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Determinants of Inflation in the Islamic Republic of Iran— A Macroeconomic Analysis

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Determinants of Inflation in the Islamic Republic of Iran—A Macroeconomic Analysis

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Abstract

This study establishes a framework for analyzing the major determinants of inflation in the Islamic Republic of Iran. An empirical model was estimated by taking into consideration disequilibria in the markets for money, foreign exchange, and goods. Results strongly support the need for a sustained prudent monetary policy in order to reduce inflation and stabilize the foreign exchange market. The estimation shows that an excess money supply generates an increase in the rate of inflation that, in turn, intensifies asset substitution (from money to foreign exchange), thereby weakening real demand for money and exerting pressures on the foreign exchange market. The study also found that a permanent rise in real income tends to increase the real demand for money and reduces inflation in the long run.

JEL Classification Numbers: E31, E41, O53

Keywords: Iran, money demand, exchange rate, output gap, inflation and cointegration

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I. INTRODUCTION

This study establishes a framework for analyzing the major determinants of inflation in the Islamic Republic of Iran during 1989/90–1999/2000. Equilibrium relationships pertaining to the markets for money, foreign exchange, and goods are established along with their dynamic specifications. The study assesses the transmission mechanism of monetary policy and explores the predictive power of key policy variables, including nominal money, in forecasting inflation dynamics. To further identify the leading determinants of inflation, impulse response functions and the variance decomposition technique are used to examine the responses of relevant variables to shocks emanating from money, goods, and foreign exchange markets.

Most macroeconomic empirical studies on Iran focused on a single sector of the economy. Bahmani (1996) developed a stable long-run demand for money under a system of multiple exchange rates using annual observations for the period 1959–90. He found that the parallel market exchange rate (in its nominal form) played an important role in the money demand function. Also, Pesaran (1998) estimated a real money demand equation using annual data for 1960/61–1995/96, a period characterized by significant political, social, and international instabilities, including the Islamic revolution in 1979 and the eight-year war with Iraq (1980–88). The author found a structural break around the time of the revolution, relating to the income elasticity of real demand for money, which shifted from 1.85 during the prerevolution period to 0.53 in the postrevolution period. Both studies confirm that real income is an important determinant of the real money demand in Iran. Becker (1999) used the common (stochastic) trend model to investigate the evolution of prices, market exchange rate, money, and real output during 1959–96 and concluded that monetary shock would have a temporary effect on real output but a permanent effect on the price level.

Other studies have investigated determinants of exchange rates in Iran. Bahmani-Oskooee (1996) applied a purchasing power parity framework and found that the real exchange rate depends on the productivity differential between Iran and the trading partners. Sundararajan and others (1999) explored determinants of the equilibrium exchange rate (using annual data for 1970–95). A long-run relationship was established between the real exchange rate and economic fundamentals including the fiscal balance, terms of trade, broad money, net foreign assets, capital stock, and productivity.

The methodology adopted in this paper is in line with the one used by Kujis (1998) for the Nigerian economy. The study achieves the following objectives:

- First, it establishes constant long-run equilibrium relationships for each market. Building upon them, the study develops a macroeconomic framework that links these markets through a stable dynamic model of inflation, which explicitly incorporates the error-correction terms of the three markets to examine the impact of external shocks and internal disequilibria on inflation dynamics.

- Second, it investigates the impact of excess money supply and monetary growth on the exchange rate dynamics under a system of restricted exchange and trade regime and multiple exchange rates. Moreover, it analyzes the transmission mechanism of monetary policy in an environment of significant interest rate rigidities and administratively fixed official exchange rates.

- Third, it establishes a stable model over a period characterized by major economic shocks, including the attempt at liberalizing the exchange and trade systems (1993/94), unforeseen slumps in global oil prices (1993/94–1994/95 and 1998/99), emergence of balance of payments crisis (1994/95–1995/96), internal economic imbalances emanating from policy reversals, and weak demand management.

- Fourth, the study uses quarterly data rather than annual observations to conduct an in-depth analysis of lagged effects among key economic variables.

The paper is organized as follows: Section II provides a brief background of the Iranian economy. Section III discusses a theoretical framework for a small economy like Iran, whose exports are relatively insensitive to exchange rate movements because of its dependence on oil. Section IV presents the cointegration results of long-run equilibrium relationships of the monetary sector and balance of payments, as well as the results obtained from the use of the Hodrick-Prescott filter approach for the construction of the real output gap. Section V discusses the short-term dynamic error correction models for inflation, money, exchange rate, and real output. Section VI presents policy implications and conclusion.

II. BACKGROUND

Over the last two decades, the Iranian economy has been subject to a number of major adverse shocks. Some of them are external, including the eight-year war with Iraq and volatility in global oil prices. However, major imbalances in the economy were also policy driven, resulting from the controls on the allocation of credit and foreign exchange, intensive exchange and trade restrictions, distortions in the pricing system including exchange rates, interest rates, and domestic energy prices in an environment of inadequate demand management. This has induced inefficiency in the allocation of resources, rendered the economy less competitive, and weakened its capacity to response to external shocks. These factors have led to chronic inflation in Iran in the range of 20 percent to 30 percent in recent years. To a large extent, the internally imposed constraints have prevented Iran from taking the full advantage of productivity gains through efficient resource allocation and globalization, and rendered the government incapable of formulating effective and consistent policy responses. The harmful consequences of the policy-induced imbalances have now become more acute in light of Iran's strong population growth and the pressures on employment.

The government has made attempts to reform the economy within the framework of the two Five Year Development Plans since 1989/90, which established a relatively cohesive macroeconomic framework based on the consensus reached among government ministries and parliament on key economic issues. Growth objectives under the first Plan were ambitious and were anchored on expansionary financial policies, including public investment programs financed by monetary expansion and short-term external borrowing, while maintaining the highly appreciated exchange rate and significantly negative real interest rates as well as other price incentives. These distortions further aggravated the degree of resource misallocation, inhibited sustained high growth and employment generation, and eventually led to inflationary pressures and balance of payments difficulties.

Against this background, the second Plan (1995/96–1999/2000) focused on rationalizing relations with external creditors, lengthening the maturity of external debt, curtailing the total external debt stock, and reducing inflation. However, the economy continued to depend heavily on crude oil revenues, resulting in large implicit subsidies for energy products, appreciated exchange rates, and negative real interest rates. The combined effects of inefficient allocation of resources under a controlled system, declines in oil export receipts, and severe import compression adopted during 1995/96–1999/2000 to service the external debt, contributed substantially to lower economic growth in recent years (at an average of 3.2 percent during 1994/95–1998/99, compared with 8.1 percent during 1989/90–1993/94) and a decline in the real demand for money.

In early 1999/2000, the government reinforced its reform efforts to: (a) establish a market-clearing exchange rate in the Teheran Stock Exchange (TSE) to cover a significant share of current account transactions; (b) introduce positive real interest rates; (c) increase domestic petroleum prices; (d) initiate steps to liberalize the trade system; and (e) develop the framework to restructure the banking and state enterprise sectors. In the process, access to foreign exchange in the TSE market has been liberalized and the Iranian rial has been allowed to depreciate in the TSE in response to market prices. As a result, the parallel market premium declined substantially to below 5 percent by end-1999/2000. At the same time, exchange restrictions were liberalized, regulations relating to foreign exchange transactions simplified, and transparency in foreign exchange operations improved. However, progress remains slow on other fronts.

III. The Long-Run Model

The model describes an economy that is small relative to the rest of the world but open to terms-of-trade shocks and effects of international financial flows (mainly through the parallel exchange market). The financial system is dominated by the state-owned banks, operating under mostly fixed interest rates and administratively determined official exchange rates with limited financial assets for investment. In this context, long-run specifications linking the markets for money, foreign exchange, and goods are constructed. The model is estimated to analyze the impact of market disequilibria on dynamics of price, money, and exchange rate.

