Research Department Working Paper *No:10*

INFLATION DYNAMICS AND REACTION FUNCTION IN HIGH-INFLATION ENVIRONMENT:

An Implication for Turkey

September 2002

The Central Bank of the Republic of Turkey

Inflation Dynamics and Reaction Function in High-inflation Environment : An Implication for Turkey*

Runchana Pongsaparn
University of Bristol, United Kingdom
R.Pongsaparn@bristol.ac.uk

September 2002

Abstract

Inflation in Turkey has been an area of active research since 1980s. Despite series of stabilization programs, high inflation remains an issue yet to be successfully tackled. This paper sets sights on answering the following questions : what are the driving forces behind inflation dynamics? and would adjustment to reaction function improve performance in terms of inflation, exchange rate and interest rate? The paper examines the background with respect to macroeconomic development and policies throughout the late 1980s and 1990s, then seek out plausible culprits for inflation. The literature on this issue is also accounted for. Having done so, an analysis on determinants of inflation is carried out based on VAR and VECM techniques. In the later part, for the sole purpose of policy implication, simple modelling (small scale macroeconomic model) and simulation are employed to inspect the effects of adjustment to reaction function. The findings suggest significant role played by both monetary and fiscal factors in determining inflation. Slight improvement in performance could also be achieved through adjustment in the degree of sensitivity of interest rate to inflation and/or exchange rate movement.

* The author wish to thank staffs at the Research Department of the Central Bank of the Republic of Turkey for their helpful comments and suggestions on the paper as well as for providing a pleasant research environment during the internship. Special thanks are also addressed to Kursat Kunter for his kind help and advice and Pelin Basak for ensuring the well-being of the author.

Introduction

Inflation in Turkey has been an area of active research since 1980s. Despite series of stabilization programs, high inflation remains an issue yet to be successfully tackled. This paper sets sights on answering the following questions : what are the driving forces behind inflation dynamics? and would adjustment to reaction function improve performance in terms of inflation, exchange rate and interest rate?

The outline of this paper is as follows. First, we examine the background with respect to macroeconomic development and policies throughout the late 1980s and 1990s, then seek out plausible culprits for inflation. The literature on this area is also accounted for. Having done so, an analysis on determinants of inflation is carried out based on VAR and VECM techniques. In the later part, for the sole purpose of policy implication, simple modelling (small scale macroeconomic model) and simulation are employed to inspect the effects of adjustment to reaction function. Conclusions in response to aforementioned questions could be reached.

Background

In this section, we examine the economic background as well as policies implemented since the 1980s to provide us with a good account of the factors that interplay in the determination of inflation in Turkey.

General overview

Inflation in Turkey throughout the late 1980s and 1990s has been high and chronic; nevertheless, hyper-inflation was not evident. Output growth has been volatile due to series of crises, from 1990-91 Persian Gulf, 1994 Turkish financial crisis, 1998 Russian crisis and earthquakes in 1999. (See Chart 1) Acceleration in inflation in 1990s compared to the preceding decade was apparent. After inflation was brought down from its peak in 1980, there had been two apparent jumps in 1988 and 1994. (See Chart 2) Depreciation in Turkish lira also gained momentum in 1990s. As interest rate in real terms rise after 1989, this prompts short-run capital flows. The link between fiscal and monetary policy has been strong. High and chronic inflation, large public-sector borrowing and floating exchange rate are constraints on the central bank's ability to maintain real interest rate stability and competitive exchange rate[1] in 1990s. Reform attempts to bring down inflation appear to have failed.

[1] Sahinbeyoglu (2001)

Chart 1 : Real GDP growth

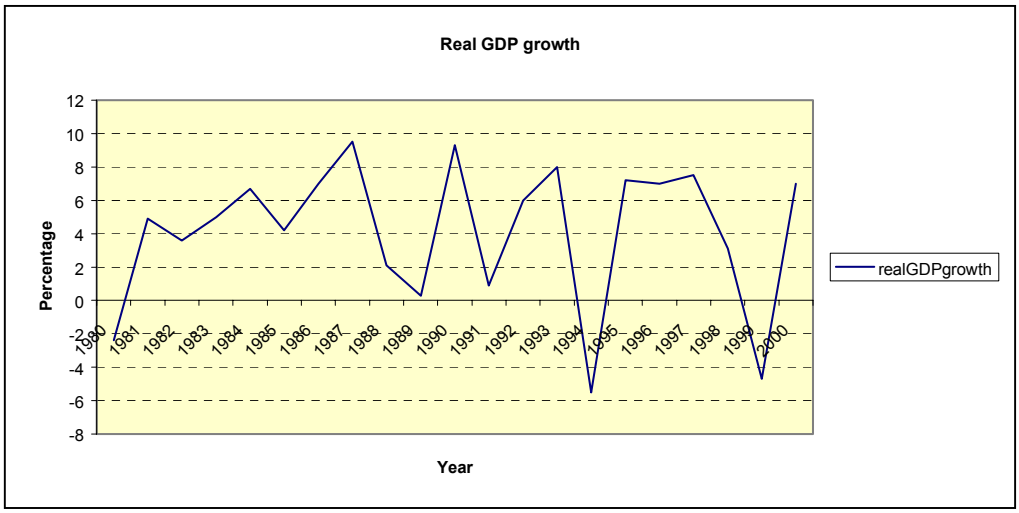
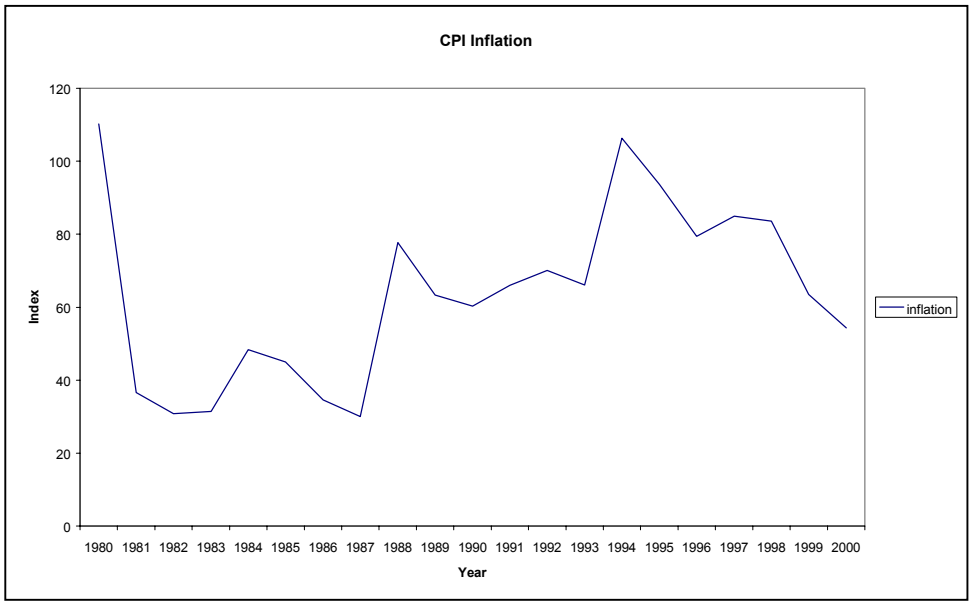


Chart 2 : Inflation



Turkish economy and policies[2]

1) Import-export policy and exchange rate

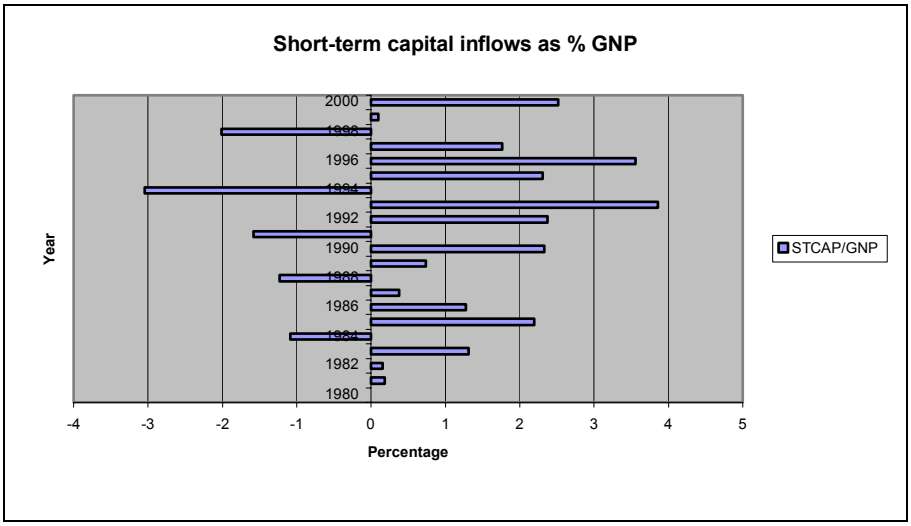
An attempt to revert import-substitution policy in 1970s was to pursue export-incentives policy from 1980 onwards. The policy includes maintained depreciation in real exchange rate to enhance competitiveness. Depreciation rate was slowed down from 1988 onwards. Fixed exchange rate prior to 1980 was implemented through determination of Turkish Lira value and adjustment was made by the government according to the level it perceived appropriate. Floating exchange rate scheme was initiated in 1980 stabilization program. Attempt to foster export-led growth had been successful throughout the 1980s. Together with reduction in labour costs, exchange rate policy and export subsidies raised exports from 2.9 billion dollars in 1980 to 11.8 in 1989. Industrial product gained increasing share from 36% to 78% of total exports. Import was liberalised gradually and started to increase at a slower rate than exports. Imports increased from 7.9 billion to 15.8 over the same period. In 1990s, conflicts between export-led growth and exchange rate policy arose as appreciation in Lira put a haul to export growth and increase import share. This is somehow alleviated by improvement in tourism revenues. Current account deficit was perceived as a factor contributing to the crisis in 1994.

