Deficits, Debt Financing, Monetary Policy and Inflation in Developing Countries: Internal or External Factors? Evidence from Iran

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Abstract:

This paper focuses on internal and external factors, which influence the inflation rate in developing countries. A monetary model of inflation rate, capable of incorporating both monetary and fiscal policies as well as other internal and external factors, was developed and tested on Iranian data. It was found that, over the long run, a higher exchange rate leads to a higher price and that the fiscal policy is very effective to fight inflation. The major factors affecting inflation in Iran, over the long run, are internal rather than external. However, over the short run, the sources of inflation are both external and internal.

Keywords: Demand for money, inflation, fiscal and monetary policies, external and internal factors

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I. Introduction

The determinants of inflation rate in developing countries are extremely important for policy makers as when the causes of inflation are correctly specified the appropriate policy change can be easily diagnosed and effectively implemented. Inflation in a small-open economy can be influenced by both internal and external factors. Internal factors include, among others, government deficits, debt financing, monetary policy, institutional economics (shirking, opportunism, economic freedom, risk, etc.) and structural regime changes (revolution, political regime changes, policy constraints, etc.). External factors include terms of trade and foreign interest rate as well as the attitude of the rest of the world (sanctions, risk generating activities, wars, etc.) toward the country. The objective of this paper is to develop and test a model of inflation rate, which takes into account all of these factors. To the best knowledge of the author, no such study for developing or developed countries exists. The model is tested on Iranian data. The choice of Iran is based on the fact that it has witnessed several changes in policy regimes and undergone numerous exogenous shocks during the past two decades. This makes Iran an ideal case to test whether external or internal shocks or a combination of these shocks cause inflation.

The channels through which government deficits and debt financing influence inflation include the formation of capital (crowding out effect), the monetization of debt and the wealth effect of debt. Institutional economics by reducing information costs can also reduce the inflation rate in a country. Furthermore, the change on terms of trade and foreign interest rates can influence the inflation rate in a country for which the economy is heavily dependent on imports and foreign financing of its debt. This is particularly important for developing/emerging countries.

The model used in this study is an augmented version of the monetarist model which, contrary to the existing literature, is designed in such a way to incorporate both external and internal factors, which cause inflation in the country**.** Furthermore, since the model also incorporates government deficits and debt we can test Sargent and Wallace's (1986) views that (i) the tighter is the current monetary policy, the higher must the inflation rate be eventually and (ii) that government deficits and debt will be eventually monetized over the long run.

The contribution of this paper to the literature is as follows. The model developed in this paper is unique in the sense that it is capable of taking into consideration both monetary and fiscal policies as well as debt management. Furthermore, the model allows external and institutional shocks to affect the inflation rate in the country. It was found that the model is successful in capturing the impact of both anticipated and unanticipated effects of fiscal instruments, i.e., deficits, debt and debt management, and of monetary instruments on the inflation rate in an emerging country like Iran. Moreover, a policy toward a stronger currency is deflationary and most sources of inflation in Iran are domestic factors. Finally, it was found that Sargent and Wallace's view on a tight monetary policy leading to higher inflation over the long run does not necessarily apply to a country like Iran, which, at least officially, banned predetermined interest rates.

Section II gives a brief background and is followed by a section on the development of the theoretical model. Section IV describes the data and the long-run empirical methodology and results. Section V is devoted to the short-run dynamic model for the country. Section VI evaluates the impact of unanticipated domestic factors on the inflation rate. The final section provides some concluding remarks.

II. Background

The impact of government deficits and debt financing on inflation rate can be thought of through different channels. Higher government deficits result in higher interest rates, which then leads to lower domestic investment. This crowding-out effect of deficits will eventually translate into a lower formation of capital and lead to a lower aggregate supply and a higher price. However, the impact of deficit on interest rates is still debatable. For example, Bradley (1986) lists twenty-one studies on the deficit-interest rate link and finds that only four provided supporting evidence for a positive and statistically significant impact of the deficit on interest rates. The rest of the studies finds either no evidence of a significant impact or produces mixed results, including the absence of any linkage. The literature on the deficit-interest rate link for a small-open economy under capital mobility is limited to theoretical studies. Empirical studies pertain to either large open, or closed economy models, see Evans (1985), Giannaros *et al.* (1985), Tanzi (1985), Cebula (1985), Hoelscher (1986) and Bradley (1986).

The second channel in which deficits and debt financing can affect the inflation rate is through the monetization of the deficit/debt. Monetary authorities must then act to ensure that the government's intertemporal budget is balanced, i.e., a situation of fiscal dominance. With fiscal dominance, an increase in government debt will eventually require an increase in seigniorage. King and Plosser (1985) and Grier and Neiman (1987), e.g., found mixed evidence for fiscal dominance in the United States; however, Ashra *et al.* (2004) find no systematic relationship between money and fiscal deficits in India. It is also believed that the uncertainty as to the time the deficits are financed can influence the rate of inflation. For example, Dornbush *et al.* (1990) and Drazen and Helpman (1990) find such an uncertainty creates fluctuation in the inflation rate.

The third channel is the wealth effect of deficits/debt financing. When deficits and debts are financed by issuing bonds and bondholders do not consider bonds as future taxes (a non-Ricardian view), the wealth of the nation is perceived to have gone up. A higher wealth effect increases the demand for goods and services and drives prices up. However, Tekin-Koru and Ozmen (2003) find no support for the linkage between the budget deficit and inflation through the wealth effect in Turkey. Instead, they found that deficit financing leads to a higher growth of interest-bearing broad money, but not currency seigniorage.

Institutional economics reduces information costs, encourages capital formation and capital mobility, allows risks to be priced and shared and facilitates cooperation. These institutions improve aggregate economic performance, see North and Thomas (1973), North (1990), Drobak and Nye (1997), Levine (1997) and Klein and Luu (2003). Such improvements should lead to a lower inflation rate.

External factors include terms of trade and foreign interest rate besides, among others, sanctions and wars. The countries, especially developing countries, for which the economy depends heavily on the import of capital, are subject to higher prices through the supply effect (cost-push inflation), as the price of imported capital goods goes up. For example, Senhadji (2003) argues that a stylized developing economy relies heavily on imports for the capital formation and since it faces an upward-sloping supply function of foreign loans, its debt accumulation increases with the size of debt and the cost of servicing the debt. If an unfavorable change in the terms of trade increases the cost of the imported capital, then the formation of capital will suffer. This in turn suppresses the aggregate supply and causes inflation. The same result can be obtained with a hike in foreign interest rates, as such hikes make the financing of the imported capital (foreign loans) more expensive. An unfavorable change in the terms of trade can result in an imported inflation. Bahmani-Oskooee (1995), e.g., finds the world price has a positive impact over the long run on the consumer price in Iran and Arize *et al.* (2004) find inflation in 82 countries responds positively to the volatility of real and nominal exchange rates. Finally, sanctions, wars, etc. clearly generate, through the supply effect, a higher inflation. For example, Berument and Kilinc (2004) find shocks in the industrial production of Germany, the United States and the rest of the world will affect positively the inflation rate in Turkey. To the best knowledge of the author, there is no study so far in the literature that investigates the impact of all the above-mentioned factors on the inflation rate for developing or developed countries.

III. The Model

Many studies on inflation rate for both developed and developing countries used different versions of the monetarist approach. For example, for developed countries, see, McGuire (1976), Meltzer (1977) and Korteweg and Meltzer (1978). For developing countries, see, e.g., Harberger (1963), Bomberger and Makinen (1979), Sheehey (1979), Nugent and Glezakos (1979), Saini (1982), Ize and Salas (1985), McNelis (1987), Darrat and Arize (1990), Bahmani-Oskooee and Malixi (1992), Bahmani-Oskooee (1995) and Ashra *et al.* (2004).

The monetarist approach to inflation determination is based on the quantity equation, which relates the current rates of change of aggregate expenditure, m + v, to the nominal value of current income, π + y, where m, v, π and y are the growth rate of nominal money supply, velocity of money, price and real income, respectively. In this approach, the inflation rate is related to the growth rate of money in excess of the growth rate of income. Along a steady growth path, the fully anticipated rate of price change remains constant. Departures from long-run equilibrium give rise to an excess demand for, or supply of, money and goods. Another approach is based on the equilibrium in the money market where the demand for money is derived from individual optimization and the supply of money is exogenous. Then again, departures from long-run equilibrium give rise to an excess demand for, or supply of, money and goods. Prices should adjust so that the markets will be cleared again. To avoid an ad-hoc determination the latter approach will be followed in this paper.

Consider an economy with a single consumer, representing a large number of identical consumers. The consumer maximizes the following utility function:

$$E\left\{\sum_{t=0}^{\infty}\beta^{t}U(c_t, c^*_t, g_t, k_t m_t, m^*_t)\right\}, \qquad (1)$$

where c_t and c^*_t are single, non-storable, real domestic and foreign consumption goods, respectively. m_t and m^*_t are the holdings of domestic real (M/p) and foreign real (M*/p*) cash balances, respectively. E is the expectation operator, and the discount factor satisfies $0<\beta<1$. g is the real government expenditure on goods and services and it is assumed to be a “good”. In the specification of the utility function (1), for the sake of simplicity, following Cox (1983), Drazen and Helpman (1990), Hueng (1999) among many others, we assume that the total output is exogenously given. In other words, we assume labor is supplied inelastically. Note that none of the results will be affected if we relax this assumption.