A. Demand for Money

In Iran, financial markets are in their early stage of development. Investment options are limited to three main categories: money, real assets, and foreign exchange. Asset allocation is influenced by the expected real rates of return, liquidity, and associated transaction costs. Interest rates on money are not only fixed in nominal terms but also significantly negative in real terms. Over time a permanent shift, away from holding of money to real assets and foreign exchange, has taken place as a result of a sustained period of large negative real rates of return, as well as large exchange rate misalignment.

Equation (1) below specifies the long-run demand for money as a function of real income, price, and degree of asset substitution. When large negative real rates of return on money are expected against positive and substantial real rates of return on foreign exchange (i.e., through depreciation of rials), an investor would substitute money for foreign exchange as much as possible at a given level of income. Consequently, the degree of asset substitution is affected by the parallel market exchange rate. The long-run demand for money can be specified as:

$$M = \alpha * Y^{\beta} * PAR^{-\gamma} * P^{\eta}, \qquad \alpha, \beta, \gamma, \text{ and } \eta > 0 \qquad (1)$$

where M is the nominal money balance; Y, real income; PAR, the parallel market exchange rate; and P, the price level (measured by GDP deflator). Taking logarithms, the long-run real demand for money can be written as: [2]

$$m - p = a + b_1 * y - b_2 * par \qquad a, b_1, \text{ and } b_2 > 0 \qquad (2)$$

where m-p denotes real money balance (deflated by the GDP deflator, p);[3] y is real income; and par is the parallel market exchange rate.

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[2] Equation (2) can be established by imposing homogeneity between money and price (η=1). This restriction is tested; it cannot be rejected at the 10 percent interval. In addition, the rate of inflation measuring the opportunity cost associated with the foregone return on physical assets, is found to be stationary, thus, it has no bearing on the determination of demand for money in the long run. All other variables are found to satisfy the AR(1) processes.

[3] In Iran, a more appropriate measure of prices for the economy is the GDP deflator. The CPI basket contains a large share of government subsidized essential goods and services as well as energy-related products that are administratively priced.

B. Balance of Payments

The structure of the Iranian economy is mostly dictated by its reliance on crude oil exports, which accounts for over 80 percent of Iran's total foreign exchange earnings. Crude oil exports are subject to the OPEC quota and are vulnerable to price volatility in the global oil market. Over the sample period, crude oil exports experienced cycles of significant ups and downs emanating from external shocks. Evidences suggest that, to a large extent, Iran's export earnings are exogenously determined. In the model for balance of payments, specified in Equation (3), export earnings, combined with the capacity of external borrowing and net changes in net international reserves, determine the real foreign exchange supply in Iran (*RSfx*):

$$RSfx = \frac{(X + NFB - \Delta R)}{P_i} \qquad (3)$$

where X represents the exogenous export revenue; NFB, the net foreign borrowing; ΔR, the net accumulation of international reserves; and P_i, the price of imports. The change in international reserves is a policy variable in Iran, while net foreign borrowing could contain both the exogenous factors (such as debt service payments and private capital flows) and policy driven items (such as official external borrowing).

Real demand for foreign exchange can be specified as the sum of real imports, as a function of real exchange rate (*RER*) and real domestic expenditure (*RD*), and real demand for currency substitution, which is a function of the excess money supply (M^s-M^d):

$$RDfx = \underset{-}{f}(RER, \underset{+}{RD}) + \underset{+}{g}(M^s - M^d) \qquad (4)$$

During most of the study period (1993/94–1998/99), Iran implemented extensive exchange and trade controls aimed at compressing imports in order to service the rescheduled external obligations, while maintaining the fixed official exchange rates at more appreciated levels. As a consequence, demand for foreign exchange at the official exchange rates far exceeded the supply of foreign exchange at all times. While imports are compressed through trade restrictions, the unmet private demand for foreign exchange (i.e., for both the current and capital account needs) are channeled to the parallel market, exerting pressure on the parallel market premium. The public sector is officially barred from using resources from the parallel market. Therefore, the parallel market exchange rate does not reflect the effect of unmet import demand of the public sector.

With this in mind, the equilibrium condition of the exchange market can be derived in the long run with excess money supply at zero ($M^s - M^d = 0$). It can be expressed by setting the identity, $RSfx \equiv RDfx$, in logarithms as:

$$fxs \equiv \alpha - \beta_1 * rer + \beta_2 * rd, \qquad \beta_1 \text{ and } \beta_2 > 0 \qquad (5)$$

Rewriting Equation (5) in nominal terms, the nominal exchange rate (*par*) can be related to real supply of foreign exchange, *fxs*; real expenditure, *rd*; domestic prices, p; and international prices, p_i:

$$par = \alpha - \beta_1 * fxs + \beta_2 * rd + \beta_3 * p - \beta_4 * p_i, \qquad (6)$$

$$\beta_1, \beta_2, \beta_3, \text{ and } \beta_4 > 0$$

It is important to note that Equation (6) describes an equilibrium condition for a system with import control. Thus, parameter estimates in Equation (6) are sensitive to the liberalization of the import regime. The unrestricted long-run equilibrium exchange rate (in the absence of import control) could be substantially more depreciated as compared to the level estimated by Equation (6). Indeed, the gap between the observed market exchange rate and unrestricted equilibrium exchange rate (unobserved) measures the degree of restriction on import demand of the public sector that are excluded from using resources of the parallel market.

C. Goods Market

The model investigates the goods market to incorporate the impact of output gap on inflation. The Hodrick-Prescott filter (HP filter) is used to decompose the actual real GDP to potential and cyclical components, which is in line with the methodology used by a number of studies, including Isebelle and Lim (1998) and Phillips and Roldos (1997).[4] The difference between the actual GDP and its trend as given by the HP filter estimates the output gap. Specifically, the HP approach uses a smoothing estimation method to separate the permanent component of the GDP from the temporary one by choosing y^* to minimize the following function:

$$\sum_{t=1}^{T}\left(y_t - y_t^*\right)^2 + \lambda \sum_{t=2}^{T-1}\left[\left(y_{t+1}^* - y_t^*\right) - \left(y_t^* - y_{t-1}^*\right)\right]^2 \qquad (7)$$

The parameter λ controls the smoothness of the series y_t^*. The larger the λ, the smoother the y_t^* (potential output).

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[4] Views have been expressed as regards the deficiencies of using the HP approach as the basis for extracting potential output from actual output, including the arbitrary choices of frequencies of the business cycle and the smoothing parameter λ. A follow-up study will use the Cobb-Douglas production function to estimate potential output in Iran.

IV. Cointegration Results

A long-run equilibrium model is estimated using the cointegration technique on quarterly observations for 1989/90–1999/2000.[5] Stable long-run equilibrium relationships are established in the markets for money, foreign exchange, and goods. Deviations from the long-run equilibrium levels, which are specified in error correction terms, are allowed to enter the dynamic equations for inflation, money growth, exchange rate, and real output in Section VI.

A. Real Demand for Money

Estimation of the long-run real demand for money (Equation (2)) suggests a unique cointegration vector among real money balance, real income, and market exchange rate.[6] The estimated real demand for money can be written as:[7]

$$m - p = \underset{(24.33)}{0.63} * y - \underset{(3.48)}{0.11} * par \qquad (8)$$

Income elasticity of money is estimated at about 0.6, significantly below unity. The exchange rate elasticity of 0.1 suggests that a 10 percent permanent depreciation in the parallel market exchange rate over the long run would lead to a decline in real demand for money by about 1 percent. During 1993/94–1999/2000, the parallel market exchange rate depreciated by about 400 percent, implying a significant weakening in the real demand for money (Figure 1).

The result indicates that there was a large excess money supply in 1990/91, which contributed to chronic inflation and economic instability in subsequent years. During 1990/91–1995/96, nominal monetary expansion was increasingly absorbed by the accelerating high rate of inflation, which led to a sharp decline in real supply of money. During the same period, real demand for money, that increased initially to reflect high economic growth (at an average of 8 percent per annum) during 1990/91–1993/94, reversed to a declining trend during 1994/95–1995/96 owing to a combined effect of a sharp slowdown in economic activities and intensified currency substitution as a result of high inflation.