2) Capital account liberalization

Capital account liberalization started in 1980 was completed in 1989. In 1984, foreign exchange rate regime was liberalised. Banks were allowed to take foreign currency deposit from residents, at the same time, non-residents were able to purchase foreign denominated securities and hold Turkish Lira account. Residents could purchase and sell securities quoted at the foreign stock exchange and foreign treasury and government bonds. Imports and exports in all kinds of securities were permitted. In 1988, deposit interest rates were liberalized. With liberalized capital account, high interest rates attract hot money – leading to real appreciation in exchange rate. High domestic interest rates hindered investment and raise credit costs for real sector – increasing dependency to short-term capital inflows. Short-term capital flows predominated after the liberalization process and has been volatile (See Chart 3). Foreign direct investment in Turkey is incremental – only 0.4% GDP in 1990s. A negative consequence of liberalization was a jump in inflation in 1988. According to Rodrik (1991), the 1988 jump was induced by opening of capital account and increasing dollarization, which leads to a fall in demand for reserve money compulsing the authority to increase inflation so as to earn seigniorage revenue.

[2] based mainly on CBRT (2002)

Chart 3 : Short-term capital inflows as percentage to GNP



3) Fiscal account

Budget deficit as share of GNP widened from around 4% in 1981 to around 7% and 12% in 1990 and 2000 respectively. Financing of consolidated budget as percentage of GNP increased from 2.7% to 6.3%. Structure of finance is mainly from domestic debt – 1.6% GNP in 1980s and 5.6% of GNP in 1990s. Financing from foreign debts was insignificant. Foreign debt stock then increased from 34.9% GNP during 1980s to 42% in 1990s. Private sector accumulated an increasing share of external debt – from 5.8% to 14.3% GNP, while public foreign debt proportion declined from 24.2% to 21.8%.

Substantial public sector deficit has been caused by lax income policies, ineffective tax collection system – evident in the failure to broaden tax base, while indirect taxes is proportionally more important as source of revenue, transfers to social security institutions (increased from 0.4% of PSBR in 1990 to 33% in 1997), subsidies to agricultural sector through public banks and State Economic Enterprises' pricing in line with attempts to control inflation. Increase in subsidies to agricultural sector contributed to banking system volatility, as this 'duty losses' increased from 0.7% of GNP in 1993 to 16.7% in 1999. These loses were not recorded in the budget.

Domestic borrowing to finance deficit induces high interest rates. The consequence of high domestic borrowing to finance debts was costly to financial systems. As Turkish banks collect savings and lend to the government, their balance sheet is increasingly bond-denominated. Credit line to firms was not operating well. According to Dibooglu and Kibritcioglu (2001), PSBR has risen in real terms by 156% between 1979 and 2000. Monetisation of public sector deficit has reduced due to increasing bond-financing but the braod money supply (M2) increased substantially.

4) Monetary policy

From 1986, the Central Bank conducted monetary policy through control on Turkish lira reserves of the banking system, indirectly controlling money supply by targeting broad money supply M2. In 1989, the use of short-term advance facility by the treasury was limited and credit extension to banks through rediscount window was brought under control. The central bank also targeted its own

level of balance sheet. Due to capital account liberalization in 1989, the Central Bank lost its control over monetary aggregates. Priority was given to financial stability rather than controlling inflation in the face of increasing currency substitution as seen from a rise in the share of foreign currency denominated bank deposits in total deposits from 24% in 1989 to 46% in 1999. Monetary policy has been highly dependent on fiscal policy. Monetisation of debts and short-term advances granted by the Central Bank to the Treasury was reduced from May 1985, as treasury bills and bonds were issued to finance budget deficit. A secondary bills and bonds market was set up at Istanbul Stock Exchange to enable government securities to be auctioned under the free market condition. Hence, yields on these auctions can be accepted as major rates for the economy. The Central Bank's main tool of monetary policy has been through the open market operations targeted at control on the money supply through liquidity adjustment in the banking system since 1987.

The development on external and financial liberalization front complicated the central bank's ability to control money. Objective of central bank has gradually moved away from financial institution restructuring in late 1980s to real exchange rate stability and financial market stability. Inflation has been a 'residual' objective. (Alper and Ulcer 1998) Moreover, according to Sahinbeyoglu (2001), high real interest rate, which could have been used as a monetary instrument, is the cause and consequence of inflation. A contraction in monetary policy worsens the debt dynamics via increasing debt stock, which feeds in to the greater possibility of future monetisation, leading to expectation of inflation and interest rate. The process then become self-fulfilled by higher interest rate and inflation. Another jump in inflation in 1994 was attributed to lack of credibility in stabilization program throughout the early 1990s and attempts to maintain demand for TL-denominated assets, which propped up interest rate[3].

5) Banking system

Despite the series of reform, banking sector does not effectively act as a channel to foster investment. With highly volatile output, risk and increasing share of government debt instruments in the balance sheet, bank loans are secondary source of finance for corporate firms after inter-firm trade-credits which accounted for over 30% of corporate firms' finance. Larger corporates took advantage of capital account liberalization by borrowing directly from abroad. Banking sector credit only amounted to 23% of GNP. Despite several attempts of reforms, the banking sector is still vulnerable. 7 out of 80 banks were state-owned – making up 34% share of total banking sector's assets. Their balance sheet consists mainly of treasury bills and bonds, contributing to need for liquidity – which consequently shot up interest rates.

6) Stabilization program

A disinflation program (Staff Monitored Program) was launched in 1998 but was interrupted by political uncertainties and earthquakes in August and November 1999. Another program supported by the IMF was launched at the end of 1999 to decrease inflation and reduce real interest rate was exchange-rate oriented. First, a basket of exchange rate is announced for the first one and a half year.

[3] Alper and Ucer (1998)

Then exchange rate was allowed to fluctuate within a band. Incomes policy together with structural reforms and discipline were imposed on fiscal aspects. As a consequence of the program, interest rate fell due to reduced risk in exchange rate, inflation was also brought down. However, inertial element leading to real appreciation of foreign exchange rate coupled with revival in domestic demand worsened current account balance. Delays of structural reforms and deterioration in current account balance reversed capital inflows causing liquidity problems for banks especially those reliant on foreign funds and consequently, shot up interest rate in August 2000. Price of securities went down, impairing banks' balance sheet. Disinflation program designed in 2000, which aimed to increase primary surplus, committed to a specified path of exchange rate depreciation and imposed an income policy and privatising industries – failed apart as evidenced by the 2001 crisis.

A new agreement was made with the IMF made in May 2001 with primary aims to reduce uncertainty in financial sector and stabilize foreign exchange through series of well-defined restructuring measures in many aspects – financial sector, institutional, independence of central bank, strengthening of public finance and administration as well as reforms in agricultural sector and social security system to be ready for the EU accession. In July 2001, exchange rate regime was changed from crawling peg to widening bands due to low credibility. However, foreign-denominated deposit made it difficult to control exchange rate. There was an attempt to bring down inflation expectation by pre-announced intervention through auctions. In November 2001, controls on net domestic assets, which restricts the Bank's ability to act as the lender of last resource, were lifted. Exchange rate is left float, adjustment is made through Repo rate.

Literature survey on Turkish inflation

In contrast to output-gap and policy credibility explanation of inflation in industrialised countries, numerous factors, namely, budget deficits, supply shocks, exchange rate and inflation inertia were evidently culprits for inflation in developing countries[4]. Consequently, there has been several literature on the source of high and persistent inflation for the Turkish economy. The studies could be classified into 5 broad categories:

1. Public sector
2. Monetary aggregate
3. Exchange rate
4. Inflation inertia
5. External sector: world commodity and raw material prices

In so far as the literature is concerned, world commodity and raw material price shocks were not regarded as the main factors driving Turkish inflation. Most literature would suggest their subsidiary and transitory role. Dibooglu and Kibritcioglu (2001) found an evidence to play down the role by supply-side shock, namely, oil price and balance-of-payments on inflation. While inflation could be accounted for mostly by demand shock such as public deficits and devaluation, output is mainly explained by supply shocks.

The followings are analyses conducted on Turkish inflation between 1970s - 1990s. Bearing in mind possibility of structural shifts[5], analyses on inflation determination have to be taken with precautions.