Including government expenditure in preferences is based on the assumption that individuals benefit from government services in their consumption, say, clean and safe roads, foods which have been inspected, etc. provide a higher utility to consumers. Alternatively, following the literature, we can consider g as public demand for public goods. In fact, allowing consumer preferences to depend on government spending is not new in the literature, see, e.g., Barro (1981), Aschauer (1985), Christiano and Eichenbaum (1992), Baxter and King (1993), Karras (1994), Ahmed and Yoo (1995), Ambler and Cardia (1997), Amano and Wirjanto (1997, 1998), and Cardia, *et al.* (2003). Following Sidrauski (1967), it is assumed services of money enter the utility function. Furthermore, following Stockman (1980), Lucas (1982), Guidotti (1993) and Hueng (1999), it is assumed that purchases of domestic and foreign goods are made with domestic and foreign currencies, respectively, and, therefore, the services of both domestic and foreign currencies enter the utility function. Again following Sidrauski (1967), we chose the units in such a way that the services of domestic money S[=m] and the services of foreign money S*[=m*]. Note that one can simply show that none of the results given in this paper will change if instead of Sidrauski’s services of money in the utility function we assume a shopping time or cash-in-advance model.

Following Kim (2000), variable k_t, which summarizes risk associated to holding domestic money is also included. However, in contrast with Kim, we assume variable k is a function of anticipated fiscal variables over the long run and policy and political regime changes over the short run. Specifically, we postulate that over the long run:

$$\log (k_t) = k_0 \text{ defgdp}_t + k_1 \text{ debtgdp}_t + k_2 \text{ fdgdp}_t. \qquad (2)$$

Equation (2) is held subject to a short-run dynamic system, which is a function of a set of predetermined short-run (stationary) variables known to individuals. These variables include the growth of money supply, changes in fiscal variables per GDP, the growth in exchange rate, domestic and foreign inflation as well as changes in interest rates. Furthermore, it is assumed that the short-run dynamics of the risk variable [log (k)] includes a set of interventional dummies which account for wars, sanctions, political changes, innovations as well as policy regime changes which influence services of money.

Variables defgdp, debtgdp and fdgdp are real government deficits per GDP, the government debt outstanding per GDP and the government foreign-financed debt per GDP, respectively. We assume government debt pays the same interest rate as deposits at the bank (i.e., R). In a risky environment agents substitute real or interest-bearing assets for money. For example, as the government deficit per GDP increases agents perceive higher future taxes or money supply (inflation). At the same time, the higher is the outstanding government debt relative to the size of the economy, the riskier the environment will be perceived. Individuals may hold these bonds to bridge the gap between the future labor income and expenditures, including tax expenditures. Consequently, we hypothesize constant coefficients $k_0>0$ and $k_1>0$. Furthermore, an increase in the amount of government debt held by foreign investors/governments may be considered a cause for future devaluation of the domestic currency. Consequently, demand for domestic money may fall, implying $k_2>0$.

The utility function is assumed to be increasing in all its arguments, except variable k that is decreasing, and is strictly concave and continuously differentiable. The demand for monetary services S[=m] and S*[=m*], following Sidrauski (1967), will always be positive if we assume $\lim_{s\to 0} U_s(c, c^*, g, k\, m, m^*) = \infty$ and $\lim_{s^*\to 0} U_s(c, c^*, g, k\, m, m^*) = \infty$, for all c and c*, where, e.g., $U_s = \partial U(c, c^*, g, k\, m, m^*)/\partial s$. Assume also that the U.S. dollar represents foreign currency. Given g, defgdp, debtgdp and fdgdp, the consumer maximizes (1) subject to the following budget constraint:

$$\tau_t + y_t + (1 + \pi_t)^{-1} m_{t-1} + q_t (1 + \pi^*_t)^{-1} m^*_{t-1} + (1 + \pi_t)^{-1} (1 + R_{t-1})\, d_{t-1} +$$

$$q_t (1 + \pi^*_t)^{-1} (1 + R^*_{t-1})\, d^*_{t-1} = c_t + q_t c_t^* + m_t + q_t m_t^* + d_t + q_t d_t^*, \qquad (3)$$

where τ_t is the real value of any lump-sum transfers/taxes received/paid by consumers, q_t is the real exchange rate, defined as $E_t p_t^*/p_t$, E_t is the nominal market (non-official/black-market rate in some developing countries) exchange rate (domestic price of foreign currency), p_t^* and p_t are the foreign and domestic price levels of foreign and domestic goods, respectively, y_t is the current real endowment (income) received by the individual, m^*_{t-1} is the foreign real money holdings at the start of the period, d_t is the one-period real domestically financed government debt which pays R rate of return and d_t^* is the real foreign issued one-period bond which pays a risk-free interest rate R_t^*. Assume further that d_t and d_t^* are the only two storable financial assets.

Define $U_c = \partial U(c, c^*, g, k\, m, m^*)/\partial c$, $U_{c^*} = \partial U(c, c^*, g, k\, m, m^*)/\partial c^*$, $U_m = \partial U(c, c^*, g, k\, m, m^*)/\partial m$, $U_{m^*} = \partial U(c, c^*, g, k\, m, m^*)/\partial m^*$ and λ_t = the marginal utility of wealth at time t. Maximizing the preferences with respect to m, c, m*, c*, d and d*, and subject to budget constraint (3) for the given output and fiscal variables, will yield the first-order conditions:

$$U_{ct} + \lambda_t = 0 \tag{4}$$

$$U_{c^*t} + \lambda_t q_t = 0 \tag{5}$$

$$U_{mt} + \lambda_t - \beta\lambda^e_{t+1} (1 + \pi^e_{t+1})^{-1} = 0 \tag{6}$$

$$U_{m^*t} + \lambda_t q_t - \beta\lambda^e_{t+1}q^e_{t+1} (1 + \pi^{*e}_{t+1})^{-1} = 0 \tag{7}$$

$$\lambda_t - \beta\lambda^e_{t+1} (1 + R_t) (1 + \pi^e_{t+1})^{-1} = 0 \tag{8}$$

$$\lambda_t q_t - \beta\lambda^e_{t+1} q^e_{t+1} (1 + R^*_t) (1 + \pi^{*e}_{t+1})^{-1} = 0. \tag{9}$$

Note that $x^e_{t+1} = E\ (x_{t+1} \mid I_t)$ is the conditional expectations of $x_{t+1,}$ given current information I_t. From (4) and (5) we can write:

$$U_{ct}/U_{c^*t} = 1/q_t. \tag{10}$$

Equation (10) indicates that the marginal rate of substitution between domestic and foreign goods is equal to their relative price. Solving (5), (7) and (9) yields:

$$U_{c^*t} (1 + R^*_t)^{-1} + U_{m^*t} = U_{c^*t.} \tag{11}$$

Equation (11) implies that the expected marginal benefit of adding to foreign currency holdings at time t must equal the marginal utility from consuming foreign goods at time t. Note that the holdings of foreign currency directly yield utility through its services (U_{m^*t}). Furthermore, from (9) and (5) we have $-U_{c^*t} = \beta\lambda^e_{t+1} q^e_{t+1} (1 + R^*_t) (1 + \pi^{*e}_{t+1})^{-1}$ which implies that the expected real foreign currency invested in foreign bonds has a forgone value of $-U_{c^*t}$. Consequently, the total marginal benefit of holding money at time t is $U_{c^*t} + U_{m^*t}$.

Similarly, from (4), (6) and (8), we have:

$$U_{ct}\,(1 + r_t)^{-1} + U_{mt} = U_{ct}. \tag{12}$$

Equation (12) implies that the expected marginal benefit from adding to domestic currency holdings at time t must equal the marginal utility of consuming domestic goods at time t.

To construct a parametric demand for real balances, assume the utility has an instantaneous function as:

$$U(c_t, c_t^*, g_t, k_t m_t, m_t^*) = (1-\alpha)^{-1}\,(c_t^{\alpha 1}\, c^{*\,\alpha 2}_t\, g_t^{\alpha 3})^{1-\alpha}$$

$$+\ \xi\,(1-\eta)^{-1}[(m_t/k_t)^{\eta 1}\, m^{*\,\eta 2}_t]^{1-\eta}, \tag{13}$$

where α_1, α_2, α_3, α, η_1, η_2, η and ξ are positive parameters and $0.5<\alpha<1$, $0.5<\eta<1$ and $\eta_1<\eta(1-\eta)^{-1}$.[1] The latter assumption ($0.5<\alpha<1$, $0.5<\eta<1$ and $\eta_1<\eta(1-\eta)^{-1}$) is needed to ensure a standard demand for money. Since none of the following results is sensitive to the magnitude of α_1, α_2, α_3, η_1 and η_2 for the sake of simplicity we assume these parameters are all equal to one.