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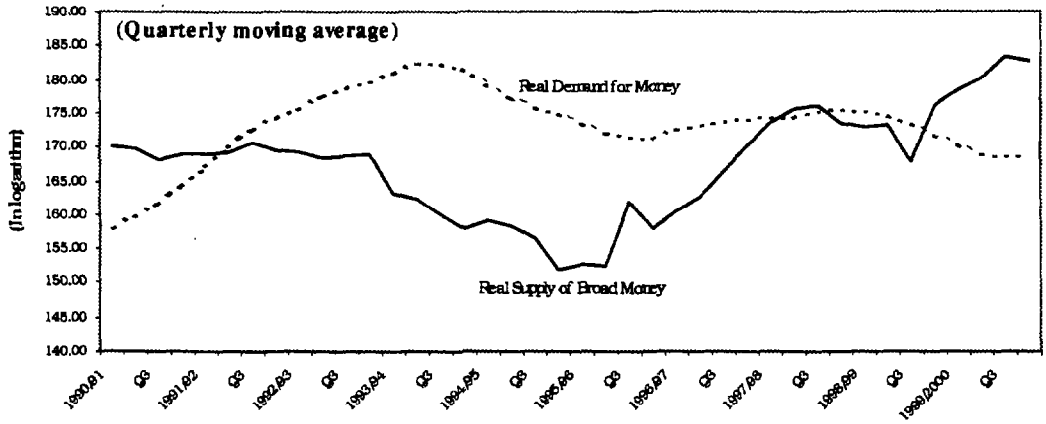
[5] Appendices I–III report the test result on cointegration analysis, unit root tests, impulse response function, and variance decomposition.

[6] Empirical tests can not reject the homogeneity between money and price at a 10 percent interval, whereas homogeneity between money and real income is rejected.

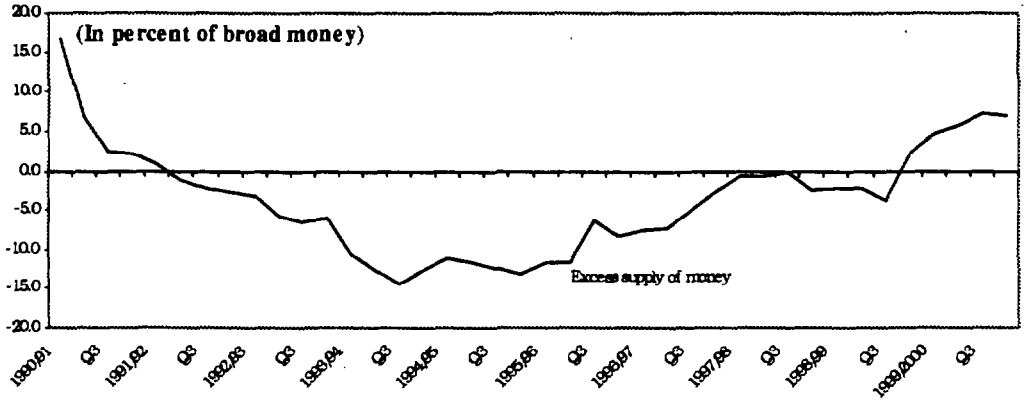
[7] Numbers in parentheses represent the t-statistics.

Figure 1. Islamic Republic of Iran:
Equilibrium and Actual Demand for Money, 1990/91-1999/2000



Monetary policy was accommodative in 1996/97. Real supply of money increased significantly as nominal monetary growth accelerated. Real demand for money stabilized with the impact of currency substitution compensated by the income effect on money. Monetary expansion (in real terms) was successfully contained during 1997/98–1998/99, to levels consistent with the real demand for money. However, this prudence was weakened in 1999/2000 by the monetization of large increases in net foreign assets arising from sharp increases in global oil prices. Real supply of money surged, while real demand for money declined further as a result of a continued depreciation of the rial in the parallel market. However, exchange reform initiated by the authorities in early 1999/2000 succeeded in stabilizing the market exchange rate by end–1999/2000, which helped to further instill a decline in real demand for money. The evolution of excess money supply is presented in Figure 2.

Figure 2. Islamic Republic of Iran:
Excess Money Supply, 1990/91-1999/2000



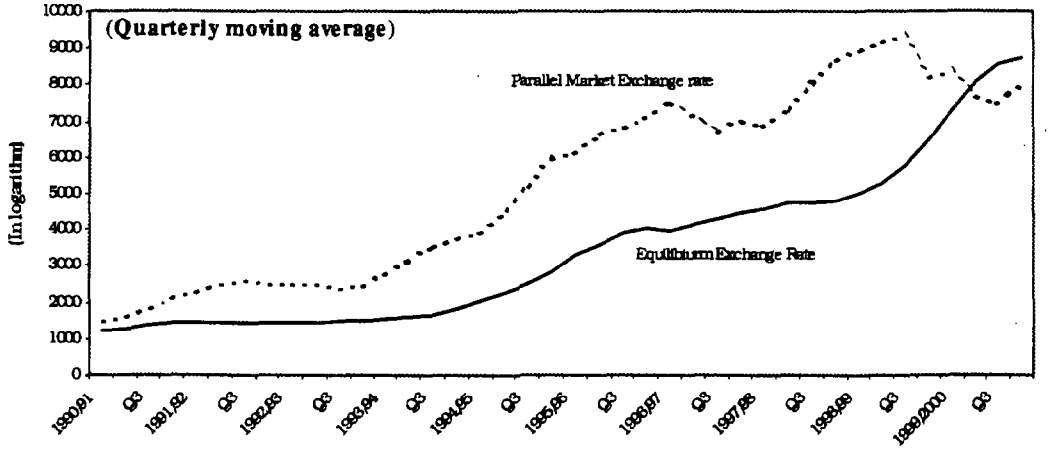
B. Equilibrium Exchange Rate

The equilibrium exchange rate, derived from Equation (9), can be considered as a restricted equilibrium exchange rate under constant exchange and trade controls. A unique cointegration vector is found among the parallel market exchange rate, *par*; real foreign exchange supply, *fxs*; real expenditure, *rd*; and domestic price, p. The import price, p_i, is insignificant and consequently removed from Equation (9). Exchange rate movement (Δe) is stationary, therefore, it is also excluded from the estimation. The derived equilibrium exchange rate can be written as (in logarithms):

$$par = -1.7 - 0.9 * fxs + 1.1 * rd + 1.2 * p \qquad (9)$$
$$(2.22) \quad (3.28) \quad (5.75)$$

Figure 3 shows the actual and equilibrium exchange rates in a quarterly moving average. For most of the study period, the parallel market exchange rate deviated from the long-run equilibrium level by an average of 40 percent, before it narrowed significantly in 1999/2000. Exchange rate disequilibrium during the study period reflects the significant impact of import controls on the parallel market exchange rate: during 1993/94–1998/99, exchange and import controls were strictly enforced, and a substantial amount of unmet import demand of the private sector was channeled to the parallel exchange market, which exerted significant pressure on the parallel market exchange rate.

Figure 3. Islamic Republic of Iran:
Market Exchange Rate and Long-Run Equilibrium, 1990/91-1999/2000



Reform of the TSE exchange market, which started in the second half of 1998/99 and continued throughout 1999/2000, included significant liberalization in exchange controls, combined with some easing in trade restriction. The import list was expanded, together with a significant share of current account transactions being transferred to the TSE. Importers with legal licenses have rights to access to foreign exchange in the TSE at market-clearing

prices. Although large increases in demand for foreign exchange emanating from the exchange and trade liberalization was met in part by the larger allocations of official oil export receipts to the TSE, and by increased and more timely repatriation of export earnings of the private sector, demand for foreign exchange in the TSE continued to exceed the supply, and consequently the observed adjustment in equilibrium exchange rate. In the parallel market, however, the demand pressure for foreign exchange eased, which led to a stabilization in the parallel market exchange rate (with some appreciation).

