INFLATION, OUTPUT GROWTH, AND STABILIZATION IN TURKEY, 1980-2002

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Abstract

Using a dynamic aggregate supply and aggregate demand model with imperfect capital mobility and structural VARs, we decompose inflation and output movements into those attributable to terms of trade, supply, balance-of-payments, fiscal, and monetary shocks. Empirical results show that terms of trade shocks have a significant effect on inflation in the short run. In the long run, monetary, and balance of payments shocks dominate while budget deficits play a limited role in the inflationary process. Demand shocks have limited effects on output movements; output is mostly driven by terms of trade and supply shocks. The results highlight the importance of a credible disinflation program and structural reform that restrain discretionary aggregate demand policies.

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I. Introduction

The Turkish economy has been plagued by high and persistent inflation in the last two decades. Although the economy grew at reasonable levels, economic growth has been volatile and macroeconomic instability became the hallmark of the post-1980 period. Despite many attempts to stabilize the economy, these stabilization attempts have been unsuccessful. Common explanations of inflation since late 1970s include (1) high public sector deficits (due to, among other things, populist government expenditures before elections, military expenditures, massive infrastructure projects, bankrupt social security institutions, losses incurred by state owned enterprises), (2) monetization of public sector deficits, (3) increases in prices of major imported inputs (particularly, crude-oil prices), (4) inflationary effects of rising exchange rates via increases in prices of imported goods, (5) persistent inflationary expectations of economic agents. High and persistent inflation has been blamed for, among other things, major distortions in the economy, worsening of the income distribution, increase in directly unproductive activities, an increase in the underground economy, and curtailing of foreign direct investment.

The unprecedented hovering of inflation at levels short of hyperinflation over the last two decades in Turkey poses a challenge yet a systematic macroeconomic account of the underlying shocks has attracted scant attention in the literature. The main objective of this paper is to examine the sources of fluctuations in inflation and output growth in Turkey over the last two decades. To that end, we use a dynamic open-economy aggregate supply aggregate demand model and structural Vector Autoregressions (VAR) to decompose inflation and output movements into those attributable to terms of trade, supply, balance of payments, fiscal, and monetary shocks. To our knowledge, this is the first attempt in documenting the sources of inflation within the context of a dynamic, open-

economy aggregate supply, aggregate demand model. An advantage of our model is that it does not assume perfect capital mobility and uncovered interest parity. Moreover, following Quah and Vahey (1995), we estimate core inflation as inflation driven by aggregate demand shocks in the broad sense. The issue is germane in that if inflation is driven by shocks to the economic environment or the terms of trade, the government has little leverage in attempting a successful stabilization program. Finally, it is possible to decompose output into components driven by particular shocks. The resulting decomposition may provide an idea on the output costs of disinflation in Turkey. To preview our results, inflation is mainly driven by terms of trade, balance of payments, and monetary shocks while output is mostly driven by supply side shocks. Moreover, a substantial portion of inflation is demand-driven "core inflation."

Section II of the paper details major macroeconomic developments since 1970. Section III presents a selective survey on sources of Turkish inflation. In section IV, we develop a dynamic open economy aggregate supply - aggregate demand model with imperfect capital mobility to identify various macroeconomic shocks. Section V presents the empirical results based on variance decompositions and impulse response functions and estimates "core inflation". The last section has the concluding remarks.

II. An Overview of Major Macroeconomic Developments in Turkey

Chronic inflation in Turkey is accompanied by volatile output growth. Year-to-year changes in consumer prices sampled monthly from January 1970 to December 2002 and some sub-period averages of these annual inflation rates are shown in Figure 1. As seen in the figure, Turkey experienced many accelerations in inflation since 1970. Common explanations of these episodes in

inflation rates are devaluations, oil-price shocks, balance-of-payments crises, public sector deficits, the Persian Gulf crisis in 1990-1991, financial crises at home and abroad, and recent earthquakes.

(Insert **Figure 1** about here **)**

Figure 2 shows real growth rates for gross domestic product (GDP) of the Turkish economy. Oil-price shocks in the 1970s and related balance-of-payments problems contributed substantially to a deep economic recession and a political and social crisis in late 1970s. After the introduction of a broad stabilization and liberalization program in January 1980, the government installed by the military regime in September 1980 was able to lower inflation below 40 percent per year and accelerate economic growth in the following four years. However, after 1983, the volatility of annual GDP growth rates increased substantially. Other events such as the 1990-1991 Persian Gulf crisis, the 1994 Turkish financial crisis, the 1998 Russian crisis, two earthquakes in 1999, and the 2000-2002 disinflation and economic restructuring program which failed in early 2001 contributed to rising output volatility in the economy.

(Insert **Figure 2** about here**)**

On the institutional and policy side, Turkey embarked on far reaching structural reforms after 1979. In 1980, in response to a strong balance-of-payments crisis accompanied by a deep recession and accelerated inflation, Turkey abandoned its inward-oriented development strategy and gradually started to introduce free-market based reforms. The Government devalued the Turkish lira to eliminate its excess overvaluation, increased the prices of public sector products and removed restrictions on interest rates. The first steps of external liberalization concentrated on current account transactions. The 1980 stabilization and liberalization program was aimed not only at reducing inflation and accelerating output growth but also hoped to liberalize the capital

account in a reasonable future. All of these were done at the cost of an initial jump in the annual inflation rate over 100% in 1980.

In May 1981, the Government took the first step from fixed to a managed floating-exchange-rate system. In 1984, domestic citizens were allowed to open foreign exchange deposit (FED) accounts in Turkish banks.[1] In 1989, the Government took serious steps to liberalize the capital account. Following the introduction of convertibility, the overvaluation of the Turkish lira and high domestic interest rates on government bonds attracted short-term capital inflows to the country. The change in the deficit financing method of the public sector from money to bond-finance starting in 1986, and attempts to stabilize the exchange rate to prevent the inflationary effects of rising exchange rates made this fiscal policy combination unsustainable within a short period of time. This led to an "exchange-rate" crisis in the first half of 1994 without a "balance-of-payments" crisis typical of the 1970s. In 1994, the annual inflation rate exceeded 100% as in 1980.

Turkish governments introduced new disinflation measures to stabilize the economy after the 1994 financial crisis. However, these efforts in 1995, 1998 and 2000 failed to reduce the inflation rate to levels below 25% per year, as it had been in the early 1970s. Although the government introduced a three-year program in December 1999, the program had to be revised in light of the two successive liquidity and interest-rate crises; first in November 2000, and then in February 2001. The government abandoned the crawling peg regime under the original plan and floated the Lira in February 2001. The revised three-year plan adopted in early 2002 contained provisions for fiscal adjustment to help bring about debt sustainability, reform of the banking sector through an operational and financial restructuring of public banks, and regulation and

supervision of private banks. The early elections on 3rd of November 2002 dramatically changed the political climate in Turkey; currently the newly established government is in contact with the International Monetary Fund to make minor changes in the program to disinflate and restructure the Turkish economy.