A few words on the parametric function (13) are worth mentioning. This utility is in the general class of utility functions used by Fischer (1979). However, here the utility function includes the consumption of public and foreign goods as well as the holding of foreign real balances. Furthermore, it allows individuals to get satisfaction from the consumption of domestic and foreign goods as well as public goods even in the absence of money, but with money the satisfaction will obviously increase.

Using (10) and (13) we have:

$$c_t^* = c_t\, q_t^{-1}. \tag{14}$$

[1] Note that if we relax the assumption that labor is supplied inelastically (income is exogenous) then we need to add an extra term, say, $-(1-\eta_3)^{-1}(N_t)^{1-\eta_3}$, to (13), where N is hours worked and $\eta_3 \geq 0$ represents Frisch labor supply elasticity. In such a case, one can easily verify that none of our results will be different.

Using (11), (13) and (14) we have:

$$m^*_t = (R^*_t/1+ R^*_t)^{-1/\eta} (c_t^{1-2\alpha} g_t^{1-\alpha} q_t^{\alpha})^{-1/\eta} (\xi^{1/\eta} k_t^{-1} m_t^{(1-\eta)/\eta}) \qquad (15)$$

Using (12), (13), (14) and (15), and assuming the domestic real consumption (c_t) is some constant proportion (ω) of the domestic real income (y_t), where for simplicity we assume ω=1, we will have:

$$m_t^{1-(1-\eta/\eta)(1-\eta/\eta)} = (i_t)^{-1/\eta} y_t^{[(2\alpha-1)/\eta]+[(2\alpha-1)(1-\eta)/\eta\eta]} g_t^{[(\alpha+1)/\eta]+(\alpha-1)(1-\eta)/\eta\eta}$$

$$(q_t)^{-[\alpha(1-\eta)/\eta\eta]-[(\alpha-1)/\eta]} (\xi k_t^{-\eta})^{(1/\eta)+(1-\eta/\eta\eta)} (i^*)^{\eta-1/\eta\eta}, \text{ or}$$

$$\log(m_t) = m_0 + m_1 i_t + m_2 \log(y_t) + m_3 \log(g_t) + m_4 \log(k_t) + m_5 \log(q_t)$$

$$+ m_6 i^*_t. \qquad (16)$$

Where, $i^*_t = \log(R^*_t/1+ R^*_t)$, $i_t = \log(R_t/1+ R_t)$ and,

$m_0 = -1/(1-2\eta) \log(\xi)>0$, $m_1 = -\eta/(2\eta-1)<0$, $m_2 = (1-2\alpha)/(1-2\eta)>0$,

$m_3 = (1-\alpha)/(1-2\eta)< 0$, $m_4 = -(1-\eta)/(2\eta - 1) <0$, $m_5 = (\alpha-\eta)/(1-2\eta)=?$,

$m_6 = (1-\eta)/(1-2\eta)< 0$.

Equilibrium in the money market requires $\frac{Ms_t}{p_t} = \frac{Md_t}{p_t} = m_t$, where Ms_t and Md_t are nominal money supply (M1) and money demand, respectively. This implies that

$$\log(p_t) = \log(Ms_t) - \log(m_t). \qquad (17)$$

Substitute $\log(q_t)$ [$=\log(E_t) + \log(p_t^*) - \log(p_t)$] and (2) in (16) and the resulting equation in (17) to get:

$$lp_t = \beta_0 + \beta_1 lMs_t + \beta_2 i_t + \beta_3 ly_t + \beta_4 lE_t + \beta_5 i^*_t + \beta_6 lp^*_t + \beta_7 lg_t + \beta_8 defgdp_t$$

$$+ \beta_9 debtgdp_t + \beta_{10} fdgdp_t + \beta_{11} trend + u_t, \qquad (18)$$

where an l before a variable means the logarithm of that variable and u is a disturbance term assumed to be white noise with zero mean. βs are the parameters to be estimated and are defined as:

$\beta_0 = -m_0/m_7$, where $m_7 = 1 - m_5 = (1 - \alpha - \eta)/(1 - 2\eta) > 0$,

$\beta_1 = m_7^{-1} > 0$, $\beta_2 = - m_1/m_7 > 0$, $\beta_3 = - m_2/m_7 < 0$, $\beta_4 = - m_5/m_7 = ?$, $\beta_5 = - m_6/m_7 > 0$,

$\beta_6 = -m_5/m_7 = ?$, $\beta_7 = - m_3/m_7 > 0$, $\beta_8 = - m_4/m_7\, k_0 > 0$, $\beta_9 = - m_4/m_7\, k_1 > 0$,

$\beta_{10} = - m_4/m_7\, k_2 > 0$.

To capture technological changes we also added a linear trend to the equation. Equation (18) is a long-run relationship between the inflation rate and its determinants. Note that according to this model $\beta_4 = \beta_6$. However, we will not put this restriction in our estimation so that we can distinguish between imported inflation which is purely exogenous to the country and exchange rate which is a policy variable, but we added the error term u_t which is assumed to be white noise.

According to the model, a higher money supply and a higher interest rate (tight monetary policy) increase the price level over the long run. This confirms the theoretical model of Sargent and Wallace's (1986, p. 160) view that "[…] given the time path of fiscal policy and given that government interest-bearing debt can be sold only at a real interest rate exceeding the growth rate n, the tighter is current monetary policy, the higher must the inflation rate be eventually." A higher real income results in a higher real demand for money and a lower price level. We cannot determine theoretically the impact of the exchange rate and the foreign price level on the domestic price level. A higher government spending results in a higher price level. The impact of deficit, outstanding government debt and debt financed externally, for a given output level, on the price level according to our model is positive. Consequently, these fiscal variables, according to our theoretical model are inflationary. Note that since real government expenditure is considered a "good", in fact, a public good, its level influences the price, while deficits and debt are measures for future taxes and inflation and so their proportions to GDP may influence the price level.

IV. Data, Long-Run Empirical Methodology and Results

The model is tested for Iran for the period 1970Q1-2002Q4. All observations are quarterly, not seasonally adjusted and the sample period is chosen according to the availability of the data. The sources of data, unless specified, are the *International Financial Statistics* (IFS) online. Some of the variables were available on an annual basis and, therefore, quarterly observations were interpolated, using the statistical process developed by RATS. This procedure keeps the final value fixed within each full period. Data on outstanding debt (Debt) were not available and therefore were constructed according to the following formulas:

$Debt_t = Debt_{t-1}[1 + R_{t-1}$(=interest rate on debt)] + gc_t (=government spending on goods and services and transfer payments) - T_t(=government tax revenues) - ΔMB_t (=change in monetary base) = $Debt_{t-1}$ + $deficits_t$ (=$R_{t-1}\ Debt_{t-1} + gc_t - T_t$) - ΔMB_t.

It was assumed that $Debt_0$ (debt at the first observation) is zero. Some missing data were taken from the *Word Development Indicator* (WDI). When some observations within a series were missing they were interpolated. Data series on GDP, government deficits and expenditures as well as debt financed externally are only available yearly. Quarterly observations were, consequently, interpolated using the statistical process developed by RATS. This procedure keeps the final value fixed within each full period.

Information on institutional and policy changes was taken from various Central Bank publications, including *Economic Trends*, as well as from Kia (2003). lp is the logarithm of Consumer Price Index (CPI) and lMs is the logarithm of nominal M1. Because of the abolition of fixed-predetermined interest rates in Iran, the domestic interest rate is irrelevant. On March 21, 1984, the Iranian government started implementing tight restrictions on the payment of fixed interest rate on most financial transactions in the country. In the case of private banks and non-bank credit institutions, the Central Bank of Iran (CBI) banned all fixed rates of interest on the asset and liability sides of these institutions, requiring them to bear market-based profit rates. However, for government-owned banks, CBI imposed a minimum "profit" rate for bank depositors to ensure the attractiveness of such deposits. Various reports of CBI suggest that the minimum rates from 1984 until 2001 were as follows: short-term 8%; special short-term 10%; one-year 14%; two-year 15%; three-year 16% and five-year 18.5%. However, since May 2001, these minimum rates have been reduced to the following: short-term 7%, one-year 13% and five-year 17%. With an annual inflation rate running at about 35%, the apparent reason for these minimum profit rates is to compensate deposit holders for the erosion in the value of financial obligations resulting from such high inflation rates. Since these rates are constant during the sample period it is plausible to assume the coefficient β_2 in Equation (18) is zero.

Variable y is the real GDP, which is the nominal GDP divided by CPI. Variable g is the real (nominal deflated by CPI) government expenditures on goods and services, E is the nominal market exchange rate (the black market rate for part of the sample period, see the description of dummy variables in Section IV), which is equal to the domestic currency in terms of \$US for all three countries. Foreign rate i* is the logarithm of (R*/1+R*), where R* is the LIBOR (3-month London interbank) rate at the annual rate, in decimal points. Note that in Iran the rate on foreign deposits in the domestic banking system is LIBOR, see Kia (2003). Following Bahmani-Oskooee (1995), among others, the industrial countries unit value export price index was used as a measure for the foreign price p*. Variables defgdp, debtgdp and fdgdp are deficits, outstanding debt and foreign debt per GDP, respectively.