The pattern of misalignment captures reasonably well the intensification of exchange and trade restrictions through most of the 1990s, particularly, the two episodes of the balance of payments crisis: the debt rescheduling of 1993/94–1995/96 and terms of trade shock of 1998/99. During both episodes, the misalignment between the parallel market exchange rate and (restricted) equilibrium exchange rate widened, which reflects the increased degree of exchange and trade restrictions.

C. Output Gap

The output gap based on annualized GDP is given by: [8]

$$output\ gap = \frac{y - y^*}{y^*} \tag{10}$$

where y is the actual real GDP and y^* is potential output as given by the HP filters.

Equation (10) indicates that, over the entire study period, actual output was relatively close to its potential, ranging from -0.4 percent to 0.2 percent. The output gap reveals a cyclical trend of two to three years: actual output rose above potential during 1990/91–1993/94 but fell below potential during 1994/95–1995/96, only to exceed potential again in 1996/97–1997/98. During 1998/99–1999/2000, there was virtually no output gap.

V. Dynamic Specification of the Model [9]

General forms of dynamic equations are estimated for inflation, money growth, exchange rate, and real output. The disequilibria (ECMs) in markets for goods, money, and foreign

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[8] In the estimation using the HP filter as the basis for decomposing a variable into its potential and cyclical components, the study applied a standard parameter for λ (equal to 1,600).

[9] In specifying the short-run determinants of inflation, exchange rate, and output, diagnostic tests were conducted, including the serial correlation tests, autoregressive conditional heteroscedasticity tests, and Chow's breakpoint test.

exchange are represented by ECM_{output}, ECM_{money}, and $ECM_{exchange}$, based on Equations (8), (9), and (10), respectively. Excess money supply (ECM_{money}) was found to have a significant adverse impact on the short-term dynamics of inflation and the exchange rate, but no significant effect on real output. Misalignment in the exchange rate ($ECM_{exchange}$) and output gap (ECM_{output}), however, were estimated to have significant effects only on the short-term dynamics of the respective variables (exchange rate and output growth).

The analysis of the dynamic model suggests that:

- A monetary expansion, as well as excess money supply, could significantly raise the rate of inflation and worsen the balance of payments in about three months.

- An increase in the rate of inflation would lower the growth of nominal money within three to nine months.

- An increase in the rate of inflation would exert pressures on the balance of payments in about six to nine months.

- An increase in real income would lead to an expansion in real demand for money at a given rate of inflation in three months.

A. Inflation

The dynamic specification of inflation can be presented in terms of excess money supply (ECM_{money}), monetary growth (dm), changes in exchange premium ($dprem$), and expected rate of inflation ($dp(-t)$). After removing insignificant arguments, the dynamic equation for inflation can be written as:

$$dp = -0.02 + 0.67 * ECM_{money}(-1) + 1.66 * dm - 0.19 * dprem(-2) + 0.38 * dp(-4) \qquad (11)$$
$$\qquad\qquad (5.04) \qquad\qquad (4.83) \qquad (-3.47) \qquad\qquad (3.50)$$

R^2=0.8, σ=0.03, DW=2.0

where ECM_{money} is the excess money supply; dm, nominal money growth; $dprem$, change in the exchange premium (defined as the difference between the parallel market rate and weighted average official exchange rates); and lagged value of dp, the expected rate of inflation.

Specifically, given the trade regime, the difference between the parallel market rate and weighted average official rates ($prem$) is used as a measure of the degree of exchange restriction in Iran.[10] The greater the restrictions, the lower the weighted-average exchange

[10] Bulk of the foreign exchange from oil receipts is allocated at official rates to public enterprises. The unmet demand of the private sector for current account transactions and

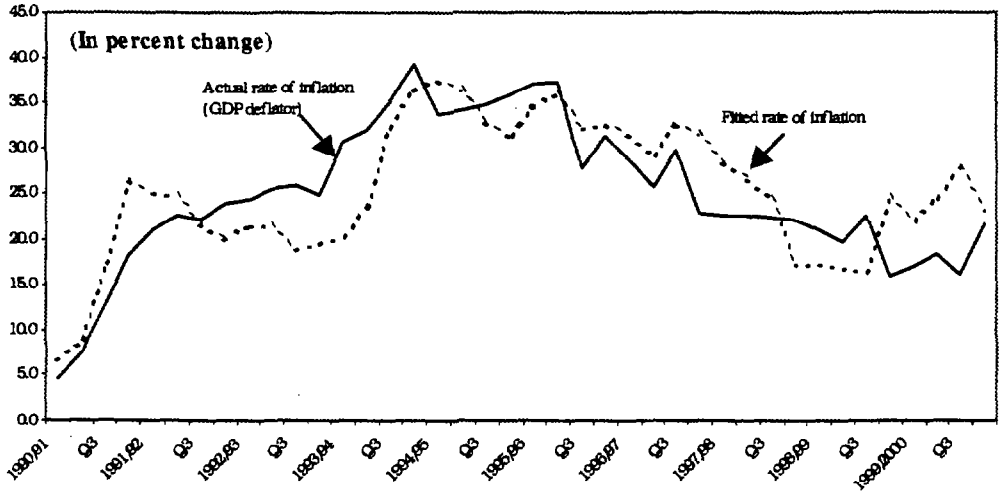
(continued...)

rate (derived from official exchange rates) and the higher the parallel market exchange rate. The inclusion of *dprem* is necessary to measure the impact of exchange liberalization on inflation. An ease in exchange control in Iran will be reflected in an effective depreciation of the weighted average exchange rate. This will result in a narrowing of the exchange rate premium (or a decline in *prem*).

As expected, excess money supply has a significant impact on inflation. The "speed of adjustment" is relatively fast: a 10 percent excess money supply is likely to push up the rate of inflation by 7 percent in about three months. The elasticity of 1.7 with respect to the contemporaneous monetary growth is high, reflecting a compounding effect of a monetary expansion and a continued monetary overhang. Inflation expectation, expressed by the lagged variables of the rate of inflation, was found to have a significant self-fulfilling effect on inflation dynamics—a 10 percent increase in the expected rate of inflation would push up the contemporaneous rate of inflation by 4 percent. Empirical analysis also suggests that a relaxation of the exchange control, reflected by a decline in *prem* (thus, a negative *dprem*), given unchanged trade regime, would temporarily increase inflation.

The absence of a significant impact on inflation from the exchange market (both in terms of short-run variation and long run disequilibrium) is not unusual as the causality test indicates that the parallel market exchange rate tends to reflect the movements in the rate of inflation but not the other way around. Besides, the parallel market exchange rate also contains other random noises emanating from the political and social events, which may not be captured in the empirical analysis of inflation. Figure 4 shows the actual and fitted rate of inflation.

Figure 4. Islamic Republic of Iran: Actual and Fitted Rate of Inflation (1990/91-1999/2000)



some capital account activities are conducted through the parallel market. The size of the parallel market, combined with the offshore Dubai market, was estimated at about US$2–3 billion per year.