III. Macroeconomic Determinants of Inflation in Turkey: A Selective Survey

There is a large body of literature focusing on specific aspects of post-1979 inflation in Turkey. These empirical studies differ in their sample period, methodology, and hence, their conclusions. Using monthly data from 1981-87, Onis and Ozmucur (1990) explore inflationary dynamics in Turkey. The authors reject a pure monetary explanation of inflation based on a VAR and a simultaneous equation model. Although they find devaluations of the Turkish lira to have a strong impact on domestic inflation, supply-side factors seem to have significant effects on inflation. On the other hand, using annual data from 1960-88, Atesoglu and Dutkowsky (1995) present supportive evidence that the Turkish economy behaves consistent with predictions of a real business cycle model. Particularly they find none of the aggregate demand variables are significant in influencing output, and prices respond to monetary expansions at the same rate.

Using a broad data set with annual and quarterly data, Metin (1995) finds that fiscal expansion dominates Turkish inflation from 1950 to 1988. An implication is that, in order to reduce inflation successfully, governments have to reduce public sector deficits. Moreover, devaluations have some inflationary effects. Inflationary effects of the depreciation of domestic currency are also implicated by Erol and van Wijnbergen (1997), Lim and Papi (1997), Agenor and Hoffmaister (1997), and Leigh and Rossi (2202). The link between devaluations and inflation

highlights the importance of stabilizing the exchange rate in order to achieve price stability in Turkey. Using input-output tables, Kibritcioglu and Kibritcioglu (1999) find negligible role of oil prices on inflation in Turkey.

Recently, Lim and Papi (1997), Alper and Ucer (1998), and Baum et al. (1999) emphasize the increasing role of *inertia* in the process of inflation in Turkey. This makes government stabilization attempts difficult given the unusual resistance these disinflationary measures face.

(Insert **Table 1** about here **)**

Table 1 presents averages of changes in consumer price index, real GDP, exchange rate, crude-oil import price, money supply and public sector borrowing requirement in the 1980-2002 period. The figures in last two columns on the current account balance and short-term capital inflows are given as period averages in millions of US dollars. According to overall figures, the consumer price index increased 287 times in the 1990-2000 period but it increased only 53 times from 1979 to 1989. The recent acceleration of inflation in the 1990s seems to have been accompanied by a slowdown in output growth. Depreciation of the Turkish lira also seems to have accelerated in the 1990s. In real terms, however, the depreciation of the Turkish lira in the 1980s is followed by a slight appreciation in the first half of the 1990s if we ignore changes in foreign price levels in the same period. This development along with increases in real domestic interest rates after 1989 explain the rise in short-term capital inflows in the 1990s. In contrast to the oil-price shocks of the 1970s, crude-oil price changes in the 1981-1998 period were relatively small.

From 1979 to 2001, the broad money supply M2 has increased substantially which points to an accommodating monetary policy. In real terms, the M2 measure of the money supply rose 133 percent while the increase in real reserve-money (the IMF definition) was limited to about 53 percent in the same period. The borrowing requirement of the Turkish public sector (PSBR) increased in nominal as well as real terms particularly in the second half of the 1990s. The overall increase in PSBR in real terms from 1979 to 2001 is about 261 percent. There is evidence that monetization of public sector deficits decreased as a result of the availability of bond-financing since 1986 in Turkey (Alper and Ucer, 1998). Moreover, Central Bank credits to the public sector have been sharply declining since 1998. However, sustained monetary growth, despite the diminishing role of monetization of government deficits, indicates that inflation in Turkey may still have a monetary character rather than being a fiscal one.

The foregoing discussion highlights the importance of identifying *shocks* driving inflation and output, since observed movements in the data are combinations of macroeconomic "shocks" and responses to these shocks. Did inflation arise because of negative supply shocks? What is the significance of terms-of-trade shocks in driving inflation? Do shocks to the balance of payments play a role in the inflationary process? What role the fiscal deficits played in the inflation process? In the following two sections, we address these questions using a dynamic aggregate supply aggregate demand model. We also isolate components of inflation due to particular shocks based on historical realizations of the shocks. The resulting decomposition can be used to pin down the size of policy driven inflation vs. inflation due to the macroeconomic environment. It is also possible to assess the output costs of disinflation.

IV. Sources of Inflation: An Illustrative AS - AD Model

This section presents a dynamic aggregate supply, aggregate demand model that incorporates some important elements of a developing economy, namely balance of payments problems and finite capital mobility. The model is consistent with a vertical long-run Phillips curve, and represents a middle ground between market clearing approaches and models based on short run nominal inertia and nominal rigidities. A similar small, open economy model based on household optimization can be found in Clarida, Gali, and Gertler (2001). Moreover, Quah and Vahey (1995) propose a technique for measuring core inflation based on aggregate demand neutrality: Core inflation is defined as that component of measured inflation that has no long-run impact on real output, a notion consistent with the vertical long-run Phillips curve. Recently, Wehinger (2000) use aggregate demand neutrality to derive core inflation for the G7 countries and we follow a similar strategy in this paper.

In order to motivate the restrictions embedded in the structural VAR model, consider a dynamic, open economy aggregate supply- aggregate demand model:

$r_t = r_{t-1} + \varepsilon_t^r$	Evolution of terms of trade	(1)
$y_t^s = \breve{y}_t + \theta\, r_t$	Aggregate supply	(2)
$\breve{y}_t = \breve{y}_{t-1} + \varepsilon_t^s$	Evolution of capacity output	(3)
$k\,[i_t - i_t^* + (E_t s_{t+1} - s_t) - \rho_t] + \eta_1(s_t - p_t) - \eta_2 y_t + b_t = 0$	Balance of Payments (BOP)	(4)
$i_t = (E_t s_{t+1} - s_t) - (\eta_1/k)\ (s_t - p_t) + (\eta_2/k)\, y_t + [i_t^* + \rho_t - (1/k) b_t]$		(4')
$z_t = [i_t^* + \rho_t - (1/k) b_t]$	"BOP" shock	(5)
$z_t = z_{t-1} + \varepsilon_t^z$	Evolution of "BOP" shock	(5')
$y_t^d = \beta d_t - \gamma[i_t - E_t(p_{t+1} - p_t)] + \eta_1(s_t - p_t) - \eta_2 y_t$	Aggregate demand/IS	(6)
$\Delta d_t = - t\Delta y_t + \varepsilon_t^f$	Evolution of the budget deficit	(7)
$m_t^d = p_t + y_t - \lambda\, i_t - \mu z_t$	Money demand	(8)

$\Delta m_t^s = \alpha_1 \Delta d_t + \alpha_2 \Delta z_t + \varepsilon_t^m$ Money supply growth (9)

$y_t^s = y_t^d = y_t$ Goods market equilibrium (10)

$m_t^s = m_t^d = m_t$ Money market equilibrium (11)

where r is the terms of trade, y is domestic output, $\check{y}$ is capacity output, i is domestic nominal interest rate, i* is the foreign interest rate, s is the exchange rate expressed as the domestic currency price of foreign currency, p is the domestic price level, m is the money stock, d is the budget deficit, ρ is a risk premium on domestic currency investments, b represents an exogenous shift in net exports due to e.g., a change in competitiveness, z represents exogenous elements in the balance of payments equation, ε^j are stochastic disturbances, and E_t is the expectations operator conditional on information available at time t. In the model, all variables except interest rates are in logarithms, and the remaining Greek letters designate parameters which are assumed positive.