To investigate the stationarity property of the variables, I used Augmented Dickey-Fuller and non-parametric Phillips-Perron tests. Furthermore, to allow for the possibility of a break in intercept and slope, I also used tests developed by Perron (1997) and Zivot and Andrews (1992). According to the test results, all variables, except debt per GDP, are integrated of degree one (non-stationary). They are, however, first-difference stationary. The variable debt per GDP is stationary according to Perron (1997), but has a unit root according to all other tests. We accept the result of Perron's test as it allows for breaks in both intercept and slope. In fact, rational agents do not hold the debt of a government if it is not stationary. Therefore, Perron’s test result reflects more accurately the reality. For the sake of brevity, these results are not reported, but are available upon request.

We analyze a p-dimensional vector autoregressive model with Gaussian errors of the form:

$$X_t = A_1 X_{t-1} + \ldots + A_k X_{t-k} + \mu + \phi\, DUM_t + u_t,\ u_t \sim niid(0, \Sigma), \tag{19}$$

where $X_t = [lp_t, lMs_t, i_t, ly_t, lE_t, lg_t, defgdp_t, debtgdp_t, fdgdp_t]$, μ is $p\times 1$ constant vector representing a linear trend in the system.

The p-dimensional Gaussian X_t is modeled conditionally on long-run exogenous variables i^*_t, lp^*_t and the short-run set of $DUM_t = (Q1_t, \ldots, Q4_t$, intervention dummies and other regressors that we can consider fixed and non-stochastic), where Q's are centered quarterly seasonal dummy variables. The interventional dummies include variables which account for wars, sanctions, political changes, innovations as well as policy regime changes which influence services of money. Note that DUM appears only in the short-run dynamics of the system. Parameters $A_1,\ldots, A_k$, ϕ, and Σ are assumed to vary without restriction. The error correction form of the model is

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + \phi\, DUM_t + u_t, \qquad (20)$$

where Δ is the first difference notation, the first k data points $X_{t-1},\ldots, X_0$ are considered fixed and the likelihood function is calculated for given values of these data points. Parameters $\Gamma_1,\ldots,\Gamma_{k-1}$ and Π are also assumed to vary without restriction. However, the hypotheses of interest are formulated as restriction on Π.

Note that the set of dummy variables that constitutes the set of DUM affects only the short-run dynamic of the system. Except Q's these dummy variables vary for each country. They account for institutional and policy regime changes, which could affect inflation rate in the country, see the next section for a complete description of these dummy variables.

In determining a long-run relation between the domestic price level and its determinants, conditional on the foreign price level and the interest rate, we need to test whether the domestic price level contributes to the cointegrating relation. If Π has a reduced rank we want to test whether some combinations of X_t have stationary distributions for a suitable choice of initial distribution, while others are non-stationary. Consequently, we need to find the rank of Π, i.e., r.

In determining the lag length one should verify if the lag length is sufficient to get white noise residuals. As it was recommended by Hansen and Juselius (1995, p. 26), set p=r in Equation (19) and test for autocorrelation. LM(1) and LM(4) will be employed to confirm the choice of lag length. The order of cointegration (r) will be determined by using Trace and λ_{max} tests developed in Johansen and Juselius (1991). Following Cheung and Lai (1993), both tests were adjusted in order to correct a potential bias possibly generated by a small sample error. Table 1 reports the result of λ_{max} and Trace tests as well as the identified long-run relationships in space.

According to diagnostic tests reported in this table, the lag length 4 was sufficient to ensure that errors are not autocorrelated. According to the normality test result (not reported, but available upon request), the errors are not normally distributed. However, as it was mentioned by Johansen (1995a), a departure from normality is not very serious in cointegration tests, see also, e.g., Hendry and Mizon (1998). Both λ_{max} and Trace test results reported in Table 1 reject $r \leq 3$ at 5% level while we cannot reject $r \leq 4$, implying that r=4.[2]

Table 1 about here

Since we found more than one cointegrating relationship we need to identify the estimated cointegrating vectors. Namely, in order for the estimated coefficients of cointegrating equations to be, in fact, economically meaningful, identifying restrictions must be imposed to ensure the uniqueness of both β and α. In this case, we need three identifying conditions to be satisfied in order for the uniqueness of coefficients to be ensured. Furthermore, the normalization of a variable, when there is more than one cointegrating rank, makes the resulting equation interpretable and meaningful if these conditions are satisfied. These conditions include generic identification, empirical identification and economic identification. As explained by Johansen and Juselius (1994) the generic identification is related to the linear statistical model and requires the rank condition, which is given by their Theorem 1, to be satisfied. The empirical condition is related to estimated parameters values and finally, the economic identification is related to the economic interpretability of the estimated coefficients of an empirically identified structure.

Following, e.g., Johansen and Juselius (1994 and 1991) and Johansen (1995b), we can test for the existence of possible economic hypotheses among the cointegrating vectors in the system. The bottom panel of Table 1 reports the identified relationships. As the Chi-squared in the table indicates, restrictions are jointly accepted, the system is identified and according to Theorem 1 of Johansen and Juselius (1994) and Theorem 3 of Johansen (1995b), the rank condition is satisfied. For the sake of brevity, the rank conditions are not reported, but are available upon request.

Figure 1 plots the calculated values of the recursive test statistics for the long-run identified relationships. Note that these statistics are recursive likelihood-ratios normalized by the 5% critical value. Thus, calculated statistics that exceed unity imply the rejection of the null hypothesis and suggest unstable cointegrating vectors. The broken line curve (BETA_Z) plots the actual disequilibrium as a function of all short-run

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[2] Since unrestricted cointegrated equations, when r is more than one, are meaningless they were not

dynamics including seasonal dummy variables, while the solid line curve (BETA_R) plots the "clean" disequilibrium that corrects for short-run effects. We hold up the first fifteen years for the initial estimation. As Figure 1 shows, all these identified equations appear stable over the long run when the models are corrected for short-run effects. Having established that the long-run equations are stable, we will analyze the identified long-run equations.

Figure 1 about here

(A) Long-Run Price Determination

The first row of the bottom panel in Table 1 reports the identified long-run price determination.

(i) Monetary policy: According to our theoretical model, Equation (18), we would expect both the level of money supply and interest rate to have a positive influence on the price level over the long run. Based on our estimation result, the supply of money has a positive impact on the price level, though it is not statistically significant. This result is consistent with Bahmani-Oskooee's (1995) finding, though he uses M2.

Considering the exchange rate as a monetary instrument, a depreciation of the domestic currency leads to an increase in the price level. The positive impact of the exchange rate on the price level confirms the finding of Bahmani-Oskooee (1995). So far, we found the domestic monetary policy, including the exchange rate policy, has been a major contributor to inflation over the long run in Iran. Note that according to our model, the coefficients of the exchange rate and of the foreign price should be the same.

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reported but are available upon request.

However, when we imposed this restriction, either the rank condition was violated or the joint restriction was not accepted. Consequently, we left these coefficients unrestricted.

(ii) Fiscal policy: The long-run estimated coefficient of the log of real government expenditures is positive, as our model predicts, and statistically significant. To the best knowledge of the author, no study has dealt with the impact of the government expenditures on the price level for Iran and so comparison is not possible.

The long-run estimated coefficient of deficits per GDP is positive and statistically significant. This result confirms our theoretical model. The estimated coefficient of government debt per GDP is statistically significant, but it has a negative sign, contradicting our theoretical model. This implies that a higher government debt in Iran is not associated with a riskier environment [see Equation (2)]. The estimated coefficient of externally financed government debt per GDP is not statistically significant over the long run. However, as we will see later in this paper the situation is different over the short run. So far, we found both monetary and fiscal policies have an effective impact on inflation rate in Iran.

(iii) External factors: Foreign interest rate, contrary to what our theoretical model predicts, has a negative impact on the price level in Iran and statistically significant. One possible explanation for this result is that as foreign interest rate increases demand for foreign deposits/bonds will go up and the demand for goods and services, therefore, will fall with a depressing impact on price. The estimated long-run coefficient of foreign price is positive, but it is weakly statistically significant implying that the imported inflation exists for Iran. This result confirms Bahmani-Oskooee's (1995) finding that imported inflation is a source of inflation in Iran.

In general, so far we found domestic factors, controlled by monetary and fiscal authorities, can be very effective in curbing inflation in developing countries, at least for Iran. Finally, the impact of real GDP as expected theoretically is negative and statistically significant. This result confirms the findings of Bahmani-Oskooee (1995) for Iran.

(B) A Long-Run Demand for Money

The second row of the bottom panel in Table 1 reports a long-run demand for money. Restricting the log of the price level to one might result in an estimate of a long-run demand for real balances among our cointegrating relationships. Note that according to our model the demand for real balances should be a function of the real exchange rate. Here in the cointegration system we have nominal exchange rate and foreign price. Consequently, this restricted equation is not equivalent to the long-run demand for real balances of Equation (16). For the sake of identification, we are restricted to this equation.