B. Money

A dynamic model for nominal money growth can be specified as:

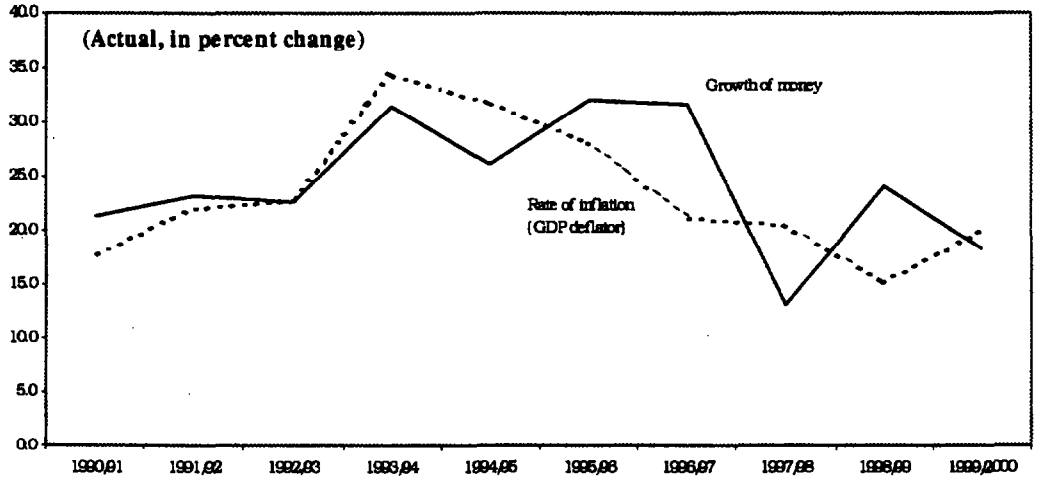
$$dm = 0.02 - 0.23 * ECM_{money}(-1) + 0.17 * dy - 0.25 * dp(-1) - 0.20 * dp(-2) - 0.1 * dp(-3)$$
$$\text{(-5.94)} \qquad \text{(6.60)} \quad \text{(-5.93)} \qquad \text{(-4.14)} \qquad \text{(-2.89)}$$
$$+ 0.04 * seasonal_{dummy}$$
$$\text{(8.98)} \qquad (12)$$

$$R^2 = 0.87, \ \sigma = 0.007, \ DW = 1.97$$

where dm is nominal money growth; ECM_{money}, the excess money supply; dy, change in real income; and dp, rate of inflation.

Equation (12) indicates that, in the short run, money growth adjusts itself toward the long-run equilibrium level at a speed of about one year (a coefficient of 0.23 on quarterly observations). Neither the $ECM_{exchange}$ nor ECM_{output} was estimated to have an impact the money growth. However, an increase in real income of 10 percent would lead to money growth of about 2 percent. The expected rate of inflation is found to exert a significant impact on the growth of money. The combined inflation elasticity on money growth is estimated to be negative and large (at -0.5), indicating that a combined inflation of 10 percent over the last three quarters would lead to a decline in money growth of about 5 percent as investors reduce their holding of money in favor of alternative assets. Exchange rate movements seem to have an insignificant impact on the growth of money. Figure 5 shows that inflation variations can be predicted by the stance of monetary policy.

Figure 5. Islamic Republid of Iran: Annual Rate of Inflation and Growth of Money 1990/91-1999/2000



C. Exchange Rate

A dynamic specification of the exchange rate was estimated and presented as follows:

$$dpar = -0.04 + 0.43 * ECM_{money}(-1) - 0.28 * ECM_{exchange}(-1) + 0.73 * dm(-1) + 0.27 * dprem$$
$$\quad (2.63) \qquad\qquad (-3.52) \qquad\qquad (2.41) \qquad (4.19)$$

$$+ 0.21 * dp(-3) + 0.21 * dp(-4) + 0.35 * dpar(-1) \qquad (13)$$
$$\quad (2.25) \qquad (2.11) \qquad (2.50)$$

$$R^2 = 0.63, \sigma = 0.025, DW = 1.81$$

where *dpar* represents the change in the parallel market exchange rate; ECM_{money} and the $ECM_{exchange}$, are excess money supply and disequilibrium in the money and foreign exchange market, respectively; *dprem*, the change in exchange premium; and *dp*, rate of inflation.

Both ECM_{money} and $ECM_{exchange}$ were estimated to have significant influences on the exchange rate: a 10 percent excess money supply is likely to cause a nominal depreciation of 4 percent in three months, whereas the speed of adjustment to the long-run equilibrium level would take about the same period of time (i.e., a "speed of adjustment coefficient" of 0.3). In addition, a 10 percent monetary growth tends to cause a nominal depreciation of 7 percent in one quarter. An intensification of exchange restrictions (i.e., an increase in the exchange premium, *prem*) and a deterioration in inflation expectation are estimated to cause a depreciation in the parallel market exchange rate with elasticity of 0.3 and 0.4, respectively.

These estimation results confirm that monetary policy is one of the most important variables that could have a significant impact on the exchange market. As shown in Equation (13), the combined exchange rate elasticity from ECM_{money} and short-term money growth implies that a joint 5 percent increase in excess money supply and 5 percent money growth could lead to a 12 percent depreciation in the market exchange rate with adverse consequences on real demand for money and inflation expectation.

D. Real Output

An attempt was made to investigate the major determinants of real income in the short run. Empirical results show that there is considerable association between the growth rate of output and its lagged values. Seasonal factors are also significant. The estimation of the real growth equation shares resemblance with the one obtained by Kujis (1998) for the Nigerian economy, where neither the ECM_{money} nor the $ECM_{exchange}$ were significant. Monetary expansion was also found insignificant in explaining the output growth. Therefore, enhancing output performance in Iran would have to rely on fundamentals such as increases in investment and total factor productivity, supported by structural policies to liberalize the economy.

However, changes in real output are significantly influenced by the ECM_{output} with a "speed of adjustment coefficient" of 0.4, indicating a correction toward the potential growth in about nine months. The dynamic estimation of real output growth can be presented as:

$$dy = -0.14 + 0.36 * dy(-2) - 0.36 * ECM_{output} + 0.14 * season1 + 0.30 * season2 + 0.13 * season3$$
$$\quad (2.59) \qquad (-2.58) \qquad (4.83) \qquad (8.00) \qquad (6.85)$$

$$R^2 = 0.99, \sigma = 0.064, DW = 1.9 \qquad (14)$$

VI. CONCLUSION

This study constructs a framework for analyzing the major determinants of inflation in Iran. An empirical model was estimated by taking into consideration disequilibria in markets for money, foreign exchange, and goods.

Specifically, the money market equation reflects a relatively underdeveloped financial market with limited financial assets, operating under an administratively controlled interest rate structure. Cointegration tests of the money market equation reveal a high degree of asset substitution between money and foreign exchange, suggesting a weakening real demand for money in an environment of high inflation and a rapidly depreciating market exchange rate. Cointegration tests of the balance of payments block is specified by relating the market exchange rate to real supply of foreign exchange, real income, real aggregate demand, and domestic and trading partner's price indices. While an increase in real foreign exchange supply eases the pressure on the exchange market, an increase in real aggregate demand requires a real depreciation of the exchange rate.

Based on behaviors of the long-run model for all three markets, *ECMs* are incorporated in the dynamic analysis. Results strongly support the argument that inflation is a monetary phenomenon in Iran. The combined effect of excess money supply and contemporaneous monetary growth are key determinants of inflation. A higher rate of inflation tends to intensify asset substitution from money to foreign exchange, thereby weakening real demand for money and inducing further exchange rate depreciation in the parallel exchange market. Empirical analysis suggests that a relaxation of the exchange control, at a given level of trade restriction and monetary stance, could temporarily increase the rate of inflation. Overall, there is a need to conduct a prudent monetary policy on a sustained basis in order to rapidly reduce the rate of inflation, stabilize the foreign exchange market, and improve real demand for money, so as to support structural reforms and economic liberalization over the medium term.

Descriptions and Data Sources, 1989/90Q1–1998/99Q4

Symbol	Description	Source
M	Broad money	*International Financial Statistics*
Y	Real GDP (1982/83)	*from the authorities*
P	GDP deflator $= \frac{\text{nominal } GDP}{\text{real GDP}}$	*from the authorities*
$P_i^{\$}$	Import price index	*staff estimates*
$P_e^{\$}$	Export price index	*staff estimates*
$\frac{M}{P}$	Real demand for money	*staff estimates*
X	Total exports	*from the authorities*
NFB	Net foreign borrowing	*from the authorities*
ΔR	Change in reserves	*from the authorities*
$Parr$	Parallel market exchange rate	*from the authorities*
$Prem$	Difference between the market rate and weighted average exchange rate	*staff estimates*
M	Total imports	*from the authorities*
rd	Real Aggregate Expenditure $= Y + \frac{X}{P_e^{\$}} + \frac{M}{P_i^{\$}}$	*staff estimates*
$Rsfx$	Real supply of foreign exchange	$\frac{X + NFB - \Delta R}{P_i^{\$}}$

Impulse Response Function and Variance Decomposition

In this section, we consider the effects of impulses hitting the system. The system contains nominal money (*M*), GDP deflator (*P*), parallel market exchange rate (*par*), and real output (*y*).