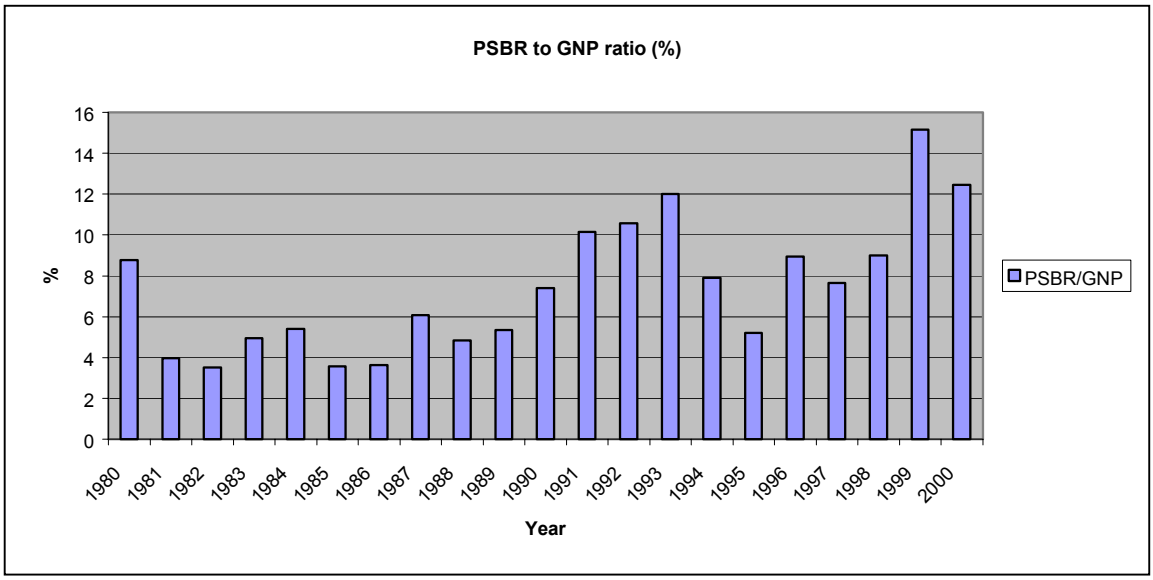
1) Public sector:

On theoretical front, this source of inflation dated back as far as 1973 – seen in the study by Phelps. Bruno and Fischer (1990) also suggested a possibility of mutiple-equilibria of inflation for a given level of budget deficit. It is not only public expenditure that is of prime concern, administered prices such as utility, transport and energy also played an important role in determining inflation. With inflation target, public prices would be raised along the same line as inflation targets. Public sector deficit and debts can be financed from seigniorage, domestic/foreign borrowing or use of central bank's foreign reserves. The risk is foreseenable in both ways of financing. Seigniorage can cause inflation, borrowing puts pressure on interest rates and contribute to accumulation of debt stock. Sustainability of debt stock is an on-going issue in Turkey. The more borrowing is made, the lower the confidence and risk premium increases – the higher interest rate will be, causing more financing obligation. This becomes a vicious cycle. The use of reserves can lead to exchange rate or balance of payment crisis. Reduced seigniorage and increased borrowing as evident in Turkey scenario imply a tendency of deficit to increase or the likelihood of monetisation to keep control on deficit to GDP ratio. Future inflation expectation will be higher. 'Unpleasant monetarist arithmetic' of Sargent and Wallace (1985) warned that switch from monetisation to debt finance is only a temporary solution. It reduces inflation

[4] Ulper and Ucer (1998)
[5] as claimed by Lim and Papi (1997) to be between 1970-80 and 1981-95

now but increases it later through higher accumulation of debt stocks or possibility of monetisation in the future period. PSBR as a ratio to GNP has been on the rise since 1980s (see Chart 4)

Chart 4 : PSBR as percentage of GNP



As far as studies on Turkish inflation are concerned, in 1983 Batavia and Lash presented an evidence of vicious cycle between inflation and public sector deficit for 1950-1975. Later in 1991, Rodrik found a one-to-one relationship between public deficits and inflation. In addition, Yelsdan (1993) and Metin (1995) confirm domination of fiscal factors in inflation process. Akcay et al. (1997) found a long-run relationship between PSBR and inflation rate. They claimed that disinflation program in December 1999 failed largely due to weak commitment on fiscal measure. There is only a weak link from budget deficit to monetary expansion and then to inflation but high deficit can lead to inflation through adjustments in private sector – crowding out effect in real sector and innovation of new financial instruments such as repos to hold interest-bearing assets that are almost as liquid as money. It could then be assumed that monetisation is done by private sector.

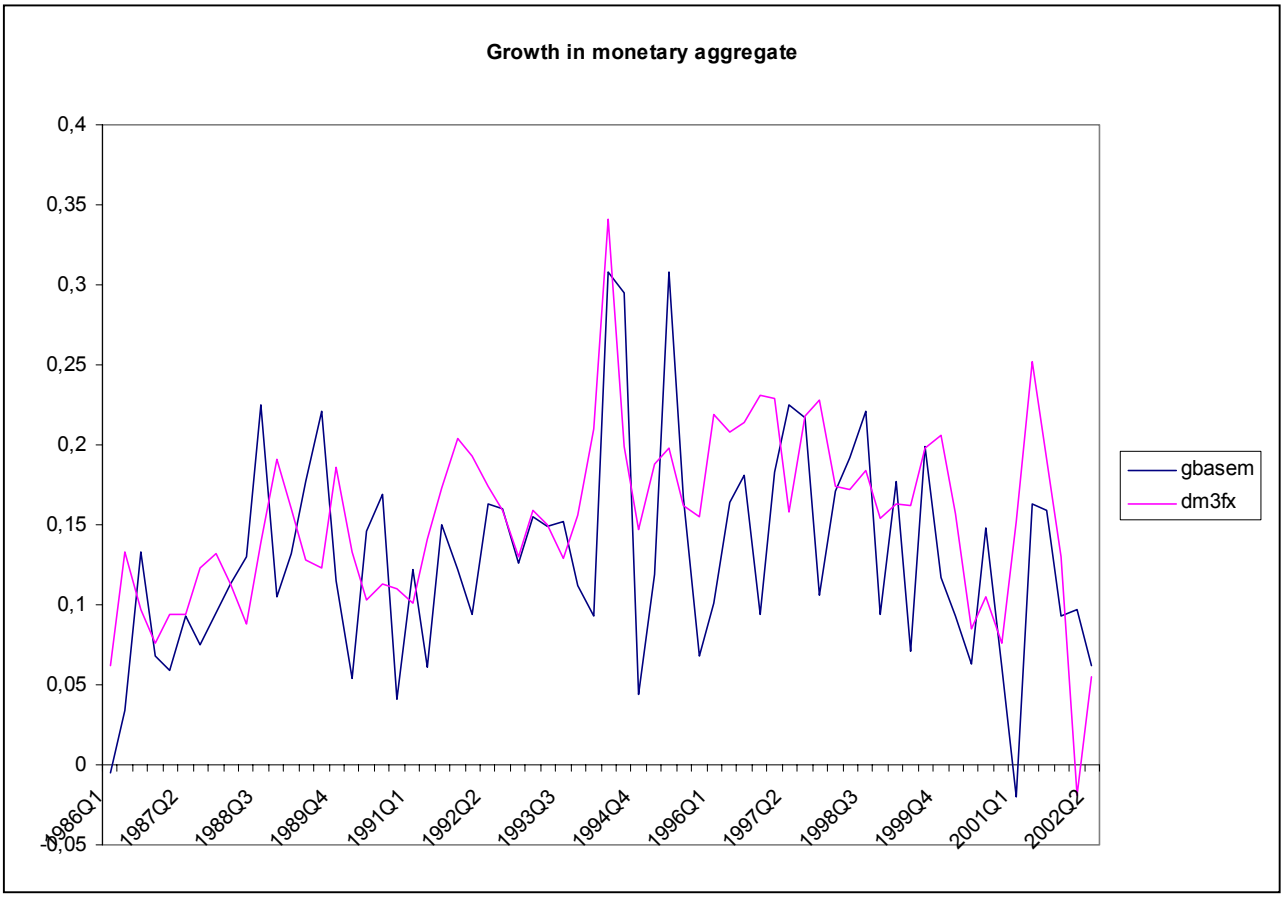
An interesting finding of reverse causality was proposed by Garanti Inflation Prospects[6]: while increasing debt induces inflation as seen above, inflation is, on the other hand, a debt-creating factor due to indexation either to foreign currency or short-term interest rate.

2) Monetary aggregate:

Based on the quantity theory of money, a change in the growth rate of money induces an equal change in the rate of price inflation (Lucas 1980). It is clear that from Chart 5, there are 2 peaks in growth of monetary aggregate – both base and broad money M3f/x occurring in 1988 and 1994 corresponding to the two peaks in inflation as seen earlier. It was found that inflation granger-causes base money[7]; nevertheless, this paper found that M3f/x granger-causes inflation. Hence, in later analysis, only m3f/x will be used.

