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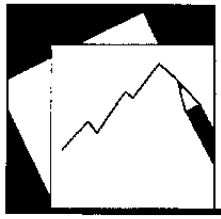

IMF Working Paper

Exchange Rate Pass-Through in Turkey

Daniel Leigh and Marco Rossi

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European I Department

Exchange Rate Pass-Through in Turkey

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Abstract

In light of the strong correlation between exchange rate movements and domestic prices in Turkey, it is important to assess the impact of the exchange rate on domestic prices, in particular as Turkey moves to an inflation targeting regime. This paper uses a recursive vector autoregression model to investigate the impact of exchange rate movements on prices in Turkey. We find that (i) the impact of the exchange rate on prices is over after about a year, but is mostly felt in the first four months, (ii) the pass-through to wholesale prices is more pronounced compared to the pass-through to consumer prices, and (iii) the estimated pass-through is complete in a shorter time and is larger than that estimated for other key emerging market countries.

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I. INTRODUCTION

There is strong correlation between exchange rate movements and domestic prices in Turkey. Figure 1 shows the month-on-month changes in the exchange rate and the wholesale price index (WPI), and the consumer price index (CPI) since the floating of the lira in February 2001. Following the sharp depreciation of the Turkish lira after the abandonment of the currency peg in February 2001, wholesale and consumer price inflation increased to a peak in April 2001 and then declined gradually. By February 2002, the inflation rates seemed to have returned back to their precrisis levels.

It is, therefore, important to assess the impact of the exchange rate on domestic prices, in particular as Turkey moves to an inflation targeting regime.[2] One of the characteristics of inflation targeting (IT) is the forward-looking nature of the policy stance. IT requires central banks to react promptly when the inflation forecast deviates from target. Various tools are used to forecast inflation: structural macroeconomic and short-term models, asset prices, and leading indicators. In a small open economy such as Turkey, the exchange rate can have a potentially large impact on inflation and inflation expectations. A fuller understanding of the impact of exchange rate movements on different prices (wholesale and consumer prices), both in terms of length and magnitude, is, therefore, important in assessing the monetary policy stance in the context of inflation targeting.

This paper investigates the impact of exchange rate movements on different prices in Turkey.[3] The aim is to determine some stylized facts regarding the exchange rate pass-through, in particular since the floating of the Turkish lira in February 2001. The paper also assesses future pressures on domestic prices that are produced exclusively by past exchange rate movements. The pass-through coefficient over a given time period is measured as the ratio between the cumulative change in the price level and the cumulative change in the nominal exchange rate over the same time period. Our data sample covers the period from January 1994 to April 2002.

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[2] Under the 1999 IMF-supported program, the Central Bank of Turkey (CBT) intended to introduce inflation targeting (IT) in 2002 as the exchange rate band widened and control of domestic monetary conditions improved. The crisis in February 2001 and the introduction of the float left the economy without a nominal anchor, underscoring the importance of moving toward IT promptly. Preparatory work was speeded up with a view to introducing IT by end-2001. Amid financial turbulence in the aftermath of September 11, the CBT felt, however, that additional time was needed to prepare for IT. The CBT has recently announced that the adoption of IT is likely to be delayed until 2003.

[3] In a companion paper, Leigh and Rossi (2002) look at the information content of leading indicators of growth and inflation.

The vector autoregression (VAR) analysis in this paper confirms the importance of exchange rate movements in explaining domestic price inflation. Three findings are worth emphasizing. First, the impact of the exchange rate on prices is over after about a year, but is mostly felt in the first four months. Second, the pass-through to wholesale prices is more pronounced compared to the pass-through to consumer prices. After a year, about 60 percent of an initial exchange rate shock has passed through to wholesale prices and about 45 percent of the shock has passed through to consumer prices. Third, the estimated pass-through in Turkey is both quicker and larger than that estimated in other key emerging market countries.

The paper is organized as follows. Section II provides a brief summary of the exchange rate pass-through literature and of cross-country experiences. Section III introduces a recursive VAR model with supply shocks, demand shocks, the exchange rate, wholesale prices, and consumer prices based on McCarthy's (1999) approach. The impulse responses are used to estimate pass-through coefficients for wholesale and consumer prices. Results on both variance and historical decomposition are then presented. Section IV assesses the quantitative impact of the February 2001 depreciation on domestic prices using the pass-through coefficients estimated in Section III, and computes the conditional price forecasts for the WPI and the CPI over the next year. Section V concludes.