There are evidences to the fact that the observed results from the use of impulse response functions and variance decompositions are not at variance with theoretical expectations.

- A one-time shock in the nominal money equation generates positive trends in the price level. A monetary shock generates currency depreciation. This begins to manifest beginning from the third quarter. Discretionary monetary policy is likely to produce cyclicality in output in the economy under consideration; thus there is evidence to relative insensitivity of output to monetary shock (Appendix II, Figure 1).

- An impulse to the price seems to generate an increase in nominal money. With constant real demand for money, an exogenous increase in price tends to be associated with an increase in money supply. This reflects the condition that in the long run the nominal money stock must account for a change in price. Positive shocks to price generate depreciation of the domestic currency, and at the same time cycles and possible fall in output (Appendix II, Figure 2).

- A positive shock to the nominal exchange rate does not impact significantly on either price or money. Money responds positively but moderately to a positive shock to the exchange rate. While there is a possibility of exchange rate depreciation causing an increase in the price level within a period of three quarters, this effect tends to die out thereafter. Thus, exchange rate depreciation is not the causative agent of sustained increase in the price level. Depreciation of the domestic currency is revealed by this econometric technique to produce output contraction within a period of three quarters, however, this is followed by an expansion in output. From a policy perspective, allowing the Iranian rial to move toward its equilibrium level is expected to produce an increase in output in the long run (Appendix II, Figure 3).

- Equally important is the association between the shocks to output and nominal money stock. A positive innovation to output generates lasting effects on money and the exchange rate, whereas the price responds negatively in the short run. The permanent effect of an increase in output on the price comes from positive association between output and the real demand for money (Appendix II, Figure 4).

- Finally, evidences from variance decomposition show that the shock to money is independent of that of price, exchange rate, and output. Thus, this validates the proposition that M2 is a useful monetary aggregate in the context of the Iranian economy. It is discovered as well that shocks to the price level are not independent of that of nominal money stock, whereas the exchange rate tends not to play a significant role in the long-run evolution of price (Appendix II, Figure 5).

Table 1. Islamic Republic of Iran: Variance Decomposition

Variance Decomposition of M

Period	M	P	PAR	Y
1	100.00	0.00	0.00	0.00
2	94.42	1.25	3.54	0.79
3	93.62	0.82	2.56	3.01
4	89.76	2.12	4.16	3.96
5	90.90	1.88	4.03	3.19
6	89.30	2.65	4.47	3.58
7	89.31	2.64	3.73	4.32
8	88.10	3.55	3.62	4.72
9	88.95	3.38	3.28	4.39
10	88.65	3.74	3.07	4.54
11	88.67	3.69	2.68	4.97
12	88.28	4.06	2.47	5.20

Variance Decomposition of P (GDP deflator):

Period	M	P	PAR	Y
1	34.85	65.15	0.00	0.00
2	37.95	58.37	3.41	0.27
3	48.49	48.66	2.63	0.21
4	51.03	46.09	2.61	0.27
5	56.69	40.73	2.36	0.22
6	58.84	38.60	2.22	0.34
7	63.14	34.47	2.09	0.29
8	64.17	33.34	2.15	0.35
9	66.78	30.76	2.15	0.31
10	67.87	29.67	2.10	0.37
11	69.93	27.57	2.16	0.34
12	70.41	26.90	2.31	0.38

Variance Decomposition of PAR

Period	M	P	PAR	Y
1	4.08	0.94	94.99	0.00
2	1.78	0.41	97.73	0.08
3	1.54	1.11	96.77	0.58
4	3.54	2.52	92.85	1.09
5	5.38	3.26	90.26	1.09
6	8.73	3.45	86.75	1.07
7	11.26	3.96	83.39	1.39
8	14.52	4.51	79.21	1.75
9	17.36	5.00	75.89	1.75
10	20.94	5.13	72.22	1.71
11	23.73	5.40	68.96	1.91
12	26.48	5.64	65.74	2.15

Variance Decomposition of Y

Period	M	P	PAR	Y
1	15.27221	1.148538	6.986514	76.59
2	14.28943	1.630861	4.310924	79.77
3	14.19817	5.39183	5.489131	74.92
4	13.30283	11.65608	7.08674	67.95
5	9.623874	10.78489	5.376026	74.22
6	11.82206	8.396633	4.222521	75.56
7	11.19314	10.14006	7.509004	71.16
8	10.76325	13.03422	10.26945	65.93
9	9.125178	12.3446	8.612107	69.92
10	10.6813	10.5538	7.720192	71.04
11	10.43577	11.33562	11.00896	67.22
12	10.10472	13.0919	13.52981	63.27

APPENDIX II

Figure 1. Islamic Republic of Iran:
Responses of One S.D. Innovations (with s.e.=+-2)