[6] August 7, 2002
[7] CBRT monetary policy report (March 2002)

Chart 5 : Growth in monetary aggregate

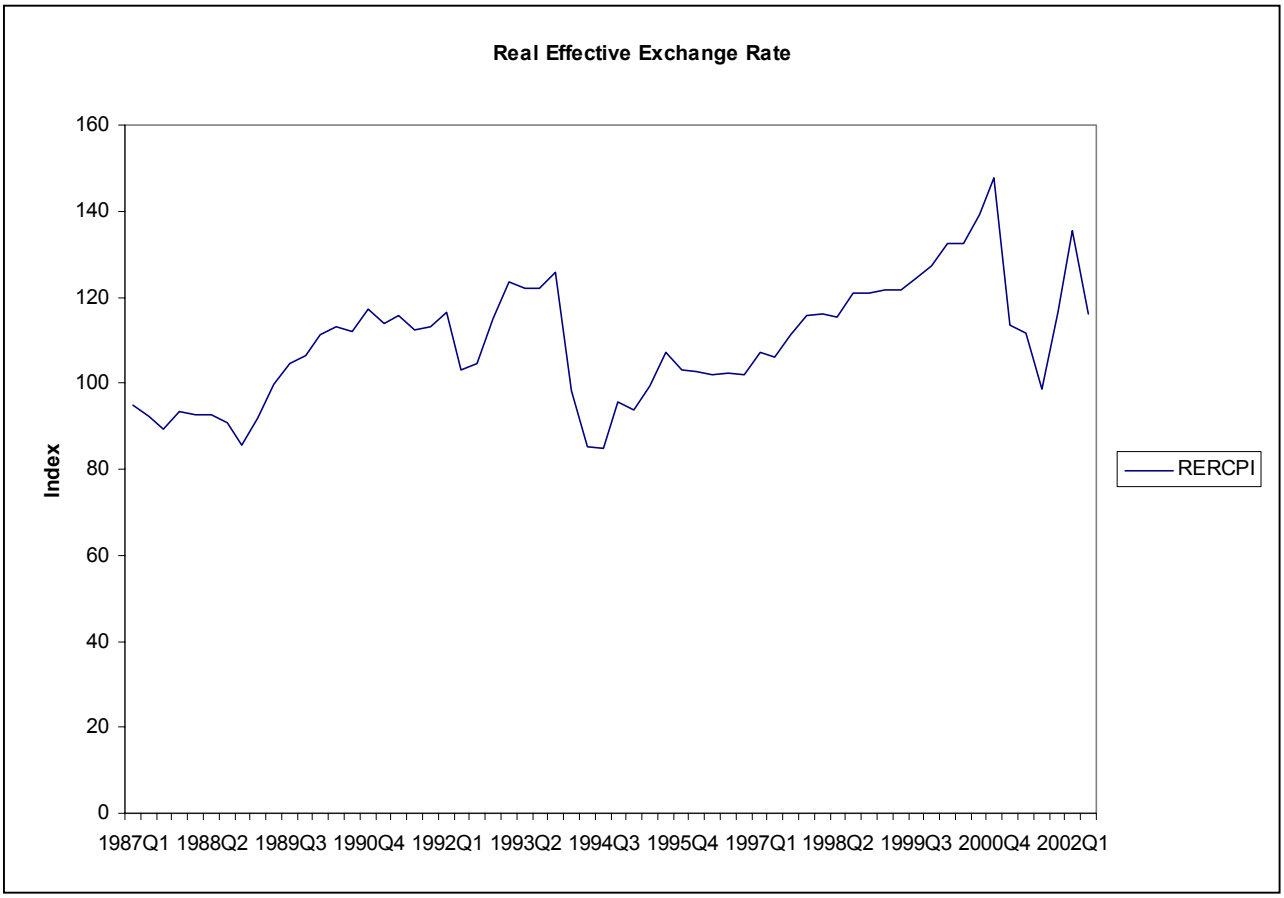


On this notion, Togan (1987), found the rate of inflation as determined by the path of money and interest rates based on a money demand model. The study was carried out for the period 1960-1983. Ozatay (1992) claimed a certain degree of predictability on movements in nominal income and GNP deflators by monetary aggregates. In a later study by Darrat in 1997, inflation appeared to be rooted from monetary growth and depreciation. Lim and Papi (1997) applied a multi-sector macro model of 1970-95 and concluded the vital role is played by monetary variables (money and exchange rate), exacerbated by public sector deficit and inertia.

3) Exchange rate:

The relationship between depreciation and inflation is easier to understand. Depreciation causes import prices to rise. Given that the Turkish economy is dependent on imports of raw materials, exchange rate channel plays a significant role in determining inflation. By inspection, real effective exchange rate strengthened after financial liberalisation, a significant depreciation took place around 1994 corresponding to the second peak of inflation. Depreciation in 1988 was not clearly evident. (See Chart 6)

Chart 6 : Real effective exchange rate



With regards to exchange rate, Onis and Ozmucur (90) found a two-way causal relationship between price and exchange rate. On the other hand, Rittenberg (93) and Metin (95) suggested only one-way relationship from price to exchange rate. Montiel and Ostry (1993) blamed depreciation as the principle cause of inflation through its expectation mechanism and indexation. In 1997, Agenor and Hoffmaister found historical shocks can largely account for inflations and claimed that nominal exchange rate depreciation was the key to Turkish inflation determination.

4) Inflation inertia:

Inertia was evident in the inflation process of Turkey, i.e. if inflation in this period is high, it is highly likely that the next period inflation will follow suit. In relation to this, Erlat 2001 found a long-run memory component in Turkish consumer and wholesale price indices. Insel (1995) and Akcay et al. (1997) pointed to inflationary expectations as an equal source of inflation besides public sector finance. Alper and Ucer (1998) played down the role of fiscal imbalances and supported the view of inflation inertia as the main force behind inflation in the short run.

As far as the sources of inertia are concerned, monetary and exchange rate policy were seen as the crucial sources of inertia rather than relative price variability and wage indexation by Alper and Ucer (1998). They assert that credible and well-designed disinflation program is necessary in eradicating the inertia component. This view is supported by a later study by Cizre-Sakallioglu and Yeldan (1999). On the other hand, Uygur (1990) suggests inflation expectation as the key in determining the extent of price changes and plays down the role of firm's mark-up on prices. Yeldan (1993) argues that prevailing income inequality and conflicting social claims on national output account for the main source of inertia in 1980s. Sahinbeyoglu (2001) proposed that strong and fast pass-through of price level changes to wage adjustment through high degree of indexation enhanced the extent of inflation inertia. It appears that inertial element is crucial so long as contracts for wages are backward-looking and credibility in monetary policy is not gained.

Hence, the main factors contributing to disappointing performance of inflation could be high budget deficit, growth in monetary aggregate and depreciation in exchange rate– further exacerbated by inertia. Taking on board all potential causes of inflation, the model used in the following analysis will incorporate them all – enabling us to carry out general-to-specific approach. As the data on wages are not readily standardised, usage of the series is avoided.

Methodology

In this section, Vector Auto-regression (VAR) and Vector Error Correction Models (VECM) are employed to gain an insight into the dynamics of the system and allow for feedbacks among endogenous variables of concern. While VAR provides us with ideas of what the dynamics should be, given virtually no restrictions on the system, VECM allows theoretical framework to come into play through imposition of long-run (co-integrating) structure upon the model. In other words, VECM is a specification, which restricts long-run behaviour of variables to converge to that of equilibrium relationship while allowing for short-run interactions. Deviation from long-run relationship is corrected for through short-run adjustments.

On VAR and VECM

The most basic unrestricted form of VAR of order p is as follows :

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + \ldots + A_p z_{t-p} + B y_t + \varepsilon_t$$

where z is an n x 1 vector of n endogenous variables. y refers to m x 1 vector of m exogenous variables. Matrices A, B are coefficients estimated and ε is a vector of innovations. Without restrictions imposed upon VAR, the estimation method is Ordinary Least Squares (OLS). Serial correlations can be absorbed by including appropriate number of lags. Classification of endogenous and exogenous variables are based primarily on Granger-Causality Test (See Table 1) as well as conformity with economic theory. Vector z comprises the following variables : inflation (inflcpi), t-bill rate (rtbill), effective exchange rate (nominal-lneer/real-lrercpi), real GDP (lrgdp) and growth in m3f/x (dlm3fx) and y vector consists of rate of change on public prices (inflpub), US t-bill rate (rustbill), debt-to-GDP ratio (ldebtgdp) assuming that fiscal authority is the first-mover and monetary policymaker take as given the level of debts generated. (This assumption will be relaxed at a later stage in a construction of small-macro model of the Turkish economy.) Another advantage for setting debt-to-GDP variable as exogenous is to avoid over-parameterisation in the VAR model given our data availability from later part of 1989 to the beginning of 2002 for most variables. Assessment will be performed only on the broadest definition of money (M3fx) – which includes components on foreign-currency deposits to take into account financial instruments as liquid as money for the reasons cited earlier[8]. Both real effective exchange rate and (constructed) nominal effective exchange rate are also looked at in turns. See data description in Data Appendix.