Equation (1) is the evolution of the terms of trade, which is assumed to follow a random walk. Equation (2) is an aggregate supply equation, where aggregate supply depends on capacity output and terms of trade. Capacity output is a function of the productive capacity of the economy (e.g., the capital stock and employment), and for simplicity, it is assumed to follow a random walk. Supply shocks are interpreted broadly to include productivity enhancing developments such as increases in the capital stock and improvements in technology as well as "cost-push" elements stemming from input markets.

A distinguishing feature of the model is that, it can accommodate non-instantaneous adjustment in the balance of payments. Capital inflows are a function of the net domestic rate of return adjusted for a risk premium. The parameter *k* represents the degree of capital mobility

where large values indicate higher levels of capital mobility. The trade balance is a function of the real exchange rate ($s_t - p_t$) and domestic income. Moreover, b_t represents exogenous increases in net exports. Although equation (4) may seem to impose a zero balance of payments, the existence of the shift term b_t provides a more general specification. For example, one can view b_t as an exogenous level for the balance of payments. Equation (4') rewrites equation (4) in terms of the domestic nominal interest rate while equation (5) pools all the exogenous elements in the balance of payments equation to define z_t. Equation (5') specifies the evolution of z_t as a non-stationary stochastic process[2].

Equation (6) is an aggregate demand (IS) equation where aggregate spending depends on the budget deficit, the expected real interest rate, and net exports. The growth in the budget deficit Δd_t in equation (7) depends negatively on output growth (through increases in tax revenues) and a random fiscal shock (ε^f). Equation (8) is a conventional money demand equation. In order to obtain a simple solution, money demand is assumed to have unitary income elasticity. Money demand is also a function of the exogenous elements in the balance of payments. This specification allows for reductions in money demand when there are exogenous shifts in the balance of payments which may necessitate a depreciation of domestic currency. Moreover, when there is a risk premium associated with domestic currency or self-fulfilling fads in exchange rate expectations, z_t will be positive. In such cases, money demand is reduced by μz_t.

Equation (9) specifies the growth of the money supply as a function of the budget deficit and balance of payments. The former captures money creation to finance the government sector while the latter introduces the influence of the balance of payments on the money supply through

changes in foreign exchange reserves. Finally we close the model by postulating goods and money market equilibrium relationships (equations 10 and 11) and proceed to solve the model for the rational expectations equilibrium.

In order to solve the model, we eliminate the interest rate from equations (6) and (8) using equation (4') to obtain the following system:

$$\begin{vmatrix} \lambda(1+\frac{\eta_1}{k}) & 1-\frac{\lambda\eta_1}{k} \\ \gamma(1+\frac{\eta_1}{k})+\eta_1 & -\gamma(1+\frac{\eta_1}{k})-\eta_1 \end{vmatrix} \begin{vmatrix} s_t \\ p_t \end{vmatrix} = \begin{vmatrix} \lambda & 0 \\ \gamma & -\gamma \end{vmatrix} \begin{vmatrix} E_t\, s_{t+1} \\ E_t\, p_{t+1} \end{vmatrix} + \begin{vmatrix} m_t-(\frac{\lambda\eta_2}{k}-1)y_t + (\mu-\lambda)z_t \\ (1+\eta_2+\frac{\eta_2\gamma}{k})y_t-\beta d_t-\gamma z_t \end{vmatrix} \qquad (12)$$

The system can be written compactly as $AY_t = B\,E_t\,Y_{t+1} + W_t$, or $Y_t = \Pi\,E_t\,Y_{t+1} + CW_t$ where $C = A^{-1}$ and $\Pi = A^{-1}B$. The eigenvalues of the matrix Π are $\{1/(1+\lambda);\ \gamma k / (\gamma k + \gamma\,\eta_1 + k\eta_1)\}$. Both eigenvalues are within the unit circle for finite values of the parameters, hence the forward looking solution is convergent. The forward looking solution to the system in (12) is

$$E_t Y_{t+1} = C \sum_{i=0}^{\infty} \Pi^i\, E_t\, W_{t+i+1} \qquad (13)$$

Given the stochastic processes for the exogenous variables, it is evident that $E_t\, W_{t+i} = W_t$ for i = 1, 2, ... Then the solutions for the real exchange rate is:

$$s_t - p_t = [\frac{k}{\eta\,(\gamma+k)} + \frac{\eta_2}{\eta}]\, y_t - \frac{\gamma k}{\eta\,(\gamma+k)}\, z_t - \frac{\beta k}{\eta\,(\gamma+k)}\, d_t \qquad (14)$$

The observed movements in the vector of variables $X_t = [r_t \;\; y_t \; d_t \; (s_t-p_t) \; p_t]'$ are due to five mutually uncorrelated "structural" shocks with finite variances, $\boldsymbol{\varepsilon_t} = [\varepsilon_t^r \; \varepsilon_t^s \; \varepsilon_t^f \; \varepsilon_t^z \; \varepsilon_t^m]$. These are terms of trade shocks, ε_t^r; aggregate supply shocks, ε_t^s; real fiscal shocks, ε_t^f; BOP shocks, ε_t^z; and monetary/nominal shocks, ε_t^m.

It can be shown that the long run impact of the structural shocks on the endogenous variables has a recursive structure. In order to show the long run effect of structural shocks, ε_t, on X_t, we express the solution to the model in first differences:

$$\Delta r_t = \varepsilon_t^r \tag{15}$$

$$\Delta y_t = \theta \, \varepsilon_t^r + \varepsilon_t^s \tag{16}$$

$$\Delta d_t = -t \, (\varepsilon_t^s + \theta \, \varepsilon_t^r) + \varepsilon_t^f \tag{17}$$

$$\Delta(s_t - p_t) = [\frac{k(1+t)}{\eta_1(\gamma+k)} + \frac{\eta_2}{\eta_1}](\varepsilon_t^s + \theta\varepsilon_t^r) - \frac{\gamma k}{\eta_1(\gamma+k)}\varepsilon_t^z - \frac{\beta k}{\eta_1(\gamma+k)}\varepsilon_t^f \tag{18}$$

$$\Delta p_t = (\alpha_1 + \frac{\lambda\beta}{\gamma+k})\varepsilon_t^f - [t(\alpha_1 + \frac{\lambda\beta}{\gamma+k}) + \frac{2\lambda\eta_2 + \lambda k}{k(\gamma+k)} - 1](\varepsilon_t^s + \theta\,\varepsilon_t^r) + (\alpha_2 - \frac{\lambda k}{\gamma+k} + \mu)\varepsilon_t^z + \varepsilon_t^m \tag{19}$$

Note that the model does not impose *a priori* restrictions on capital mobility. If capital mobility is high as may be expected in Turkey especially after the capital account liberalizations undertaken in the late 1980s, then empirical estimates of the structural parameters would reflect a high *k*. What we do not impose is "uncovered interest parity" which would correspond to *k* tending to infinity. Equation (19) indicates that the effects of terms of trade, supply, and balance of payments

shocks on inflation can be of either sign. Although all endogenous variables are unit root stochastic processes, the vector X_t is difference stationary. Finally, the long run impact of the structural shocks on the endogenous variables has a recursive structure, and we use this property to identify the shocks.