The scale variable has a correct sign and is statistically significant. The coefficient of the nominal exchange rate and the foreign price is statistically significant and has a positive sign. Note that we could not determine the sign of the real exchange rate in Equation (16). Furthermore, the estimated identifying equation reported in Table 1, as explained above, is not an exact estimate of Equation (16).

The estimated coefficient of foreign interest rate is statistically significant and has a correct sign as it was predicted by the model. The estimated coefficient of the real government expenditures has a correct sign and is statistically significant. The estimated coefficient of deficits per GDP has a correct sign, but is only weakly statistically significant. The estimated coefficient of debt financed externally per GDP is not statistically significant and has a wrong sign. The estimated coefficient of debt per GDP is positive (wrong sign) and statistically significant. This result implies that for a non traditional system in Iran, the government debt is perceived as wealth in demanding money if we can really consider this long-run restricted equation a demand-for-money relationship.

(C) Long-Run Aggregate Demand and Supply

The third identified equation, third row of the bottom panel of Table 1, resembles an aggregate supply relationship. To obtain an identified system, we needed to restrict the foreign financed debt. Since the estimated coefficient of the real government expenditures is negative and is statistically significant, we can conclude that as government expenditures increase, the aggregate supply will shift to the right. Consequently, an increase in real government expenditures in Iran will raise the output over the long run. As for external factors, the estimated coefficient of foreign interest rate is negative and statistically significant implying that a higher foreign interest rate leads to higher economic activities in Iran. This may be due to the fact that as foreign interest rates go up foreign financing becomes more expensive and investors/governments rely more on domestic resources.

We also checked Sargent and Wallace's (1986) view that government deficits and debt will be eventually monetized over the long run. However, with this hypothesis, we could not get an identified system. We also checked this hypothesis as an independent long-run relationship. According to $\chi^2(2)=16.28$, p-value=0.00 the hypothesis was rejected. Consequently, Sargent and Wallace's view that government deficits and debt will be eventually monetized over the long run is rejected for Iran.

(D) Long-Run Exchange Rate Relationship

The last identified equation in Table 1 may resemble an exchange rate determination in Iran. Note that variable E is the market-determined exchange rate. The estimated coefficient of the domestic price level, as one would expect theoretically, is positive and statistically significant. The estimated coefficient of the level of the real income is statistically significant, but has a negative sign. This implies that as the income in Iran goes up the currency appreciates. For Iran crude oil is the major export, implying that, a higher income could be due to a higher oil price which by itself would help to appreciate the value of the domestic currency in terms of the U.S. dollars. Furthermore, since the United States is a net importer of crude oil the value of its currency falls as oil price rises. This result is consistent with Bahmani-Oskooee's (1996) finding if we normalize Case 2 of his Table 1 on market exchange rate.

The estimated coefficients of foreign price and interest rate are statistically significant and as one would expect theoretically, the estimated coefficient of the foreign interest rate is positive and the estimated coefficient of the foreign price is negative. Finally, the estimated coefficient of debt financed externally is statistically significant. However, it seems as the level of the foreign-financed debt in Iran increases its currency appreciates over the long run.

V. Short-Run Dynamic Model of Inflation Rate

Having established in the previous section that long-run and identified relationships to describe the price level and its determinants, we need to specify the ECM (error correction model) that is implied by our cointegrating vectors. Following Granger (1986), we should note that if small equilibrium errors can be ignored, while reacting substantially to large ones, the error correcting equation is non linear. All possible kinds of non linear specifications, i.e., squared, cubed and fourth powered of the equilibrium errors (with statistically significant coefficients) as well as the products of those significant equilibrium errors were included.

In estimating ECMs, several concerns are important. First, to avoid biased results, we allow for a lag profile of four quarters. Second, having too many coefficients can also lead to inefficient estimates. To guard against this problem and ensure parsimonious estimations, we select the final ECMs on the basis of Hendry's General-to-Specific approach. Since there are eight endogenous variables in the system, we have eight error-correction models. However, for the sake of brevity, I only report the parsimonious ECM for inflation rate. Other results are available upon request. However, the full estimation results of all these ECMs will be used to analyze the unanticipated shocks in endogenous variables using impulse response functions. Table 2 reports the parsimonious results from the estimating ECM.

In Table 2, White is White's (1980) general test for heteroskedasticity, ARCH is five-order Engle's (1982) test, Godfrey is five-order Godfrey's (1978) test, REST is Ramsey's (1969) misspecification test, Normality is Jarque-Bera's (1987) normality statistic, L_i is Hansen's (1992) stability test for the null hypothesis that the estimated ith coefficient or variance of the error term is constant and L_c is Hansen's (1992) stability test for the null hypothesis that the estimated coefficients as well as the error variance are jointly constant. None of these diagnostic checks is significant. According to Hansen's stability test result, all of the coefficients, individually or jointly, are stable. Both level and interactive combinations of the dummy variables included in the set DUM were tried for the impact of these potential shift events in the models. As it was mentioned in the previous section, DUM also appeared in the short-run dynamics of the system in our cointegration regression.

Table 2 about here

For the dummy variables included in the set of DUM which account for regime/institutional changes, we consider seven major policy regime changes that have characterized Iran [see various publications of the Central Bank of the Islamic Republic of Iran, including *Economic Trends*, and Kia, (2003)]: (i) The revolution of April 1979. (ii) The first formal U.S. sanctions against Iran ordered by President Carter in April 1980, following the break in diplomatic relations between the two countries. (iii) The Islamization of the banking system that began in March 1984. (iv) The Iraq-Iran war over the period 1980-1988. (v) The unification of official and market-determined foreign exchange rates since late March 1993. (vi) The introduction of inflation targeting by the Central Bank over the period March 1995 through March 1998, and (vii) the introduction of the first privately owned financial institution in September 1997. Accordingly, we use the following dummy variables to represent these potential policy regime shifts and exogenous shocks: Rev = 1 from 1979Q2- 2001Q4, and = 0, otherwise, san = 1 since 1980Q2 and = 0, otherwise, Zero = 1 from 1984Q1- 2001Q4, and = 0, otherwise, War = 1 from 1980Q4-1988Q3, and = 0, otherwise, Ue = 1 from 1993Q1, and = 0, otherwise, Inflation = 1 from 1995Q2-1998Q1, and = 0, otherwise, and Private = 1 from 1997Q3-2001Q4, and = 0, otherwise.

According to our estimation results reported in Table 2, the error-correction term is significant for only the error term generated from the first identified equation, see Table 1. None of the other equilibrium errors was found to be statistically significant. Furthermore, as the growth of real GDP increases the inflation rate will increase. The growth of money supply does not have any impact on the inflation rate in Iran over the short-run as none of the estimated coefficients of this variable was found to be statistically significant. The only external factor effect on the inflation rate over the short run is the foreign interest rate since, according to the estimated positive coefficient of the foreign interest rate, as it increases the inflation rate will increase. Over the long run, however, we found (Table 1) the foreign interest rate has a depressing impact on the price level in Iran.

As for the fiscal variables, the estimated coefficient of the growth of real government expenditures is statistically significant only during the increase in oil price in late 1973 and early 1974, implying that it caused the inflation rate to increase. Furthermore, the impact of the oil price increase in that period, as the estimated coefficient of dummy variable oil indicates, is an upward pressure on the inflation rate. The change in the deficits per GDP affects negatively the inflation rate after a quarter. Furthermore, as the estimated coefficient of this variable after the imposition of sanctions indicates, the change in the government deficit per GDP resulted in a further reduction in the inflation rate. According to the estimated coefficient of the debt financed externally per GDP, as this variable increases, and as our theoretical model indicates, the demand for real balances falls and the inflation rate will increase but, after two quarters, the inflation rate will fall with an overall coefficient (the sum of two coefficients) estimated to be positive. The impact of the externally financed debt after the imposition of sanctions is an upward pressure on the inflation rate.

As for institutional and other changes, the estimated coefficient of lagged inflation rate after the revolution is positive after one and three quarters indicating that the revolution resulted in a higher inflation rate in Iran. No other institutional or other change was found to have any impact on the inflation rate. During the third and fourth quarters of the year (second and third Iranian quarters), the inflation rate was found to be lower in Iran as the estimated coefficient of seasonal dummy variable Q3 and Q4 is negative. Dummy variables Nor 1973Q1, Nor 1977Q2 and Nor 1978Q4 reflect mostly oil price shocks. The estimated coefficients of these dummy variables are all positive, indicating the oil price shocks created a higher inflation rate in Iran.

To conclude, the sources of inflation in Iran are both external and internal factors. The foreign interest rate and sanctions are external factors. Fiscal policy, as an internal factor, could be the most effective tool over the short run to fight inflation in Iran. The government debt financed externally, while reducing the price level over the long run, creates more uncertainty over the short run and causes the inflation rate to increase.