[8] Inflation granger-causes base money, while m3f/x is found to granger causes inflation

Table 1 : Granger-causality test

A → B at 10% sig	inflcpi	rtbill	lneer	lrercpi	dlm3fx	lrgdp	inflpub	rustbill	ldebtgdp
inflcpi	-	x	x	x	x	x	x	x	x
rtbill	√	-	x	x	√	√	√	x	x
lneer	√	x	-	√	x	√	√	x	x
lrercpi	√/?	x	√	-	√	√	√	x	x
dlm3fx	√	x	x	x	-	x	√	x	x
lrgdp	x	x	√	x	x	-	x	x	x
inflpub	x	√	x	√/?	x	√	-	√	√
rustbill	x	x	√	x	x	x	√	-	x
ldebtgdp	x	x	√	x	x	x	x	x	-
√ = A granger causes B, ? = ambiguous, x = no granger causality									

The same principle applies to system of equations as in the case of single equation. OLS estimates of these non-stationary variables may be deprived of long-run information. Unit root tests are then performed here to find out the order of integration. (Table 2) According to Engle and Granger (1987), a linear combination of two or more non-stationary variables may be stationary. It is then necessary to rearrange all variables in the model into its I(1) form before carrying out VAR and VECM analysis as all variables must be integrated of the same order to have equilibrium stationary relationship (or known as co-integrating vector - CIV) amongst them. Existence of CIVs among non-stationary variables implies links between their stochastic trends. (Enders 1999)

Table 2 : Unit Root Test

	inflcpi	rtbill	lneer	lrercpi	dlm3fx	lrgdp	inflpub	rustbill	ldebtgdp
level	-1.8847 (-2.9190)	-1.9208 (-2.9146)	0.78733 (-2.9077)	-2.5529 (-2.9118)	-2.6746 (-2.5928)	-1.6506 (-2.9137)	-2.6774 (-2.9109)	-2.1409 (-2.9069)	0.51553 (-2.9215)
1st dif	-4.2037 (-2.9202)	-5.4414 (-2.9157)	-3.8883 (-2.9084)	-4.7110 (-2.9157)	-5.3585 (-2.9118)	-2.7808 (-3.4919)	-5.6287 (-2.9118)	-4.0202(0) (-2.9077)	-5.2867 (-2.9228)

Having investigated the integration order of variables to be included in the model, VAR lag order need to be determined. For this purpose, log-likelihood ratio tests and order selection criteria was provided by the program. The lag orders suggested by AIC and SBC are 4 and 5 for the model with lneer and lrercpi respectively. However, bearing in mind the number of parameters to be estimated and data availability period, 2 will be chosen arbitrarily to avoid over-parameterisation. The choice of lag order is justified by the F-test of serial correlation in single-equation representation of ECM on inflation at 1% critical value.

Existence of co-integrating relations can be tested for by several means. The easiest one could be to follow Engle-Granger two-step method (See Engle and Granger 1987 for details). Complication arises once more than 2 variables are included in the model. For k I(1) series, there can be up to k-1 co-integrating relationship. Johansen (1988) maximum likelihood method to determine the number of cointegrating relationship is used instead. This procedure relies on the relationship between the rank and characteristic roots of a matrix derived from coefficient matrices A and B. From this exercise, suggested number of co-integrating vectors are 3 and 2 for models with lneer and lrercpi respectively. (See Table 3) However, if we take 3 as the number of co-integrating vectors, this implies 3 restrictions have to be placed upon each cointegrating relationship rendering at least one of them meaningless in

economic sense. Hence, 2 is selected as number of cointegrations. Just-identifying restrictions are based on simple economic logics – in the long-run output should have no effects on inflation and interest rates do not have a linear trend.

Table 3 : Cointegration LR Test

		Model with lneer		Model with lrercpi	
		λ_{max}			
Null	Alternative	Statistics	95% crit. value	Statistics	95% crit.value
R=0	R=1	124.9761	46.8400	123.9440	46.8400
R<=1	R=2	42.7845	40.9800	65.5984	40.9800
R<=2	R=3	41.7850	34.6500	29.7539	34.6500
R<=3	R=4	20.9015	27.8000	18.8535	27.8000
		λ_{trace}			
R=0	R=1	242.7687	120.0200	250.3186	120.0200
R<=1	R=2	117.7926	90.0200	126.3745	90.0200
R<=2	R=3	75.0080	63.5400	60.7761	63.5400
R<=3	R=4	33.2230	40.3700	31.0223	40.3700

Results and interpretation

Cointegrating relationship with real effective exchange rate suggests a positive relationship between inflation, exchange rate, interest rate, growth in broad money, growth in public prices, debt-to-gdp ratio. Negative relationship can be deduced for inflation and ustbill and time trend. From the way effective exchange rates are constructed, lrercpi increases means appreciation, lneer increases means depreciation. (See Box 1 and 2 for cointegrating vectors) Noteworthy, cointegrating vector only indicates relationship among variables but not the direction of causality. We will pay particular attention on inflation CIV (CV1).

Box 1 : Cointegrating vectors with real effective exchange rate

With lrercpi

CV1 (ecm1a)
Inflcpi
- [0.41631rtbill +0.98456lrercpi +2.0364dlm3fx +0.67632inflpub+1.9055rustbill+0.26565ldebtgdp-0.010801 Trend]
(0.098353) (0.37428) (0.66357) (0.16351) (0.88827) (0.10936) (0.00365)

CV2 (ecm2a)
Rtbill
- [2.5655 inflcpi -2.7641 lrercpi - 6.7121 dlm3fx + 2.4058 lrgdp -1.4995 inflpub - 4.5963 rustbill -0.37060 ldebtgdp]
(0.79765) (0.73120) (2.3991) (0.59266) (0.41578) (0.17353) (0.17353)

Box 2 : Cointegrating vectors with nominal effective exchange rate

With lneer

CV1 (ecm1b)
Inflcpi
- [0.40485 lneer - 3.1904 rustbill + 0.28982 inflpub – 0.56993 Trend]
(0.045202) (0.52463) (0.071487) (0.0062018)
CV2 (ecm2b)
Rtbill
- [1.7936 inflcpi + 0.75098 lneer – 7.5818 lrgdp – 7.7907 rustbill – 1.6226 inflpub – 1.5470 ldebtgdp]
(1.0413) (0.26546) (2.8698) (3.9581) (0.66566) (0.60718)
standard error in brackets

From Box 1, positive relationship between appreciation and inflation may arise as a result of inflation growing faster than exchange rate as cointegrating vector does not imply the direction of causation, just the relationship between them. It will be clear later that short-run impact of appreciation does lead to a decrease in inflation (from the first ECM equation in table 4). Taking away inflation effects on exchange rate, as cointegrating vector based on nominal effective exchange rate suggests (from Box2), depreciation in nominal exchange rate is associated with higher inflation.

Interest rate is found to be positively related to inflation. The effects could be both ways. An increase in interest rate signals future expectation of higher inflation or unsustainability of debt and likelihood of monetisation. This phenomena is self-fulfilled as inflation increases. On the other hand high inflation may prompt higher interest rate through a desire to curb inflation.

Growth in broad money is positively related to inflation – this makes sense in the quantity theory of money. As seen earlier from Granger-causality test – the causation is in the direction expected by the theory. Nevertheless, rapid financial liberalization may lead to unstable velocity of money, hence unpredictable effects of growth in money to inflation.

Public prices comprise utility and transportation crucial as inputs into production. Higher costs of inputs are inevitably passed on to consumers through higher inflation.

Inflation also rises with increasing debt to gdp ratio. The sustainability of debt is the key here. As debt stock rises, ability to finance is questioned and the possibility of monetisation rises. Inflation expectation is higher resulting in higher inflation.

From Box 2, with nominal effective exchange rate, rtbill, dlm3fx and ldebtgdp are found to be insignificant in the equilibrium relationship (with t-ratio less than 1). Hence they are deleted from CIV, Log-likelihood Ratio Test of over-identifying restrictions shows these deletion are valid with chi-square(4) statistics of 4.4553 (p-value = .348). With the use of nominal exchange rate, the effects of these variables may be overwhelmed by exchange rate or the nominal exchange rate, rtbill, dlm3f/x and ldebtgdp are collinear which renders coefficient estimates insignificant.

From Table 4, error correction model on inflation dynamics is shown. ECM form suggests significant effect of depreciation in real effective exchange rate on inflation in the short-run. Adjustment to equilibrium of inflation is clearly seen from the negative coefficients on ecm1 for both cases. Movement in inflation in this period corrects for 18.2% and 44% of disequilibrium in the previous period for real and nominal exchange rate cases respectively.