Identification of the Shocks

Since the vector ΔX_t is covariance stationary, it can be written as an infinite moving average process in the structural shocks:

$$\Delta X_t = \sum A_i \varepsilon_{t-i} = A(L)\varepsilon_t \qquad (20)$$

where A(L) is a matrix whose elements are polynomials in the lag operator L. Denote the elements of A(L) by $a_{ij}(L)$. The time path of the effects of a shock in ε_j on variable *i* after *k* periods can be denoted $\omega_{ij}(k)$. We also adopt the notation such that A(1) is the matrix of long run effects whose elements are denoted $a_{ij}(1)$; each element gives the cumulative effect of a shock in ε_j on variable *i* over time. Similarly, A_0 is the matrix of the contemporaneous impact effects. The objective of identification is to discern the 25 elements of A_0. Given the model structure above, the *long run* effects of the shocks on the endogenous variables are given by

$$\begin{vmatrix} \Delta r_t \\ \Delta y_t \\ \Delta d_t \\ \Delta(s_t - p_t) \\ \Delta p_t \end{vmatrix} = \begin{vmatrix} a_{11}(1) & 0 & 0 & 0 & 0 \\ a_{21}(1) & a_{22}(1) & 0 & 0 & 0 \\ a_{31}(1) & a_{32}(1) & a_{33}(1) & 0 & 0 \\ a_{41}(1) & a_{42}(1) & a_{43}(1) & a_{44}(1) & 0 \\ a_{51}(1) & a_{52}(1) & a_{53}(1) & a_{54}(1) & a_{55}(1) \end{vmatrix} \begin{vmatrix} \varepsilon_t^r \\ \varepsilon_t^s \\ \varepsilon_t^f \\ \varepsilon_t^z \\ \varepsilon_t^m \end{vmatrix} \quad (21)$$

In equation (21), the matrix of long run effects is lower triangular. Since the variance-covariance matrix is symmetric, it provides 15 restrictions on the elements of the A_0 matrix. Equation (21) provides the ten additional restrictions to recover the structural shocks.

V. Empirical Results

The data are quarterly from 1980:1 through 2002:3. The measures of the variables are: r_t = terms of trade (relative price of exports in terms of imports), y_t = GDP in constant prices, d_t = the budget deficit, q_t = real exchange rate measured as the SDR exchange rate deflated by the consumer price index, p_t = consumer price index. Data sources are explained in the Appendix.

In order to properly specify the VAR, variables ought to be tested for unit roots. We use the KPSS test, which tests stationarity as the null hypothesis, and the Augmented Dickey-Fuller (ADF) test with a unit root null hypothesis. The maximum lag in the ADF test is determined by pairing down the model starting with a maximum lag of 10, depending on whether the maximum lag coefficient is significant at the 10% significance level. The test results for all variables in levels and first differences are given in Table 2.

(Insert **Table 2** about here **)**

Statistical evidence in the table points to nonstationary variables in levels. The ADF test fails to reject the null hypothesis of a unit root for all variables at the 5 percent significance level. The KPSS test concurs except for the terms of trade which seems stationary. As for first differences of the variables, all seem stationary except the inflation rate. For the empirical model, we proceed with the assumption that all variables are difference stationary except for the inflation rate, which is a unit root process, hence the vector $\mathbf{\Delta X_t} = [\Delta r_t \; \Delta y_t \; \Delta d_t \; \Delta q_t \; \Delta \pi_t]$ is stationary, where π_t is the inflation rate.

In order to account for seasonality in the data, we include three seasonal dummies in the VAR, denoted, s_i. As an initial step, we estimate the VAR with 8 lags[3]. We then test whether the model can be pared down using likelihood ratio tests. The null hypothesis of a VAR(7) cannot be rejected against a VAR(8) as the test statistic is, $\chi^2(25) = 32.56$. However, the test statistic for the null hypothesis of VAR(6) against VAR(7) yields $\chi^2(25) = 34.64$ rejecting VAR(6) at the 10 percent significance level. Hence we conclude 7 lags are appropriate for the empirical model. Table 3 presents the VAR estimation results. Even though it is hard to interpret the coefficients directly, the statistics may give an idea about model adequacy. For example, some coefficients on higher order lags are highly significant indicating that a VAR with 7 lags is justified. Moreover, the Ljung-Box Q-statistics for 24^{th} order serial correlation fail to reject serially uncorrelated residuals except for the residual in the real exchange rate equation, which seems to be serially correlated with a 7.8 percent marginal significance level. Given degrees of freedom considerations and likelihood ratio tests presented above for the order of the VAR, 7 lags seem adequate to

capture the dynamics in the data. After imposing the identification restrictions implied by equation (21), we present impulse response functions and variance decompositions to assess the dynamic effects of each shock.

V.1. Impulse Response Functions

Figure 3 presents responses of inflation and output to each shock (terms of trade, supply, fiscal, balance of payments, and monetary). We present the median responses and 10%-90% bands based on bootstrapping with 1000 draws for the impulse response functions. Figure 3a indicates that in response to a terms of trade shock, inflation rises. The inflation rate falls in response to a supply shock but the responses are not statistically significant. The effect of fiscal shocks on inflation is insignificant. On the other hand, the impact effect of a BOP shock on inflation is negative. Finally, inflation responds positively and significantly to a monetary shock. Notice that monetary shocks have everlasting effects on inflation. This points to inflation inertia which may be due to the existence of backward looking expectations in contracts for wages, sales, rents etc. in the economy.

(Insert **Figure 3** about here **)**

Output responses to various shocks are given in Figure 3b. The output response to a terms of trade shock (an increase in the relative price of exportables) is a pronounced and significant increase in output. Note that terms of trade shocks have permanent effects on output. Output responds positively and significantly to a supply shock and reaches its long-run level within the second year. Although output responds to a fiscal shock by alternating between contraction and expansion, the response is not significant. Both inflation and output fall in response to a balance of

payments deterioration; the response is not significant except for the impact effects. It is apparent from the figure that a balance of payments deterioration has a demand deflationary effect on inflation and output. Similarly the output response to a monetary shock is significant. This is in line with Agenor and Hoffmaister (1997) who found that a monetary shock has significant expansionary short term effect on output. Overall, the responses of inflation and output conform to the predictions of a conventional aggregate supply - aggregate demand framework.