VI. Unanticipated Shocks and Inflation

To analyze the impact of unanticipated shocks in domestic factors to the inflation rate, we use the estimated coefficients of all ECMs by considering the associated impulse responses. The Choleski factor is used to normalize the system so that the transformed innovation covariance matrix is diagonal. This allows us to consider experiments in which any variable is independently shocked. The conclusions are potentially sensitive to the ordering (or normalization) of the variables. As one would expect, part of a shock in the government expenditures is contemporaneously correlated to a shock in deficits, debt financing and outstanding debt which by themselves are correlated to a shock in exchange rate, GDP and price level. Consequently, let us propose the ordering of lg, defgdp, fdgdp, debtgdp, lE, lMs, ly and lcpi. By ordering the price level last, the identifying restriction is that the other variables do not respond contemporaneously to a shock to the price level. This ordering is not critical in our analysis as, to the best knowledge of the author, no particular theory or empirical evidence conflicts with the logic of the proposed ordering.

The VAR was run in the error-correction form with four lags (the lag length of the cointegration equations, see Table 1). The impulse response functions reflect the implied response of the levels. Foreign interest rate and price are included as exogenous variables. Other deterministic variables include dummy variables which account for policy regime changes or other exogenous shocks.

Let us follow Lütkepohl and Reimers (1992) and assume a one-time impulse on a variable is transitory if the variable returns to its previous equilibrium value after some periods. If it settles at a different equilibrium value, the effect is called permanent. Figure 2 plots the impulse responses of the price level to a shock in lg, defgdp, fdgdp, debtgdp, lE, lMs, ly and lcpi. For the sake of brevity, we only concentrate on the impulse responses of lcpi to a shock in other variables.

Figure 2 about here

According to Plot (A), a one standard deviation shock to real government expenditures (equal to 0.046 units) induces a contemporaneous decrease of 0.020 units in the price level. However, the reduction in price falls in magnitude and reaches, e.g., 0.014 units at the 24th quarter; therefore, the impulse is permanent. The impact of this shock on government expenditure itself (not shown) is permanent at about 0.074 units at the 9th quarter and falls slightly up to the 12th quarter and then rises to about 0.06 units and remains at that level. According to Plot (B), a one standard deviation shock to deficits per GDP (equal to 0.0046 units) induces a contemporaneous increase of 0.001 units in the price level. The price change will fluctuate around zero, but will settle down to positive 0.00049 units at the 24th quarter; therefore, the impulse response is permanent. The rise in the price relative to its initial shock on deficits is not very significant. The response of deficit per GDP to its own shock (not shown) results in a rise to a maximum of 0.006 units at the 6th quarter and then in a fall to its initial shock. Consequently, an unanticipated fiscal policy may have a deflationary effect in developing countries.

According to Plot (C), a one standard deviation shock to foreign financing per GDP (equal to 0.0018 units) induces a contemporaneous decline of 0.006 units in the price level. The price, however, will increase permanently. The impact of the shock on itself (not shown) is permanent at 0.004 units. According to Plot (D), a one standard deviation shock to debt per GDP (equal to 0.02 units) induces a contemporaneous decline of 0.008 units in the price level. The price decline fluctuates around 0.012 units and remains permanently at about that level. Interestingly, the impulse impact of debt per GDP on itself is permanent and at 0.038 units at the 24th quarter. Overall, the impulse responses of the price level to a shock on fiscal variables, except for foreign financing, are the continuous reduction in the inflation rate in Iran. This result is in contrast with the anticipated long-run impact of government expenditures and deficits per GDP, see Table 1.

According to Plot (E), a one standard deviation shock to the exchange rate (equal to 0.065 units) induces a contemporaneous increase of 0.004 units in the price level. The price will continue to increase permanently by 0.007 units at the 24th quarter. The impulse impact of the exchange rate on itself (not shown) falls up to the 2nd quarter and then increases to its initial shock and will remain at that level. According to Plot (F), a one standard deviation shock to the money supply (equal to 0.039 units) induces a contemporaneous increase of 0.004 units in the price level. The impulse response is similar to a shock in the exchange rate. The impulse impact of the money supply on itself (not shown) is permanent at about the initial shock. Consequently, both anticipated [Equation (18) and Table 1] and unanticipated shocks in monetary variables will cause the price level to increase.

As Plot (G) shows, a one standard deviation shock to the real GDP (equal to 0.016 units) induces a contemporaneous fall of 0.008 units in the price level. The price will continue to fall permanently to 0.011 units at the 24th quarter. The impulse response of real GDP on itself (not shown) is permanent at about 0.028 units. Finally, as Plot (H) shows, a one standard deviation shock to the price level (equal to 0.013 units) induces permanent increases in itself. In sum, the most inflationary induced shocks in Iran are the foreign financing of debt as well as the monetary policy shocks, i.e., a shock to the money supply or exchange rate.

To gauge whether fiscal, monetary and other shocks have played much of a role in accounting for movements in the price level, we analyze variance decompositions for various time horizons. Table 3 reports variance decompositions for various time horizons. Each row shows the fraction of the t-step ahead forecast error variance for the price level that is attributed to shocks to the column variables. According to these results, the real government expenditures, the foreign financing per GDP, debt per GDP, exchange rate and real GDP shocks account for an insignificant percentage of the price forecast error variance at all horizons. The deficits per GDP and money supply shocks account for an increasing percentage of the price forecast error variance as the time horizon increases.

Table 3 about here

For example, after a year deficits per GDP shocks account for 1.94% of the price forecast error variance. This rises to 9.77% after three years and to 15.11% after six years. The money supply shocks account for 5.05% after a year, but rises to 14.19% after six years. These results imply that deficits and money supply shocks play a relatively important role in price fluctuations. However, the major impact of these shocks only occurs with quite a long lag. Interestingly, nearly half of the price forecast error variance is due to innovations in itself, 23.82% at one quarter ahead and 38.56% at one year ahead. It rises to 47.71% at three years ahead and falls to 43.49% at six years ahead.

VII. Conclusions

This paper focuses on internal and external factors, which influence the inflation rate in developing countries. A monetary model of inflation rate, capable of incorporating both monetary and fiscal policies as well as other internal and external factors, was developed and tested on Iran. The estimation results proved the validity of the model as it is unique in the literature. Therefore, the first contribution of this paper is the development of the model.

It was found that, over the long run, a higher exchange rate (lower value of domestic currency) leads to a higher price in Iran. So a policy regime that leads to a stronger currency can help to lower inflation. However, a higher money supply when it is anticipated does not lead to a higher price level, but an unanticipated shock in the money supply results in a permanent rise in the price level. So an unanticipated reduction in the money supply should be a powerful tool to reduce inflation in Iran.

It is also found that the fiscal policy is very effective in Iran to fight inflation as the increase in the real government expenditures as well as deficits cause inflation, but if the changes are unanticipated they cause the opposite effect. More interestingly, it was found, for the debt management policy, that a higher outstanding government debt, anticipated or unanticipated, is considered a higher asset (i.e., demand for real balances increases) over the long run. Therefore, a high debt per GDP is deflationary. As for the foreign financing of the government debt, we found no price impact when it is anticipated, but it has a positive effect if unanticipated. In general, we found the major factors affecting inflation in developing countries, at least for Iran, over the long run, are internal rather than external factors. For example, the foreign interest rate has a deflationary effect in Iran over the long run while imported inflation does not exist in that country.

The overall conclusion over the short run is that the sources of inflation are both external and internal factors. The external factors include the foreign interest rate and sanctions. The fiscal policy as an internal factor has been the most effective tool over the short run to fight inflation in Iran. The government debt financed externally, while reducing the price level over the long run, creates more uncertainty over the short run and causes the inflation rate to increase.

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Figure 1: Recursive Likelihood Ratio Tests