Table 4 : Error Correction Model for inflation

Dependent variable: dinflcpi	lrercpi Coefficient (standard error)	Lneer Coefficient (standard error)
Intercept	-1.0597 (0.79600)	-0.25861 (0.65170)
Dinflcpi(-1)	0.059265 (0.26043)	0.20873 (0.33440)
Drtbill(-1)	-0.047185 (0.033849)	-0.0052573 (0.032446)
Dexchange rate(-1)	**-0.36342 (0.13345)**	0.16547 (0.16590)
Ddlm3fx(-1)	-0.13705 (0.28261)	0.026082 (0.28655)
Dlrgdp(-1)	-0.015866 (0.046373)	-0.0000114 (0.043985)
Dinflpub(-1)	-0.10770 (0.14590)	-0.88497 (1.8943)
Drustbill(-1)	-2.3921 (1.7858)	-0.22285 (0.16479)
Dldebtgdp(-1)	0.043822 (0.093095)	0.13479 (0.090676)
Ecm1(-1)	-0.18187 (0.12571)	**-0.44022 (0.19605)**
Ecm2(-1)	-0.017212 (0.025981)	0.0044491 (0.0086774)

Data : 1989Q2-2002Q1

On Forecast Error Variance Decomposition

Variance decomposition (VD) on VECM should provide a graphical insight into the proportion of the movements in a sequence due to its own shock versus shocks to other variables. (Enders 1999) To avoid effects from particular ordering, generalized VD is used instead of orthogonalized.

VD on inflation equation suggests that movement in inflation is accounted mainly by its own shocks, suggesting high degree of persistence, then subsequently by shocks to interest rates and exchange rates (See Chart 7). Shock to output has least effects on inflation. On the other hand, movement in output was virtually due to its own shock with insignificant contributions from monetary variables (See Chart 8). This conforms with the findings by Dibooglu and Kibritcioglu (2001), where inflation is more demand-driven and output is affected more by supply shock.

In relation to the next part, from Chart 9, it is evident that apart from its own shocks, movement in interest rates was accounted for by shocks to inflation and exchange rate in the first period of 36% and 30% respectively. As time goes by, effect from inflationary shock subsides and there appear an increasing role played by output and monetary aggregate. Hence, this is a case for the study on how interest rate reacts to these variables, or a so-called 'reaction function' as shall be seen in the next part[9].

[9] Studies on reaction function such as Emir, Karasoy and Kunter (2001) suggests sterilization and accommodative monetary policy to fiscal policy by expanding domestic credits to finance budget deficit. This implies a limited role for interest rate as instruments.

Chart 7 : VD for inflation

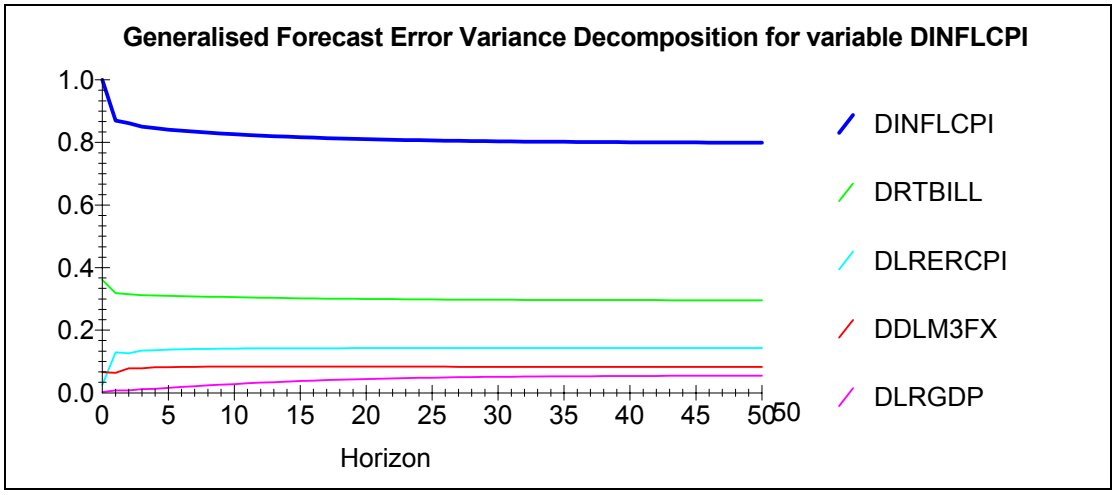


Chart 8 : VD for output

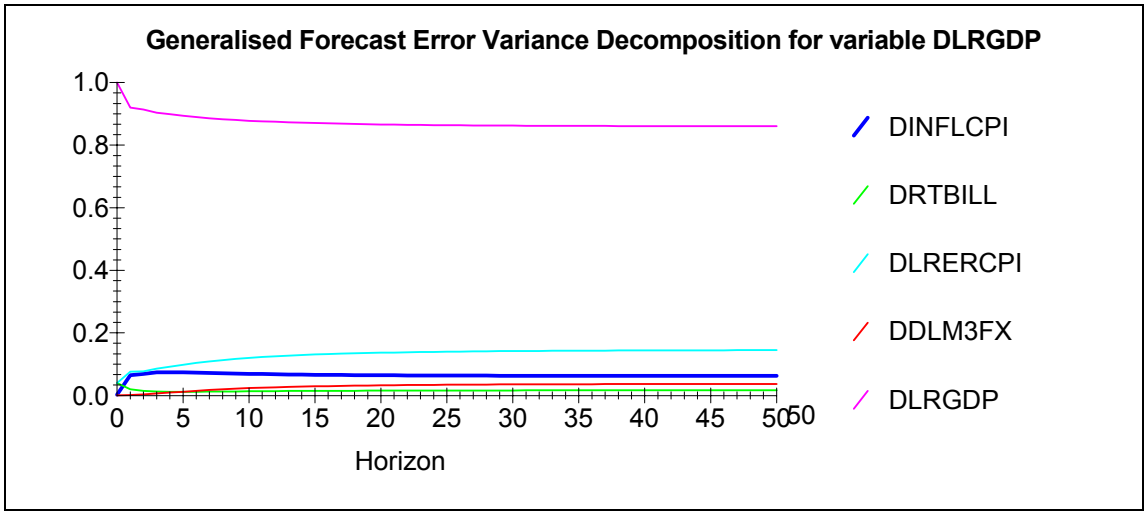
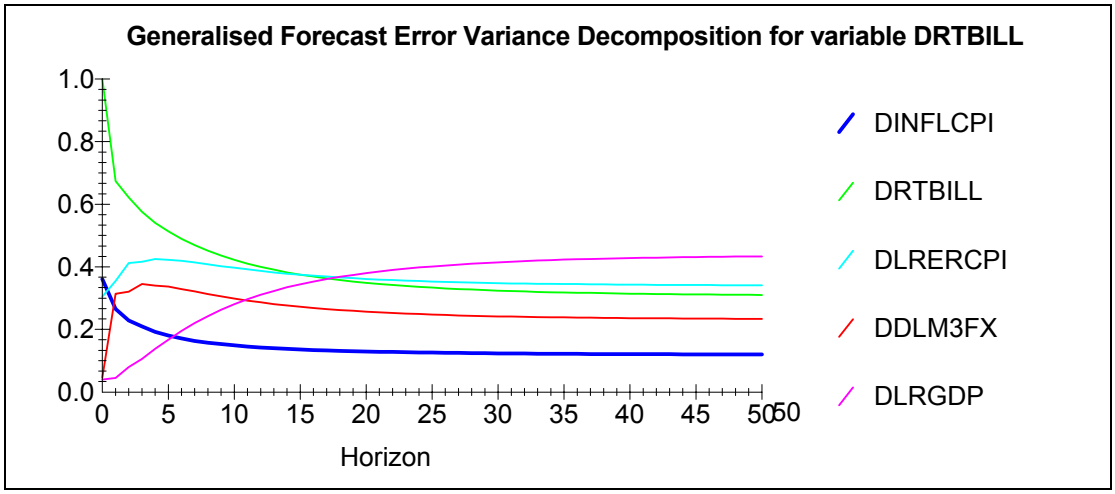


Chart 9 : VD for interest rate



Modelling

We adopt here a small scale macro-economic model[10] (SSMM) for the Turkish economy. The model will allow us to see the effects of an alteration to variables of concern on the path of other endogenous variables through simulation and impose more structure than VAR or VECM while allowing for flexibility in terms of leads and lags. Among the pioneers of SSMM is Dornbusch (1976). Several versions of SSMMs in terms of wage/price setting, closed/open economy, backward/forward-looking expectations can be seen from the literature.

Model formation process

This exercise aims for least micro-foundation but general-to-specific approach by including all variables suggested by economic theory and economic common sense, then eradicate the insignificant ones. Each equation is selected based on economic theory and econometric test-statistic suggestions to achieved the best fitted model. Each equation is then brought together to be estimated as a system and it was found that estimation by system using Seemingly Unrelated Regression Estimation method (SURE) and individual equation estimation by OLS do not yield significantly different results. Complication arises when forward-looking terms are included, instrumental variables are used instead for these equations with variables in lead terms. The final best-fitted equations are also tested for unit root in its residuals to ensure stationarity of the residuals and cast out spurious regressions.