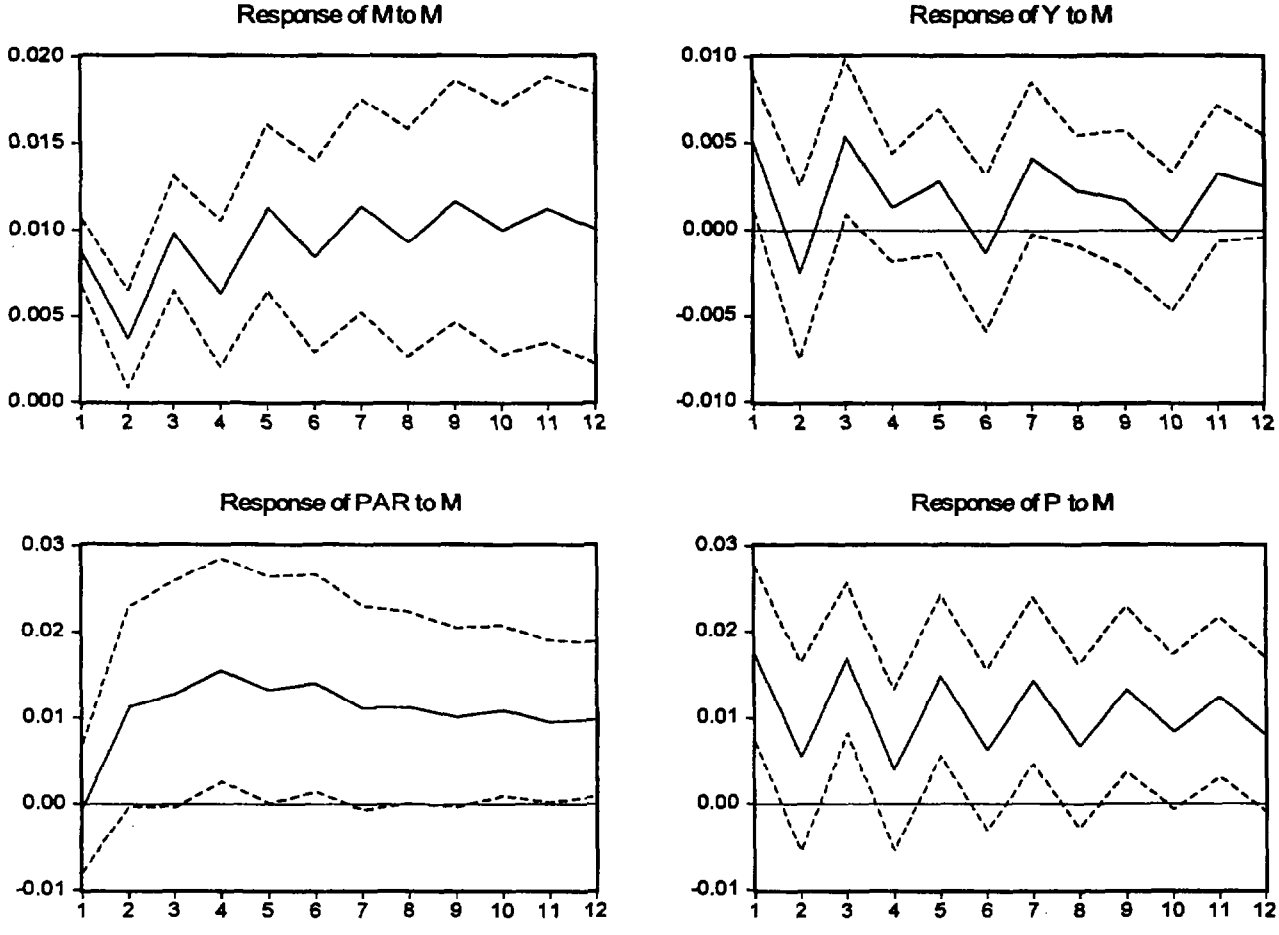
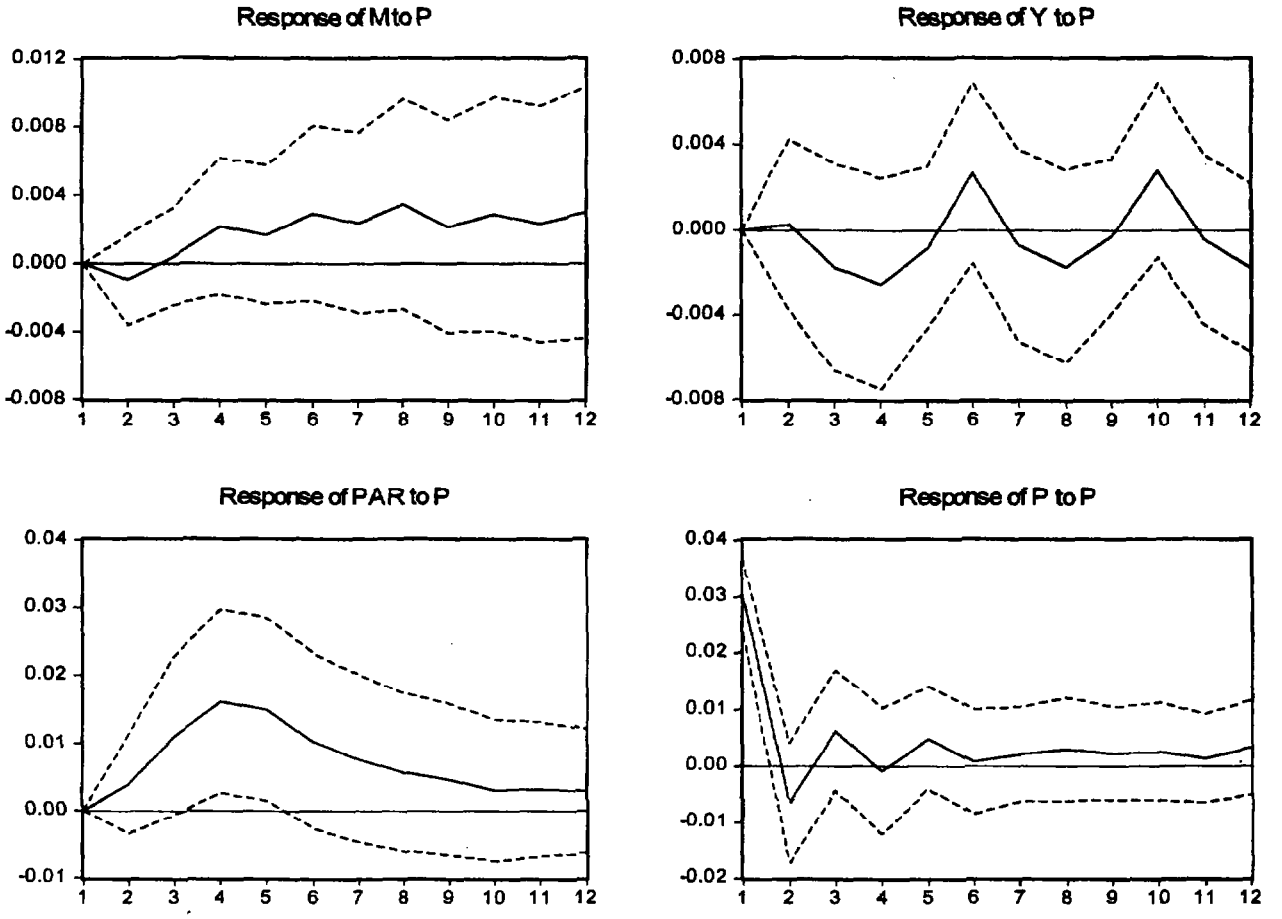


Figure 2. Islamic Republic of Iran:
Responses of One S.D. Innovations (with s.e.=+-2)



APPENDIX II

Figure 3. Islamic Republic of Iran:
Responses of One S.D. Innovations (with s.e.=+-2)

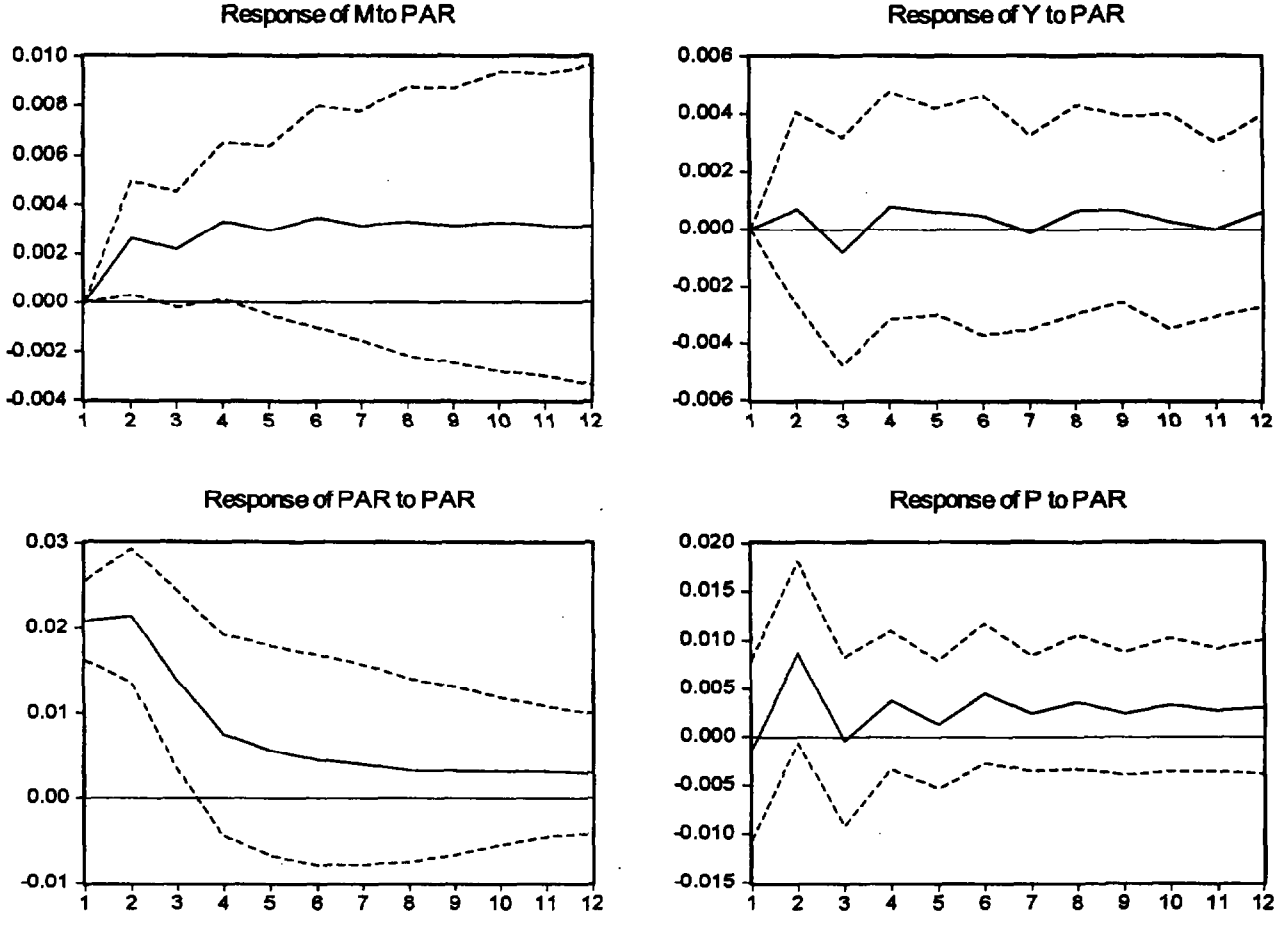


Figure 4. Islamic Republic of Iran:
Responses of One S.D. Innovations (with s.e.=+-2)