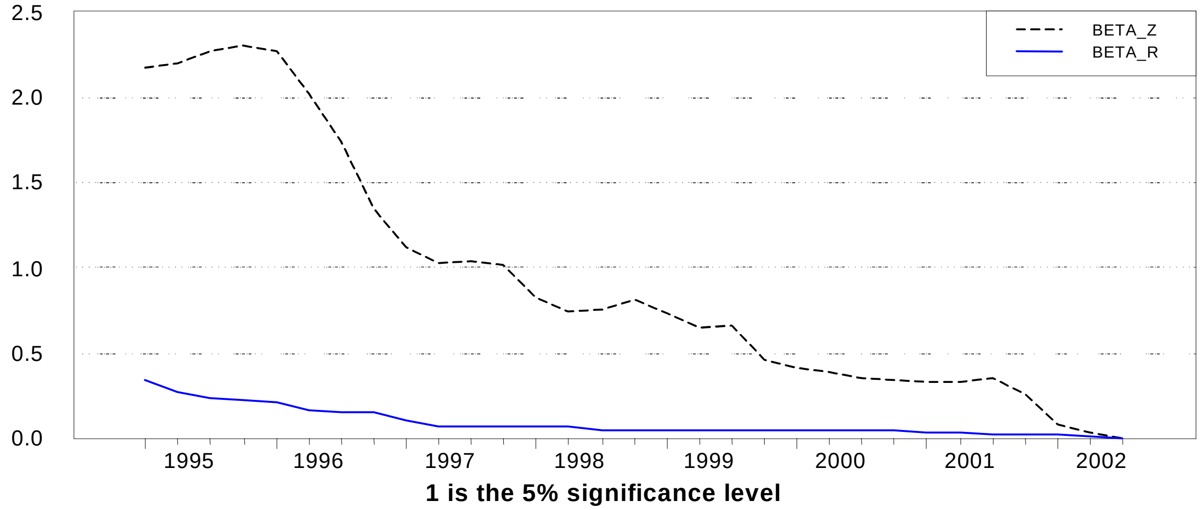
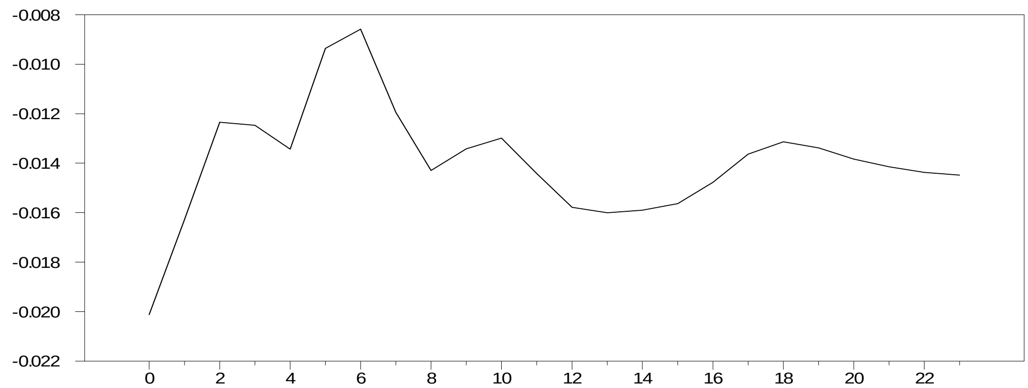
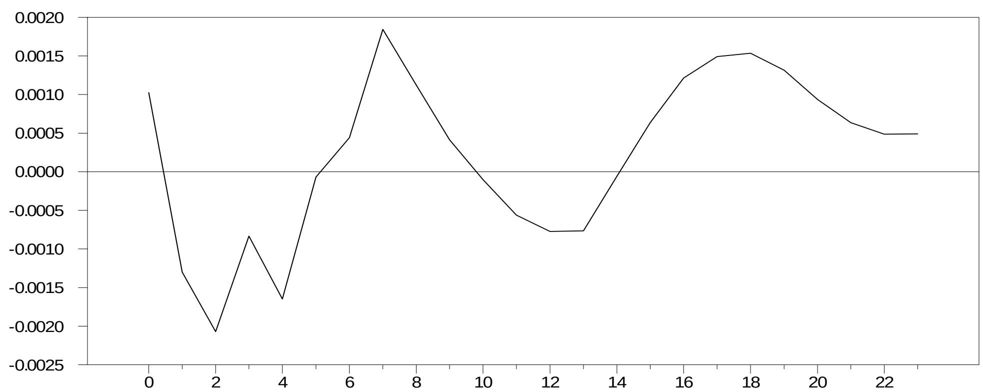


Figure 2: Impulse Responses for Iran

(A) Plot of responses of Price Level to a Shock in the Real Government Expenditures



(B) Plot of responses of Price Level to a Shock in the Deficits per GDP



(C) Plot of responses of Price Level to a Shock in the Foreign Financing per GDP

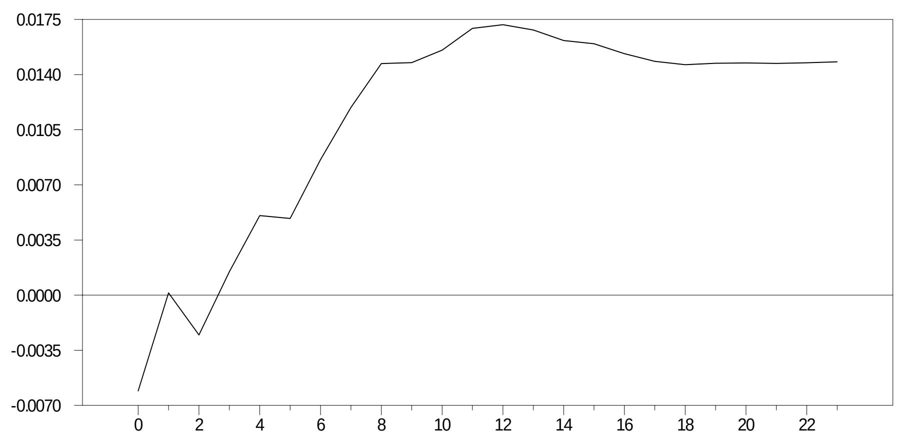
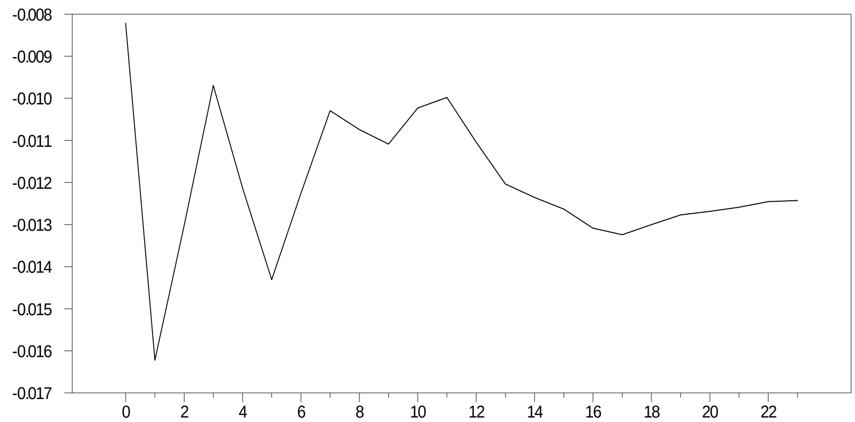
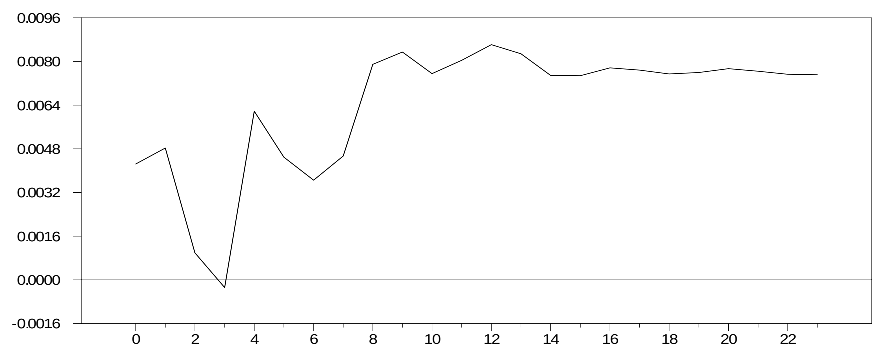


Figure 2 Continues

(D) Plot of responses of Price Level to a Shock in the Debt per GDP



(E) Plot of responses of Price Level to a Shock in the Exchange Rate



(F) Plot of responses of Price Level to a Shock in the Money Supply

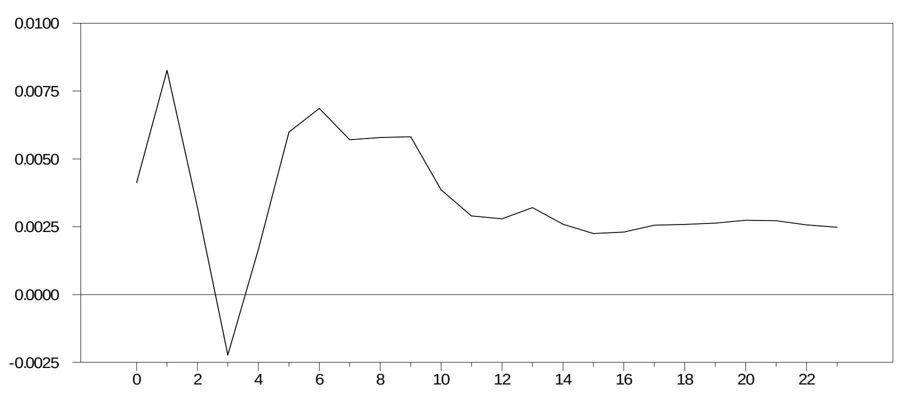
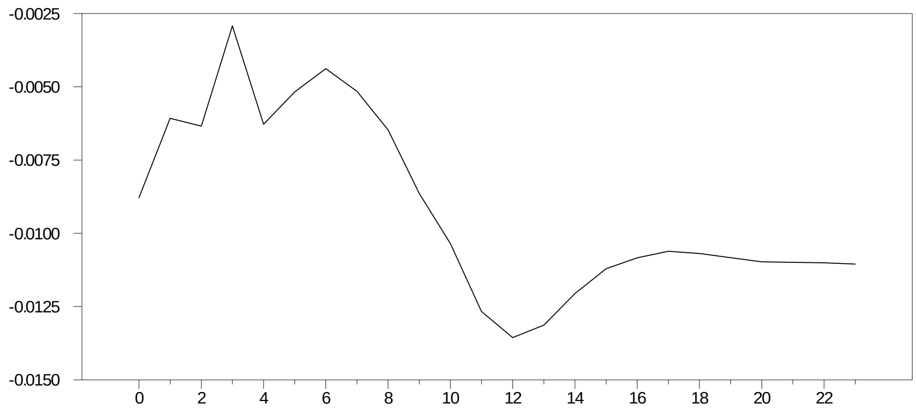