The model

This SSMM consists of 5 equations. LM relation is excluded due to suspicion on possibility of instability in money demand and disequilibrium in the money market. In addition, it deems necessary to model explicitly the stock of debt as one of the endogenous variables. Debt dynamics is important for policy implication in Turkey due to heavy interaction between fiscal and monetary sides of policy. The model comprises:

1. IS equation
2. inflation
3. exchange rate dynamics
4. debt stock
5. reaction function

1) IS equation

Maximising-utility version of IS curve suggests forward-looking term for output gap (see Clarida et al. 1999). On the other hand, Sahinbeyoglu (2001), Ball (2000), and Rudebusch and Svensson (1999) suggested inclusion of lags in output gap. The coefficients of lags and leads are expected to be positive due to inertial effect. Most articles included real interest rate and for open economy, the change in real exchange rate. A rise in interest rate is expected to reduce output gap due

[10] This terminology was first used by King (1994)

to higher costs of investment and borrowing. A depreciation should boost an economy through higher exports. The signs we expect are:

$lrgdpgap_t = f(+lrgdpgap_{t+1}, +lrgdpgap_{t-1}, - realtbill_t, - dlrercpi_t)$

2) Inflation

The literature suggests various different combination of factors determining inflation. To account for inertia and expectation, lead and lag of inflation are common to most hybrid version of the Phillips curve. Open economy version sensibly incorporates effects from exchange rate on inflation. Depreciation induces higher import prices. For a country which use imported raw materials like Turkey, depreciation could lead to inflation. In relation to the earlier part, in addition to leads and lags of inflation, the same variables except output are included at different dynamics. Output is included in the form of output gap instead to conform with the traditional Phillips curve model, while debt is differenced. These adjustments are solely to avoid non-stationarity in residuals. We expect:

$inflcpi_t = g(+inflcpi_{t+1}, +inflcpi_{t-1}, +rtbill_t, -lrercpi_{t-1}, +lrgdpgap_t, +inflpub_t, +dldebtgdp_t)$

3) Exchange rate dynamics

Along the same line as uncovered interest parity, higher interest rate differentials between domestic and abroad induces appreciation today and depreciation tomorrow. There is also a risk premium attached, which accounts for the difference in interest rate home and abroad. The uncovered interest parity is of the form : $R/I^f_T - R/I^d_T$ = expected rate of currency $depreciation_{T+1}$ + risk premium. As monetary variables move quickly and the data used is quarterly, T and T+1 here could be in the same quarter t. A proxy for risk premium factor in this case is taken to be the growth in domestic debt stock. Hence, we expect:

$dlrercpi_t = h\ (-(rtbill-rustbill)_t, -dldebtgdp_t)$

4) Debt stock

To explicitly account for intervention of fiscal part, debt stock is determined. Given two available ways of financing budget deficit – monetisation and issues of bonds (debt stock), an increase in base money should be associated with lower debt stock. Debt stock grows with higher real interest rate, as interest payment obligation is accumulated to further debts. Moreover, the higher public deficit, the more public debt will be to finance it. We would then expect:

$dldebtgdp_t = I\ (+realtbill_t, - dlbasem_t, +dlbdefgdp_t)$

5) Reaction function

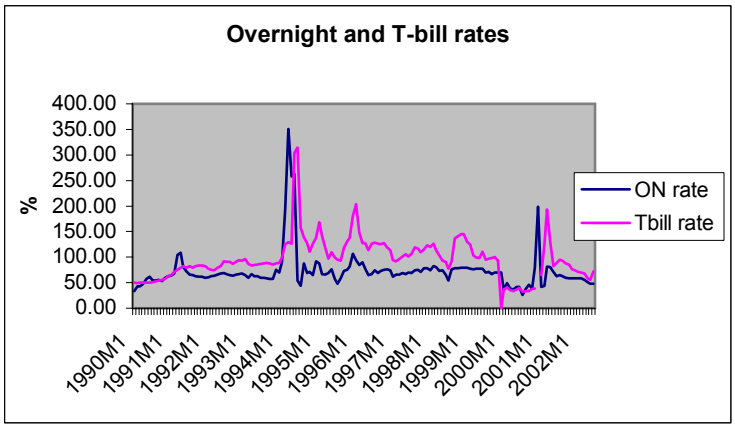
Estimation of reaction function provides us with a simplified form of how interest rate is used by the Central Bank to achieve its objectives- may they be exchange rate, inflation or output stabilization. It could be argued that Turkish central bank only accommodates but they do not have explicit reaction function. In the previous section, we found that shocks to inflation could be attributed in a large proportion to interest rate. Although it appears that there is no explicit reaction function and interest rate has been accommodative, interest rate does have a role in influencing inflation and

exchange rate. On the other hand, VD also suggests that movement in interest rate, leaving aside its own shock, could be accounted for by shocks to exchange rate and inflation. Hence, this is a ground for estimating how interest rate reacts to inflation and exchange rate. The components included in the reaction function will be a variation of simple Taylor rule (see Taylor 1993 for details) in an open economy with high exchange rate pass-through. Sensibly, it is conventional to assume that as inflation increases, interest rate is raised to tame down inflation. Interest rate could also be used to defend exchange rate. Depreciation should be encountered by a rise in interest rate to attract capital and raise demand for domestic currency. The earlier part also suggests that shock to interest rate could partly be explained by movement in output gap, while output gap displacement could hardly be explained by interest rate[11]. In addition, nominal interest rate policy usually involves interest rate smoothing (See Taylor 1999). We would then expect:

$$rtbill_t = j\ (+(inflcpi\text{-}inflcpihp)_t,\ -dlrercpi_t,\ +rtbill_{t-1},\ +\ outputgap_t)$$

Note that t-bill rate is used instead of the actual policy rate, to justify this we examine the series of overnight and t-bill rates. (See Chart 10)

Chart 10 : Overnight and T-bill rates



It is clear that both series closely track each other, there is also a high correlation between them. The correlation coefficient is 0.59731.

[11] This may make disinflation easier through interest rate policy, once it is divorced from fiscal influence.

Table 5 : Estimation Result (1989Q2-2001Q4)

Equation	R/GRbar-square	S.E.	DW
1. IS (IV estimation) $lrgdpgap_t = 0.007977 + 1.601447lrgdpgap_{t+1} + 0.054674\ lrgdpgap$ $- 0.015324reatbill_t - 0.210808dlrercpi_t$	GR-bar-square 0.50017	0.043812	2.0427
2. Inflation (IV estimation) $inflcpi_t = 1.037344 + 0.277678\ inflcpi_{t+1} + 0.470426\ inflcpi_{t-1} + 0.023137\ rtbill_t$ $- 0.204039lrercpi_{t1} + 0.437839lrgdpgap_t + 0.070633inflpub_t + 0.082015dldebtgdp_{t-1}$	GR-bar-square 0.77666	0.036390	2.4537
3. exchange rate (OLS) $dlrercpi_t = 0.073153 - 0.069124\ (rtbill - rustbill)_t - 0.180509\ dldebtgdp_t$	R-bar-sq 0.14037	0.098996	1.9953
4. debt dynamics (OLS) $dldebtgdp_t = 0.064888 + 0.107933\ realtbill_t - 0.714170\ dlbasem_t + 0.009631\ dlbdefgdp_t$	R-bar-sq 0.18255	0.069627	1.8904
5. Reaction function (OLS) $rtbill_t = 0.321295 + 0.665036\ infldev_t - 1.790958dlrercpi_t + 0.655581\ rtbill_{t-1}$	R-bar-sq 0.57584	0.25011	2.2056

Policy implication

Estimation of the above system provokes an idea of how to combat inflation, the main problem confronting the Turkish economy. Leaving aside fiscal adjustment – which needs to be done, we examine how monetary authority could have done to improve the situation. The only instrument apparent here is interest rate. Hereby, we carry out a counter-factual simulation exercise in order to find out the possibility of reducing inflation through adjustment in the sensitivity of interest rates to inflation deviation and depreciation without tampering exchange rate or inducing sky-high interest rate. First of all, from the baseline model above, we solve for variables of interest – inflation, real effective exchange rate and interest rate. Actual series and simulated series are plotted to compare (where variable_turk1 refers to simulated series) See Chart 11-13. There is a high correlation between the actual and simulated series. (See Table 6).

