for the black market foreign exchange.
Appendix B

Mathematical Derivation of Equations for Balance of Payments, Domestic Rate of Inflation and Black Market Exchange Rate

$$g = (YD^* + a^* - \pi - md^*)$$
we have:

$$a^* + (1-\gamma)\pi^* + \gamma D^* = \pi + md^* \quad (7)$$

$$\pi = \delta P_T + (1-\delta)P^* \quad (8)$$

$$P_T^* = \pi_\psi + \rho_C \quad (9)$$

$$P_{NT}^* = \pi_\psi + \lambda \delta (\gamma D^* + a^* - Md^*) \quad (10)$$

From (8) and (9):

$$(1-\delta)P_{NT}^* = \pi_\psi + \delta \pi P_T^* = \frac{\pi_\psi + \beta (\pi_\psi + \rho_0^*)}{1-\delta}$$

Substituting for $\pi$ in (10):

$$\pi = \delta (\pi_\psi + \rho_0^*) + (1-\delta)\pi_\psi + \rho_0^* + \beta (1-\delta)d(\gamma D^* + a^* - \pi - md^*)$$

$$= \pi_\psi + \beta \pi_\psi + (1-\delta)d(\gamma D^* + a^* - \pi - md^*)$$

$$= \pi_\psi + \beta d(\gamma D^* + a^* - \pi - md^*) - \lambda (1-\delta)\pi + \lambda (1-\delta)\pi_{\pi-1} \quad (11)$$

or:

$$\pi = \beta \pi_\psi + \beta \pi_\psi + (1-\delta)d(\gamma D^* + a^* - \pi - md^*)$$

$$= \beta \pi_\psi + \beta \pi_\psi + (1-\delta)d(\gamma D^* + a^* - \pi - md^*)$$

or:

$$\pi + \beta \pi_\psi + \beta \pi_\psi + (1-\delta)d(\gamma D^* + a^* - \pi - md^*)$$

For black market exchange rate:

accroding to supply of and demand for black market rate

$$d \log \tilde{S}_B^t = a(d \log \tilde{S}_B^{t-1} + d \log \tilde{S}_B^{t-1})$$
and:
\[ \log \frac{d e}{B} = b(\log P - \log \frac{w}{d \log q_B}) \]
Since at equilibrium \((s_B^e)^* = (d_B^e)^*\) then:
\[ q_B^* - q_B^* = b\tau - b\frac{\omega}{w} \]
or:
\[ q_B^* = \frac{b}{a + b} (\pi - \pi_w) + \frac{a}{a + b} q_B^* \]
Substituting for \(\pi\), we get:
\[ q_B^* = \frac{b}{a + b} \left( \theta(\pi_{w-o}) + (1-\theta)\gamma - (1-\theta)\pi \right) + \frac{a}{a + b} q_B^* \]
For the balance of payment equation, substitute Equation (11) into Equation (7) for \(\tau\), so we get:
\[ R^* = \frac{1}{1-\gamma} \left( s_{\omega'} s_{\omega''} + (1-\theta)\gamma D^* a - m d^* \right)_{t-1} - \frac{1}{1-\gamma} (\gamma D^* a - m d^*) \]
\[ R^* = \frac{\theta}{1-\gamma} (s_{\omega'} s_{\omega''}) + \frac{1-\theta}{1-\gamma} \left( (\gamma D^* a - m d^*)_{t-1} - (\gamma D^* a - m d^*) \right) \]
\[ - \frac{1-\theta}{1-\gamma} t_{t-1} - \frac{1}{1-\gamma} (\gamma D^* a - m d^*) \]
or:
\[ R^* = \frac{\theta}{1-\gamma} s_{\omega'} + \frac{\theta}{1-\gamma} s_{\omega''} + \frac{\theta}{1-\gamma} q_B^* - \frac{1-\theta}{1-\gamma} g_t - \frac{1-\theta}{1-\gamma} t_{t-1} \]
VITA

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