V.2. Variance Decompositions

Table 4 presents the decomposition of the forecast error variance of inflation and output for forecast horizons up to six years, and in the long run where the forecast horizon tends to infinity. It is evident from Table 4 that terms of trade, balance of payments, and monetary shocks figure prominently in the inflationary process in Turkey. Note that fiscal deficit shocks play a somewhat limited role. This may be due to data limitations which preclude us from using a comprehensive measure of the public sector deficits such as the "public sector borrowing requirements" which is not available on a quarterly basis. While in the short run terms of trade shocks are important, in the long run balance of payments and monetary shocks dominate. This conforms to evidence presented by Atesoglu and Dutkowsky (1995) in that monetary policy in Turkey is neutral with unitary elasticity between money and prices. Our work differs from Onis and Ozmucur (1990) in that supply shocks seem to have negligible effects on inflation. The effect of terms of trade shocks is understandable for a country which imports a substantial part of raw materials, oil, machinery, and equipment. On the other hand, balance of payments shocks necessitate devaluations of domestic currency which translate into increases in aggregate demand

for domestic output. Moreover, devaluations affect domestic prices directly depending on the degree of exchange rate pass-through. Recent evidence by Leigh and Rossi (2002) suggests that exchange rate pass-through in Turkey is pronounced in the short run particularly for wholesale prices as compared to other key emerging markets.

(Insert **Table 3** about here **)**

The right hand side of Table 4 gives the variance decomposition of output. For forecast horizons up to one year, output is influenced by supply shocks, followed by terms of trade, balance of payments, and monetary disturbances. At medium to long term forecasting horizons, output is mainly driven by terms of trade and supply shocks. The effect of terms of trade shocks on output can be explained by the relative openness of the Turkish economy in the last two decades. Indeed, if we use the ratio of imports and exports to GDP as a crude measure of the openness, the Turkish economy was virtually closed prior to 1980 as the ratio was 8.3 percent in 1979. The openness ratio climbed to an average of 19.2 percent in 1980-82, 27.5 percent in 1987-89, and 42.9 percent in 1999-2001[4].

Monetary shocks do have an expansionary output effect albeit a limited one. Except for the impact effect, monetary shocks are not significant in influencing output. In a sustained inflationary environment short of hyperinflation, the element of surprise associated with efficacious aggregate demand policies is absent. Moreover, inflation and inflationary expectations limit rigidities that normally are credited with expansionary aggregate demand. This is in line with Atesoglu and Dutkowsky (1995) who found that none of the aggregate demand variables significantly affect output in Turkey. The lack of pronounced effects of aggregate demand shocks

on output provides preliminary evidence that a disinflationary program may not involve significant output losses.

V.3. Core Inflation

Following Quah and Vahey (1995), we construct "core inflation" by eliminating supply side influences (terms of trade shocks and supply shocks). The remaining "aggregate demand driven inflation" based on historical realizations of balance-of-payments shocks, fiscal shocks, and monetary shocks gives an idea about the extent of policy-induced inflation. [5] The simulations of core inflation include the base projection. If a substantial portion of actual inflation is demand-driven or "core inflation", there is room for a successful stabilization program to bring down inflation. This assumes authorities have some discretion on demand side shocks compared to supply side shocks where the latter can be thought of as exogenous.

(Insert **Figure 4** about here **)**

A decomposition of inflation based on historical realizations of the shocks is given in Figure 4. This figure reveals several interesting features of the high inflation period in Turkey. First, there is a moderating effect of favorable supply side shocks on total inflation between 1985-1988, and 1994-1997. These can partially be attributed to favorable oil price shocks. Second, and most important, core inflation was never far below total inflation during the entire sample period. Finally, the spike in the inflation rate in 1994 seems to have been mostly driven by a "core" impulse.

Given the negligible non-core inflation and oftentimes moderating supply side influences

on inflation, the historical decomposition of inflation has some policy implications. If we assume that core inflation is mostly induced by demand policies, then stabilizing aggregate demand has a good chance of stabilizing inflation.

VI. Conclusions

Using a dynamic aggregate supply and aggregate demand model with imperfect capital mobility and structural VARs, we decompose inflation and output movements into those attributable to terms of trade, supply, balance-of-payments, fiscal, and monetary shocks. Empirical results show that terms of trade shocks have a significant effect on inflation in the short run. In the long run, monetary, and balance of payments shocks dominate. Budget deficits play a limited role in the inflationary process. Moreover, demand shocks have limited effects on output movements; output is mostly driven by terms of trade and supply shocks.

When inflation runs high for a sustained period of time, inflationary expectations and inflation inertia play a significant role in inflation dynamics. Recently Dibooglu (2002) showed that inflationary expectations have forward- and backward-looking elements in Turkey. A key result of the study is that forward expectations dominate; as such the output costs of a credible disinflation program are likely to be limited. Indeed the limited effects of aggregate demand shocks on output in this paper also provide evidence that a credible disinflation program may not have significant output costs. The lack of political determination to undertake timely structural reforms fed inflationary expectations. It can be said that Turkish macroeconomic policies in the 1980s and 1990s reflected a preference toward expansionary policies at the expense of price stability. When governments in Turkey faced a choice between responding to the immediate needs

of their constituents and reforms necessary for sustainable long-run growth, they opted for the first, and quite predictably, Turkey became one of few countries in history to have a high sustained inflation short of hyperinflation for more than two decades.

The fact that a major component of inflation is demand driven core inflation highlights the importance of structural reforms and credible commitment mechanisms that restrain discretionary aggregate demand polices. To the extent that recent government programs resolve the credible commitment problem and are accompanied by structural reforms, they can bring the high inflation era to an end, and stabilize the economy.

Appendix: Data Sources

(1) Price indexes for exports and imports: For 1980:1-1981:4: IMF's *International Financial Statistics* (*IFS*), CD-ROM Version, December 2002, *IFS* lines 74.d and 75.d, 1980=100. For 1982:1-2002:3: State Institute of Statistics, Ankara, 1994=100, retrieved from the *Electronic Data Distribution System* of the Turkish Central Bank at: http://tcmbf40.tcmb.gov.tr/cbt.html.

(2) Real GDP: State Institute of Statistics (SIS), Ankara, in 1987 prices, expenditure based, millions of Turkish lira. The data for 1987:1-2002.3 is retrieved from the *Electronic Data Distribution System* of the Turkish Central Bank at: http://tcmbf40.tcmb.gov.tr/cbt.html. The data for 1980.1-1986:4 is provided by the officials of the SIS upon authors' request.