Table 6 : Correlation coefficient between actual and simulated series

	inflation	exchange rate	interest rate
corr. coef.	0.915073	0.767520	0.584387

Chart 11 : Actual and simulated inflation

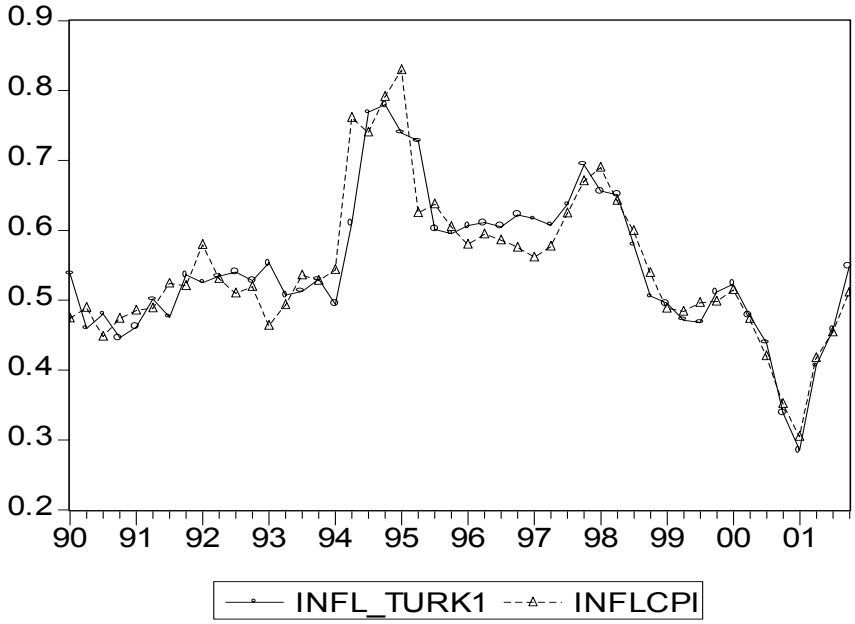


Chart 12 : Actual and simulated real effective exchange rate

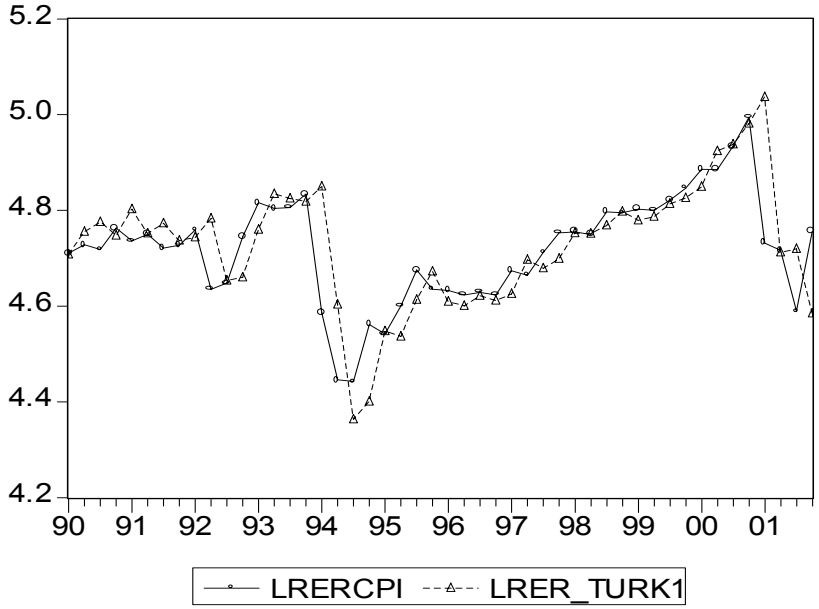
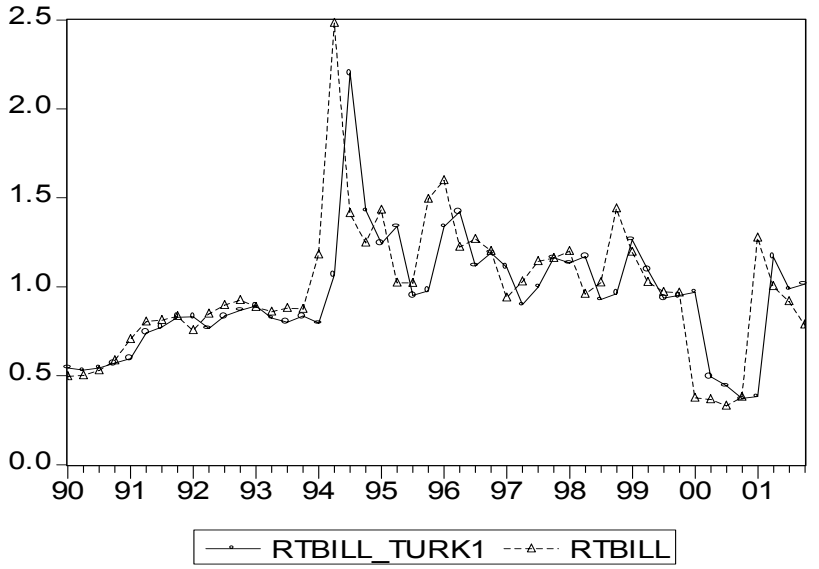


Chart 13 : Actual and simulated t-bill rate



From the model above,

$$rtbill_t = 0.321295 + \alpha\ infldev_t - \beta\ dlrercpi_t + 0.655581\ rtbill_{t-1}$$

$\alpha_{baseline} = 0.665036$, $\beta_{baseline} = 1.790958$

We seek to alter α and/or β and resolve the model to see the path of these variables. The aim is to find the combination of a and β that brings about improvement in terms of (average) level of inflation, exchange rate and interest rate. It was found that certain combinations of α and β do perform slightly better than the baseline model. However, this small improvement does come with a cost - variability of all 3 variables have also increased slightly. These combinations consist either of increasing α on inflation, keeping β at baseline level or increase α by more than double and slightly lower β. Standard error of all 3 variables can be reduced through a reduction in either α or β keeping the other constant. (See Table 7)

Table 7 : Average and standard deviation of variables for different combinations of α and β

(α,β)	av. infl	s.d. infl	av. rer	s.d. rer	av.tbill	s.d.tbill
actual	0.546767	0.103640	4.720059	0.112331	0.984488	0.378318
(0.665036, 1.790958)	0.547167	0.100991	4.726504	0.129541	0.943917	0.325039
(1,1.3)	0.547241	0.101308	4.726240	0.130363	0.946910	0.329489
(1,1.5)	0.547194	0.101413	4.726407	0.130765	0.945013	0.335349
(1,1.6)	0.547169	0.101467	4.726493	0.130973	0.944035	0.338375
(1,1.7)	0.547145	0.101523	4.726581	0.131185	0.943036	0.341468
(1,1)	0.547307	0.101158	4.726002	0.129791	0.949614	0.321150
(1.5,1.5)	0.547128	0.102279	4.726640	0.133522	0.942372	0.365893
(3,1.5)	0.546920	0.105056	4.727382	0.142570	0.933955	0.474128
(0.8,2)	0.546873	0.100160	4.721345	0.122220	0.950266	0.330164
($\alpha_{baseline}$,1)	0.547347	0.100624	4.725861	0.128111	0.951212	0.303504
($\alpha_{baseline}$,1.5)	0.547236	0.100849	4.726255	0.128986	0.946740	0.316692
($\alpha_{baseline}$,0.5)	0.547447	0.100422	4.725504	0.127322	0.955266	0.291601
($\alpha_{baseline}$,2)	0.546887	0.099960	4.721297	0.121592	0.950809	0.323275
(0.5,$\beta_{baseline}$)	0.546952	0.099626	4.721063	0.120452	0.953471	0.309311
(0.8,$\beta_{baseline}$)	0.547149	0.101224	4.726568	0.130277	0.943193	0.332624
(1,$\beta_{baseline}$)	0.547122	0.101574	4.726663	0.131383	0.942108	0.344340
(1.5,$\beta_{baseline}$)	0.547053	0.102470	4.726907	0.134240	0.939338	0.375969

The optimal choice has to depend on the objective function, which defines exactly what relative weight to place on inflation and exchange rate respectively. The higher α and/or β does reduce the level of inflation and/or appreciate exchange rate on average but induces more volatility.

Conclusion

It is clear that inflation dynamics is influenced by both fiscal and monetary factors. Fiscal deficit, hence debt has to be reduced in order to moderate the degree of endogeneity of interest rate and subsequently free up interest rate as a policy instrument. Debt is the root to inflation and banking sector failure and can be relieved in many ways such as fiscal discipline, improvement in tax collection or privatisation.

As far as monetary policy is concerned, if interest rate were to be used as an instrument, it has to be more sensitive to inflation to improve performance. The implication of this is the need to place inflation among priority list together with exchange rate. Adoption of inflation targeting is one method of imposing greater emphasis on inflation. Hence, the regime can be perceived as an appropriate way forward.

Data Appendix

Inflation

infl : $\log(cpi_t) - \log(cpi_{t-4})$; where cpi refers to consumer price index

infldev : deviation of infl from its Hodrick-Prescott filtered trend

T-bill rate

rtbill : t-bill rate/100

rustbill : US t-bill rate /100

realtbill : rtbill deflated by infl

Exchange rate

lrer : log (real effective exchange rate)

lneer: log (nominal effective exchange rate)

monetary aggregate

base money : currency issued + required reserves

lm3f/x : log (m3 + f/x deposits)

Output

lrgdp : log (GDP at constant prices, seasonally adjusted)

lrgdpgap : deviation of lrgdp from its Hodrick-Prescott filtered trend

Public sector inflation

inflpub : log (wpi $public_t$) – log (wpi $public_{t-4}$) ; wpi refers to wholesale price index for the public sector

Public deficit

lbdefgdp : log (budget deficit) – log (gdp, seasonally adjusted)

Debt

ldebtgdp : log (domestic debt) – log (gdp, seasonally adjusted)

$dx = x_t - x_{t-1}$

Data obtained from:

- the Central Bank of the Republic of Turkey website (www.tcmb.gov.tr)
- International Financial Statistics CD (IMF)

Nominal effective exchange rate is constructed from geometric weighing of Turkish Lira per Deutschmark and Turkish Lira per US-Dollar with weights 0.6 and 0.4 respectively.

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