Figure 2 Continues

(G) Plot of responses of Price Level to a Shock in the Real GDP



(H) Plot of responses of Price Level to a Shock in Itself

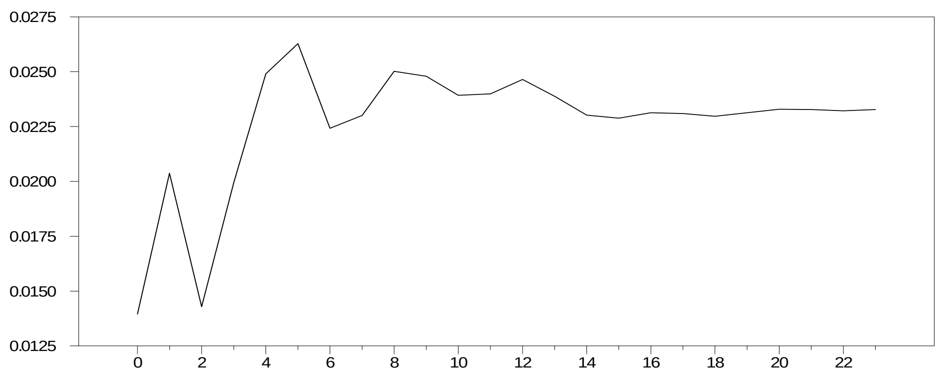


Table 1* Long-Run Test Results

Tests of the Cointegration Rank									
H_0=r	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Diagnostic tests**** p-value
λ_{max} [(1)]	99.33	71.42	65.05	43.62	31.09[a]	19.75	10.35	1.27	**LM(1) 0.18**
λ_{max} **95**[(2)]	55.50	49.42	43.97	37.52	31.46	25.54	18.96	12.25	**LM(4) 0.62**
Trace[(1)]	341.89	242.56	171.12	106.07	62.45[a]	31.37	11.62	1.27	**Lag length = 4**
Trace 95[(3)]	182.45	146.75	114.96	86.96	62.61	42.20	25.47	12.39	

Identified Long-Run Relationships for r=4. Null: Restrictions are accepted: $\chi^2(1) = 0.02$, p-value = 0.89											
Normalized	**lMs**	**lp**	**ly**	**lE**	**i***	**lp***	**lg**	**defgdp**	**debtgdp**	**fdgdp**	**trend**
lp **(St. Error)**	0.05 (0.17)	-	-0.88 (0.35)	1.19 (0.15)	-0.42 (0.11)	0.17 (0.32)	1.38 (0.28)	6.70 (0.94)	-0.66 (0.10)	-0.25 (2.43)	Restricted = 0
lMs **(St. Error)**	-	Restricted = 1	7.35 (0.64)	4.57 (0.28)	-0.62 (0.26)	6.80 (0.72)	-2.63 (0.39)	-4.24 (2.30)	2.62 (0.20)	0.28 (3.52)	-0.28 (0.02)
lp **(St. Error)**	Restricted = 0	-	0.37 (0.06)	1.40 (0.002)	-0.34 (0.06)	2.21 (0.15)	-0.02 (0.002)	Restricted = 0	Restricted = 0	Restricted = 0	-0.04 (0.002)
lE **(St. Error)**	Restricted = 0	0.71 (0.01)	-0.26 (0.04)	-	0.24 (0.05)	-1.58 (0.11)	Restricted = 0	Restricted = 0	Restricted = 0	-0.06 (0.01)	0.03 (0.002)

a =means accept the null of r=4.
(1) Both λ_{max} and Trace tests have been multiplied by the small sample correction factor (N – kp)/N, see Cheung and Lai (1993).
(2) The source is Osterwald-Lenum (1992), Table 2, p. 469.
(3) The source is Johansen (1995a), Table 15.4, p. 216.
* The sample period is 1970Q1-2002Q4. The model includes constant, trend and seasonal dummies. lMs is the log of nominal money supply, i* is the log[R*/(1+R*)] where R* is foreign interest rate in decimal points, ly is the log of real GDP, lE is the log of nominal exchange rate (domestic currency per $US), lp and lp* are the log of domestic CPI and an index of industrial countries exports unit values, respectively. lg is the log of real government expenditures on goods and services, defgdp and debtgdp are deficits and outstanding debt per GDP, respectively. fdgdp is the amount of foreign financed debt per GDP and trend is a linear time trend.
** LM(1) and LM(4) are one and four-order Lagrangian Multiplier test for autocorrelation, respectively [Godfrey (1988)].

Table 2*: Error Correction Model
Dependent Variable = Δlp

Variable	Coefficient	Standard Error	p-value for Hansen's (1992) stability L_i test
Δly_{t-1}	0.28	0.05	1.00
Δi^*_{t-1}	0.06	0.02	1.00
$(\Delta lp)(rev)_{t-1}$	0.38	0.07	1.00
$(\Delta lp)(rev)_{t-3}$	0.36	0.06	1.00
$(\Delta lg)\ (oil)_{t-4}$	0.36	0.10	1.00
$\Delta defgdp_{t-1}$	-0.97	0.24	1.00
$(\Delta defgdp)\ (san)_{t-4}$	-2.12	0.36	1.00
$\Delta fdgdp_{t-1}$	5.52	1.22	1.00
$\Delta fdgdp_{t-2}$	-3.00	0.86	1.00
$(\Delta fdgdp)\ (san)_{t-2}$	63.66	17.11	1.00
ECP_{t-1}	-0.003	0.0005	1.00
oil	0.08	0.03	1.00
Q3	-0.05	0.01	1.00
Q4	-0.03	0.01	1.00
Nor 1973Q1	0.09	0.03	To avoid nonsingular matrix the dependent variable was adjusted for these dummy variables
Nor 1977Q2	0.11	0.02	
Nor 1978Q4	0.06	0.02	
Hansen's (1992) stability L_i test on the variance = 0.26			p-value = 0.18
Joint (coefficients and the error variance) Hansen's (1992) stability L_c test = 2.57			p-value = 1.00

* The sample period is 1970Q1-2002Q4. Mean of dependent variable=0.04. Δ means the first difference, Δly is the change of the log of real GDP, Δi* is the change in log[R*/(1+R*)], Δlp is the change in the log of CPI and ΔlE is the change in the log of market exchange rate (rials per $US). Δlg is the change in real government expenditures. Δdefgdp, and Δfdgdp are the change in the log of deficits and foreign financed debt per GDP, respectively. ECP is the error correction term generated from the long-run price determination (see the first identified equation in Table 1). None of the other error correction terms were statistically significant. Dummy variable rev is equal to 1 since 1979Q2 and to zero, otherwise. Dummy variable oil is equal to 1 for the period 1973Q4-1974Q1, and to zero, otherwise. Dummy variable san is equal to 1 since 1980Q2 and to zero, otherwise. Q3 and Q4 are equal to 1, in the third and fourth quarters of the year, respectively, and to zero, otherwise. Nor 1973Q1, Nor 1977Q2 and Nor 1978Q4 are equal to 1 in the quarters indicated to eliminate the outliers in the data. The estimation method is Ordinary Least Squared. $\bar{R}^2$=0.70, σ=0.02, DW=1.98, Godfrey(5)=0.52 (significance level=0.79), White=99.66 (significance level=1.00), ARCH(5)=7.65 (significance level=0.18), RESET=0.19 (significance level=0.90) and Normality, χ^2=4.98 (significance level=0.08). Note that $\bar{R}^2$, σ and DW, respectively, denote the adjusted squared multiple correlation coefficient, the residual standard deviation and the Durbin-Watson statistic. White is White's (1980) general test for heteroskedasticity, ARCH is five-order Engle's (1982) test, Godfrey is five-order Godfrey's (1978) test, REST is Ramsey's (1969) misspecification test, Normality is Jarque and Bera's (1987) normality statistic, L_i is Hansen's (1992) stability test for the null hypothesis that the estimated coefficient or variance of the error term is constant and L_c is Hansen's (1992) stability test for the null hypothesis that the estimated coefficients as well as the error variance are jointly constant.

Table 3* Price Level Variance Decompositions

	Shock to:							
Period (Quarters)	**lg**	**defgdp**	**fdgdp**	**debtgdp**	**lE**	**lMs**	**ly**	**lp**
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.82
4	0.18	1.94	0.07	0.33	0.23	5.05	0.17	38.56
12	0.80	9.77	0.05	0.27	0.26	12.93	0.16	47.71
20	1.16	13.97	0.04	0.50	0.31	13.91	0.11	43.93
24	1.25	15.11	0.03	0.58	0.32	14.19	0.10	43.49

* See footnote of Table 1 for the mnemonics.