(3) Consolidated budget deficit: Ministry of Finance, Ankara, billions of

Turkish lira. The data for 1985:1-2002.3 is retrieved from the *Electronic Data Distribution System* of the Turkish Central Bank at: http://tcmbf40.tcmb.gov.tr/cbt.html. The data for 1980.1-1984:4 is taken from Ministry of Finance's *Annual Economic Reports*, various issues.

(4) SDR exchange rate: IMF's *International Financial Statistics*, CD-ROM Version, December 2002, *IFS* line aa, Turkish lira per SDR.

(5) Consumer price index (CPI): IMF's *International Financial Statistics*, CD-ROM Version, *IFS* line 64.

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Endnotes

1. The subsequent increase in FED may be interpreted as a gross indication of rising currency substitution in Turkey.

3. Although ε_t^z is labeled a "balance of payments shock", it is evident that it captures foreign interest rate shocks, risk premium shocks, and competitiveness shocks. Without further structure, it is impossible to disentangle ε_t^z into its constituent parts. To keep the dimensions of the VAR tractable, ε_t^z will be a composite shock of the above.

3. The estimations in this paper are carried out using the RATS software, version 5.

4. Based on data from the State Institute of Statistics and the Central Bank of the Republic of Turkey.

5. Demand-driven inflation is only an approximation to policy induced inflation as not all broadly defined demand shocks are policy related.

Table 1: Selected Macroeconomic Indicators for Turkey (annual period averages, 1980-2002)

	Consumer Price Inflation (%)	Real GDP Growth (%)	Change in Nominal TL/US$ Exchange Rate (%)	Change in CPI-deflated TL/US$ Exchange Rate (%)	Change in Average Crude Oil Import Price in US$ (%)	Change in Nominal Money Supply M2 (%)	Change in Real Money Supply M2 (%)	Nominal Change in Public Sector Borrowing Requirement (%)	Real Change in Public Sector Borrowing Requirement (%)	Current Account Balance (millions of US$)	Short-Term Capital Inflow (millions of US$)
1980-84	51.5	3.5	65.5	9.3	14.3	60.8	8.7	53.7	0.8	- 1 931.6	72.6
1985-89	50.1	4.6	42.7	- 4.7	- 5.0	54.3	3.6	66.3	13.6	- 145.4	- 104.8
1990-94	73.8	3.8	75.7	- 0.5	- 1.6	69.8	- 2.8	94.6	14.7	- 1 430.2	- 164.0
1995-99	81.0	4.0	70.2	- 5.7	5.3	104.7	13.4	117.9	21.9	- 1 358.0	1 726.0
2000-02*	50.9	2.2	55.9	3.0	15.0	34.8	- 10.9	31.0	- 13.8	- 1 943.0	- 2 595.7
1980-2002*	62.4	3.8	62.5	0.0	4.8	67.5	3.5	76.3	9.3	- 1 311.1	- 6.0

Source: State Institute of Statistics, Central Bank of Turkey, and State Planning Organization; our calculations.
* The figures for 2002 are preliminary.

Table 2. KPSS and ADF Statistics

	q_t	p_t	d_t	y_t	r_t
	KPSS η_μ Statistic				
Levels	1.19	1.89	1.45	1.83	0.36
First Differences	0.04	0.63	0.03	0.04	0.14
	ADF τ_μ Statistic				
Levels	-1.31 (3)	-0.48 (8)	0.48 (7)	-2.21 (8)	-1.50 (10)
First Differences	-7.13 (2)	-1.58 (7)	-7.21(6)	-3.31 (10)	-4.06 (9)

Notes: Critical values for the KPSS η_μ test at the 10 % level is 0.35 and at the 5 % level is 0.46. The critical value of the ADF τ_μ test at the 5 % level is -2.89. Lag truncation for the KPSS test is set at $l = 4$. The maximum lag for the ADF test is given in parenthesis.