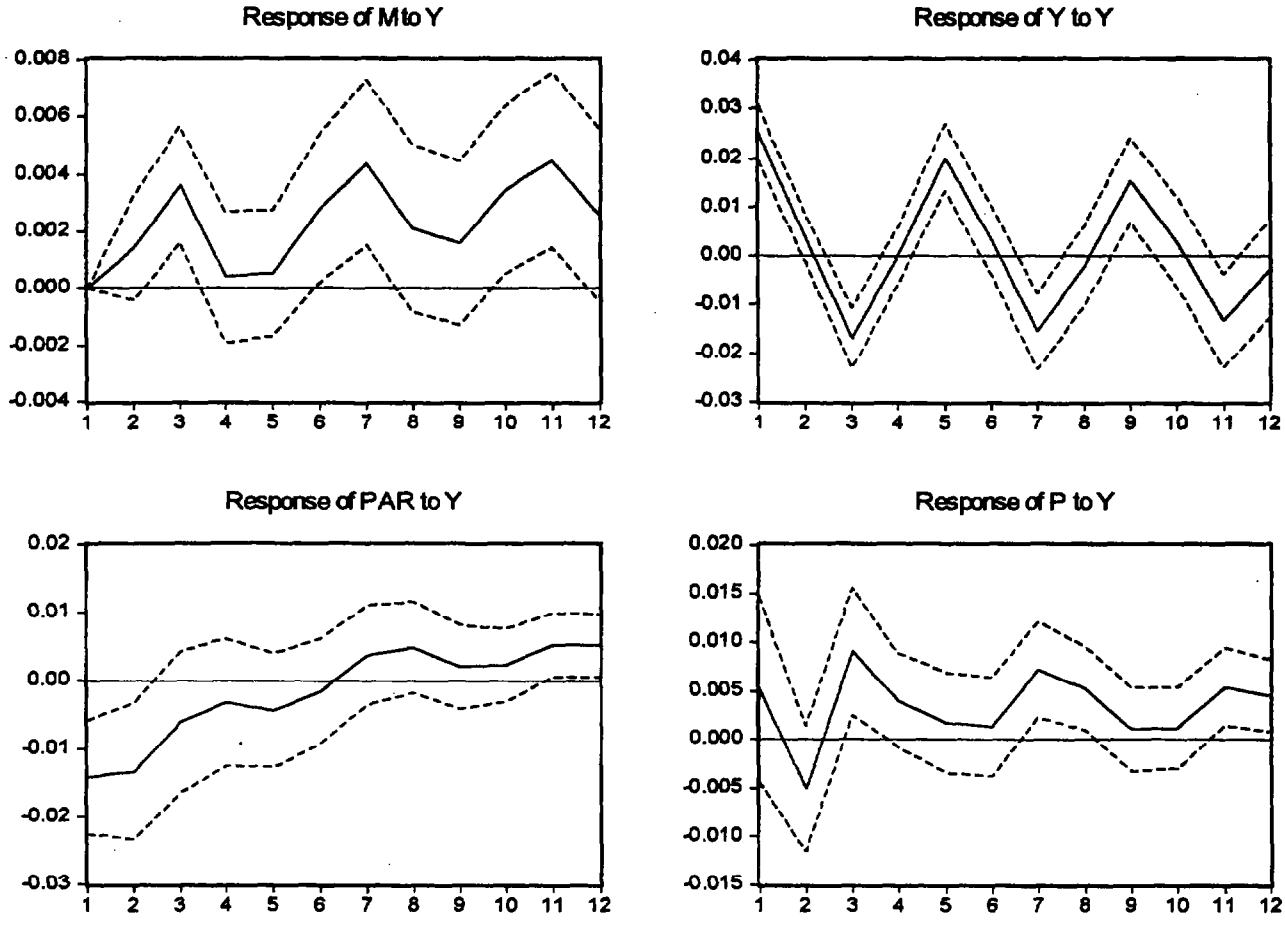


Table 2. Islamic Republic of Iran: Unit Root Tests

Variable	Lag	Level Test Statistics	Lag	First Difference Test Statistics
M/P	3	-0.95	2	-10.96
*M**	4	-0.3	3	-2.08
Y	4	-3	2	-21.83
Par	4	0.35	2	-3.27
P	3	-0.57	2	-11.1
Prem	4	-2.2	2	-4.55
Rsfx	1	-0.37	1	-6.15
Rd	1	-0.53	1	-7.07

Notes: Variables are as described in the text as well as in Appendix I. The unit root test contains a constant and a time trend, where it is significant. The tests statistics are compared with relevant Mackinon critical values. With the exception, of change in the results obtained are not sensitive to the choice of the lag length.

* The first difference of M is only stationary with the use of second lag. There is evidence that M can be approximated as an I(2) variable. In the current context, it is modeled as an I(1) variable.

Table 3. Islamic Republic of Iran: Cointegrating Vector for the Money Market: (M/P, Y, Par) 1/

Null	Alternative	Maximum Eigenvalue	95 percent Critical Value	Alternative	Trace	95 percent Critical Value
r=0	r=1	29.62	17.68	r>=1	44.71	24.05
r<=1	r=2	14.69	11.03	r>=2	15.09	12.36
r<=2	r=3	0.404	4.16	r>=3	0.404	4.16

Choice of the Number of Cointegrating Relations Using Model Selection Criteria

Null	AIC	SBC	HQC
r=0	164.45	164.45	164.45
r=1	174.27	170.1	172.77
r=2	178.6	171.95	176.22
r=3	177.81	170.32	175.12

1/ The use of Maximum eigenvalue and Trace tests as well as the information criteria point to the existence of two cointegrating vectors. Further tests and economic theory informed the choice of the long run money demand function presented in the section for empirical results.

Table 4. Islamic Republic of Iran: Cointegrating Vector for the Foreign Exchange Market (Par, Fxsp, Rd and P)*

Null	Alternative	Maximum Eigenvalue	95 percent Critical Value	Alternative	Trace	95 percent Critical Value
r=0	r=1	27.8	23.92	r>=1	54.65	39.81
r<=1	r=2	19.13	17.68	r>=2	26.85	24.05
r<=2	r=3	6.92	11.03	r>=3	7.72	12.36
r<=3	r=4	0.8	4.16	r>=4	0.8	4.16

Choice of the Number of Cointegrating Relations Using Model Selection Criteria

Null	AIC	SBC	HQC
r=0	197.25	197.25	197.25
r=1	204.15	198.33	202.06
r=2	208.72	198.74	205.14
r=3	209.18	196.7	204.7
r=4	208.58	195.27	203.8

1/ The use of Maximum eigenvalue and Trace tests as well as the information criteria point to the existence of two cointegrating vectors. Further tests and economic theory informed the choice of the long-run money demand function presented in the section for empirical results.

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