Table 3. VAR Estimation Results

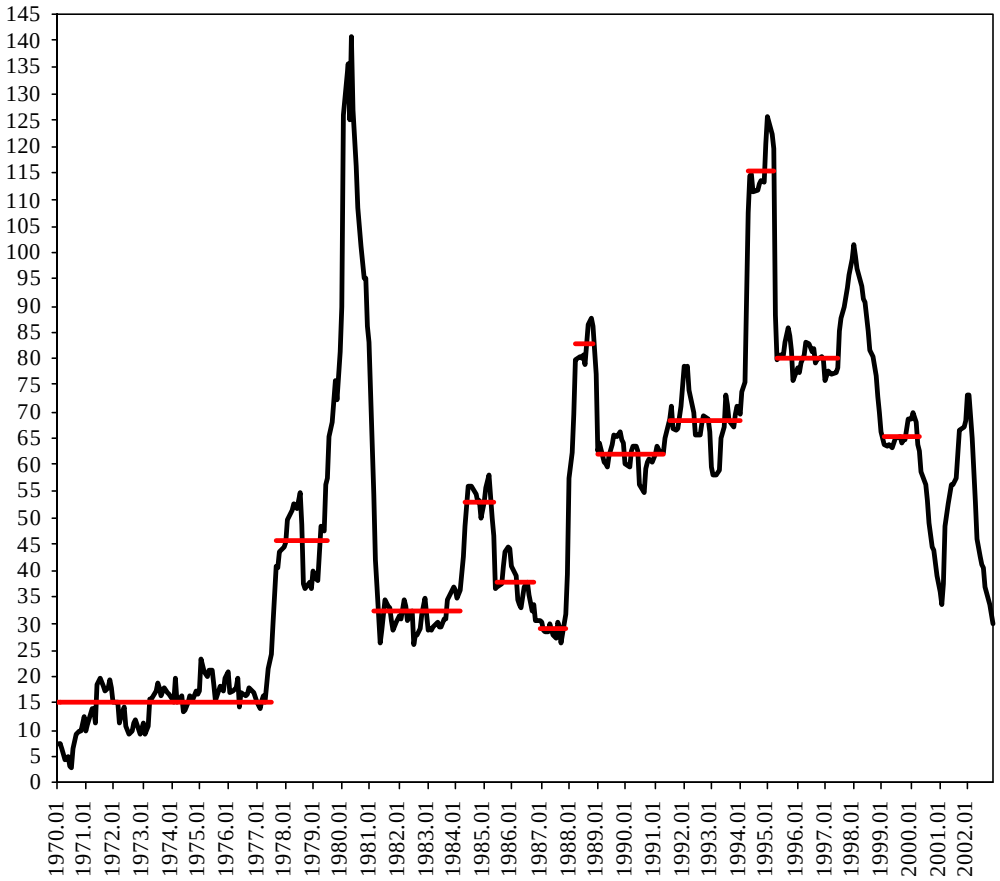
	Dependent Variable				
	Δr_t	Δy_t	Δd_t	Δq_t	$\Delta \pi_t$
Δr_{t-1}	0.024	-0.089	0.130	0.072	0.066
Δr_{t-2}	-0.130	0.257*	0.207	-0.123	0.019
Δr_{t-3}	-0.091	0.010	-0.004	-0.135	0.175
Δr_{t-4}	-0.162	-0.034	-0.013	-0.088	0.112
Δr_{t-5}	0.101	0.074	0.019	0.053	0.064
Δr_{t-6}	0.111	0.134	0.009	0.052	-0.002
Δr_{t-7}	-0.033	0.149	-0.097	-0.313	0.137
Δy_{t-1}	0.303*	-0.368**	-0.043	0.144	0.243*
Δy_{t-2}	0.246	-0.172	-0.331*	0.036	0.015
Δy_{t-3}	0.159	-0.201	-0.353*	0.689*	0.026
Δy_{t-4}	0.249	0.227	-0.174	0.348	-0.086
Δy_{t-5}	-0.087	-0.056	0.017	0.320	-0.025
Δy_{t-6}	0.020	-0.380**	0.110	0.391	-0.100
Δy_{t-7}	0.130	-0.227	0.035	-0.071	0.139
Δd_{t-1}	-0.082	-0.056	-0.858**	0.427	0.039
Δd_{t-2}	-0.137	-0.158	-0.723**	-0.064	-0.049
Δd_{t-3}	-0.090	-0.006	-0.558**	-0.006	0.046
Δd_{t-4}	-0.184	0.090	-0.494**	0.589	-0.038
Δd_{t-5}	-0.060	0.026	-0.245	0.160	-0.011
Δd_{t-6}	0.092	0.125	0.006	0.107	-0.076
Δd_{t-7}	-0.007	0.254*	-0.053	-0.136	0.009
Δq_{t-1}	-0.131	-0.214**	-0.045	0.245	0.398**
Δq_{t-2}	0.013	0.061	-0.018	-0.185	0.016
Δq_{t-3}	0.160	-0.035	-0.142	-0.127	0.028
Δq_{t-4}	-0.022	0.285**	0.065	0.263	0.007
Δq_{t-5}	0.013	0.037	-0.168	-0.252	-0.088
Δq_{t-6}	0.072	-0.100	0.162	0.399*	-0.067
Δq_{t-7}	-0.110	0.197	-0.004	-0.117	0.127
$\Delta \pi_{t-1}$	-0.090	-0.123	0.204	0.382	-0.673**
$\Delta \pi_{t-2}$	-0.273	0.045	0.508*	-0.043	-0.543**
$\Delta \pi_{t-3}$	-0.238	-0.267	0.216	-0.482	-0.301
$\Delta \pi_{t-4}$	-0.431*	-0.191	0.081	0.153	-0.225
$\Delta \pi_{t-5}$	-0.454*	-0.205	-0.328	-0.299	-0.064
$\Delta \pi_{t-6}$	-0.157	-0.521**	-0.022	0.254	-0.087
$\Delta \pi_{t-7}$	0.007	-0.284**	-0.144	-0.247	-0.029
s_1	0.032	0.041	0.120*	0.016	0.046
s_2	-0.014	0.116*	0.063	-0.037	0.003
s_3	-0.014	0.132**	-0.067	0.175	-0.007
c	-0.009	-0.049	-0.016	-0.062	-0.009
Q(24)	20.39	27.36	22.06	34.38*	30.55

Notes: (*) and (**) indicate significance at the 10 and 5 percent levels respectively.
Q(k) gives the Ljung-Box statistic for up to k^{th} order residual serial correlation.

Table 4. Variance Decomposition of Inflation and Output

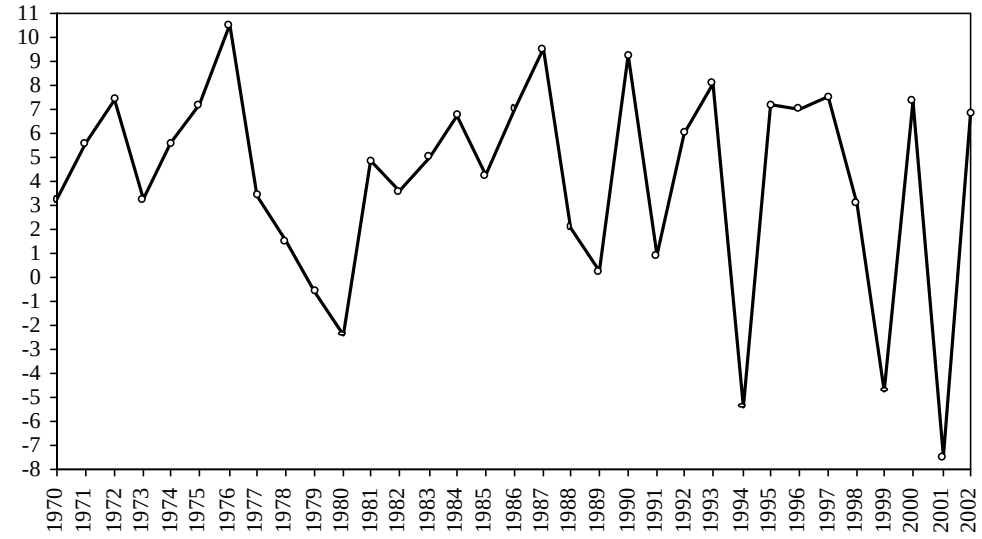
	Inflation					Output				
k	ε^r	ε^s	ε^f	ε^z	ε^m	ε^r	ε^s	ε^f	ε^z	ε^m
1	29.8	5.1	1.2	17.4	46.5	10.0	72.3	0.1	5.4	12.1
4	21.8	4.1	7.4	24.7	42.0	21.8	54.4	1.6	15.8	6.3
8	18.9	5.3	10.1	23.0	42.7	32.9	47.1	1.7	11.0	7.3
12	17.3	5.7	12.0	25.3	39.7	35.4	47.3	1.8	8.9	6.6
16	15.7	5.1	13.0	24.3	42.0	34.9	50.0	1.6	7.8	5.7
20	14.5	5.0	12.4	24.4	43.7	36.1	49.4	1.5	7.0	5.9
24	13.1	4.6	12.6	25.9	43.8	36.5	50.2	1.5	6.3	5.6
LR	0.1	0.6	8.5	30.8	59.9	44.1	55.9	0.0	0.0	0.0

Figure 1: Annual CPI Inflation in Turkey, Jan. 1970 - Dec. 2002 (in percent change)



Source: State Institute of Statistics; our calculations.
Note: Horizontal lines show selected period averages.

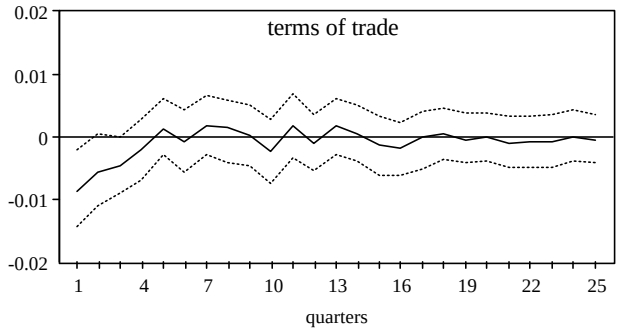
Figure 2: Annual Real GDP Growth Rates in Turkey, 1970-2002 (in percent change)

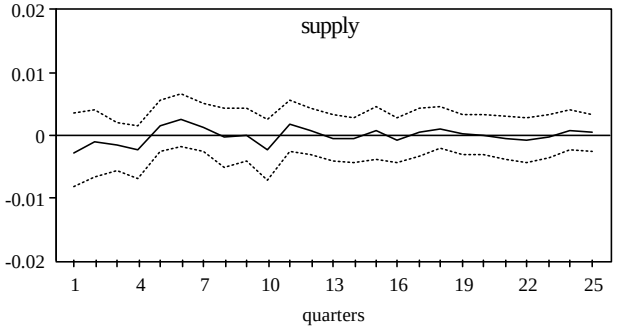


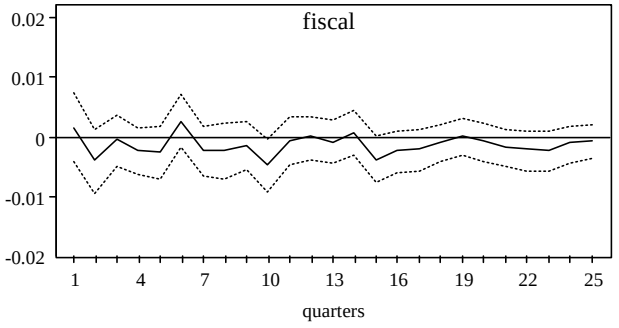
Source: State Institute of Statistics; our calculations.
Note: The figure for 2002 is only estimation.

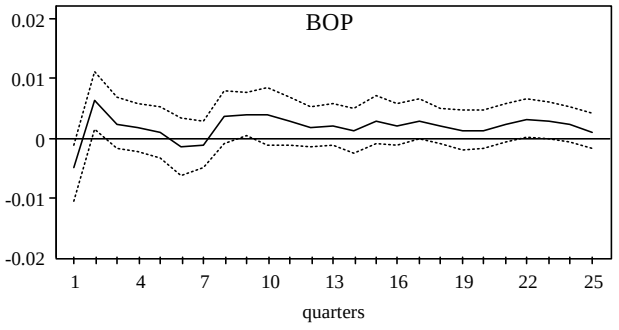
Figure 3. Responses of Inflation and Output to Various Shocks

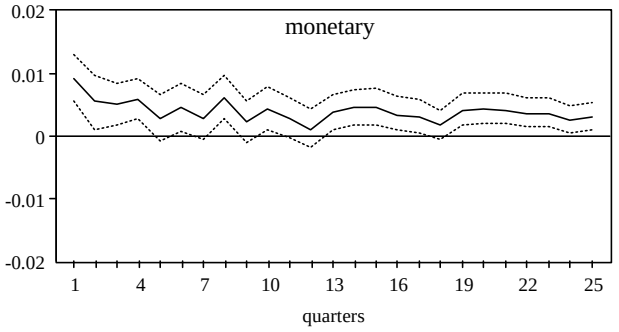
Inflation Responses



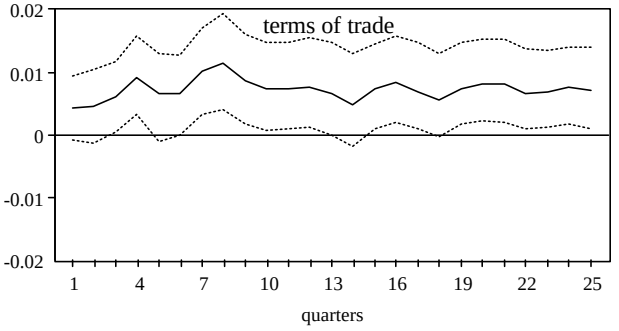


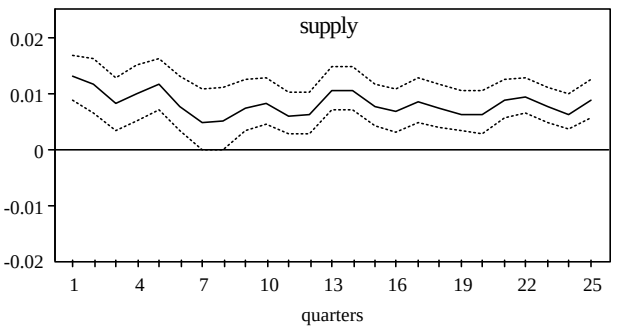


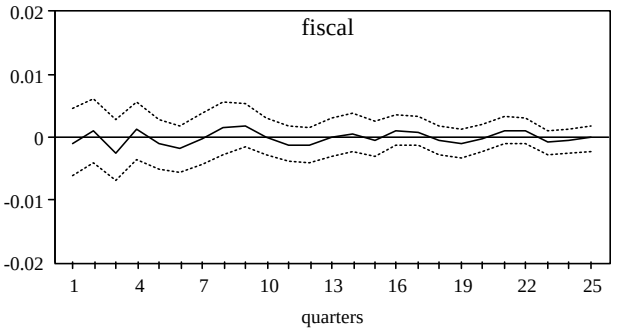


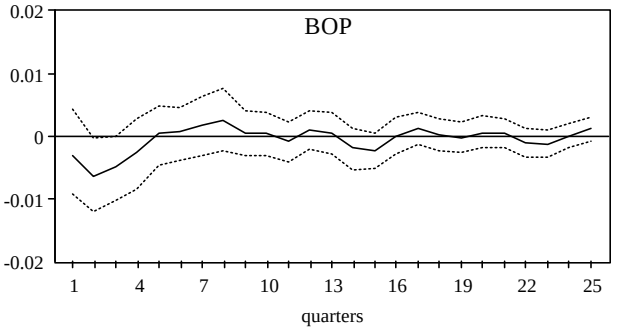


Output Responses









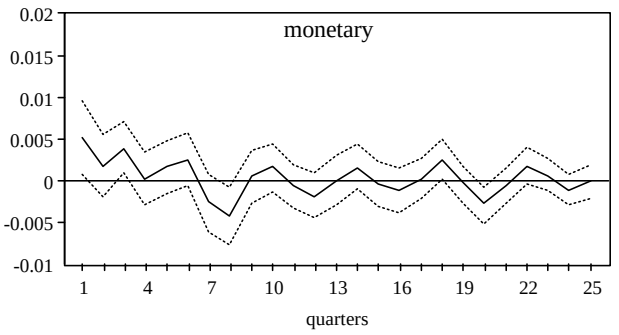


Figure 4. Core and non-core Inflation