II. Literature Review

A large body of empirical and theoretical literature studies the pass-through from the exchange rate to various domestic price measures. In the empirical literature, McCarthy (1999) analyzes the impact of exchange rate changes and import prices on producer and consumer prices in a recursive VAR framework. Using data from six industrialized OECD countries, he finds that the exchange rate has a modest effect on consumer prices. He also finds that the pass-through tends to be correlated with the degree of openness of the economy. A panel study of 71 countries by Goldfajn and Werlang (2000) finds that the pass-through is correlated with the business cycle, the size of the initial real exchange rate misalignment, the initial rate of inflation, and the degree of openness of the economy. They also find that the pass-through coefficient increases with time following the devaluation, and reaches a peak after 12 months. Rabanal and Schwartz (2000) analyze the behavior of inflation in Brazil following the floating of the *real* in January 1999. They find that "20 months after the floating ... the initial shock has worked itself through the system." Burstein, Eichenbaum, and Rebelo (2002) study the behavior of inflation after large devaluations in nine countries—Finland, Sweden, Mexico, Korea, Thailand, Malaysia, the Philippines, Indonesia, and Brazil—and find a low pass-through from the exchange rate to consumer prices. Bhundia (2002) finds that, in the case of South Africa, while the average pass-through is low, it is much higher for nominal than for real shocks.

There are several reasons why the pass-through could be incomplete. Krugman (1986) argues that "pricing to market" by foreign suppliers can explain why U.S. import prices do not fully reflect movements in the exchange rate. To maintain market shares, the foreign supplier might not change the price and instead adjust the profit margin. Burstein, Eichenbaum, and Rebelo (2002) argue that distribution costs and substitution away from

imports to lower quality local goods can account quantitatively for the incomplete pass-through of exchange rate depreciations to domestic prices.

III. Vector Autoregression Analysis

The pass-through of the exchange rate to domestic prices is evaluated using a five-variable recursive VAR approach. The methodology draws on McCarthy (1999) and has the following ordering for the endogenous variables: oil prices in Turkish lira,[4] real output, the nominal exchange rate relative to the U.S. dollar, wholesale prices, and consumer prices.[5] The structural shocks are recovered from the VAR residuals using the Cholesky decomposition of the variance-covariance matrix. Supply shocks are identified by the first variable. Demand factors are identified by the industrial production index.[6] Nominal exchange rate shocks are identified by the third variable. The price series contain sequential shocks that can be attributed to the different stages of the supply chain. The system thus allows one to trace the dynamic effect of an exchange rate shock on prices along the supply chain, going from the exchange rate, to the wholesale price index that contains a relatively high proportion of tradable goods, and finally to the consumer price index that contains a smaller proportion of tradable goods.[7] The system can thus be represented as follows:

[1] $$\pi_t^{oil} = E_{t-1}[\pi_t^{oil}] + \varepsilon_t^{oil}$$

[2] $$\Delta y_t = E_{t-1}[\Delta y_t] + \alpha_1 \varepsilon_t^{oil} + \varepsilon_t^{\Delta y}$$

[3] $$\Delta e_t = E_{t-1}[\Delta e_t] + \beta_1 \varepsilon_t^{oil} + \beta_2 \varepsilon_t^{\Delta y} + \varepsilon_t^{\Delta e}$$

[4] $$\pi_t^{WPI} = E_{t-1}[\pi_t^{WPI}] + \gamma_1 \varepsilon_t^{oil} + \gamma_2 \varepsilon_t^{\Delta y} + \gamma_3 \varepsilon_t^{\Delta e} + \varepsilon_t^{WPI}$$

[5] $$\pi_t^{CPI} = E_{t-1}[\pi_t^{CPI}] + \delta_1 \varepsilon_t^{oil} + \delta_2 \varepsilon_t^{\Delta y} + \delta_3 \varepsilon_t^{\Delta e} + \delta_4 \varepsilon_t^{WPI} + \varepsilon_t^{CPI}$$

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[4] Average of U.K. Brent, Dubai, and West Texas Intermediate (period average). Converted into Turkish lira by multiplying by the TL/US$ exchange rate. Source: IMF *International Financial Statistics* database.

[5] The results for the regression coefficient estimates and for the impulse responses are robust to changes in the ordering of these variables.

[6] The VAR analysis made using the output gap instead of industrial production delivered very similar results. Source for IP data: Central Bank of Turkey. These are seasonally adjusted using X11 method.

[7] The WPI contains about 70 percent tradable goods, and the CPI contains about 45 percent of tradable goods.

where π^{oil} is oil price inflation, Δy is the first log difference of IP, Δe is the first log difference of the nominal exchange rate, and π^{WPI} and π^{CPI} are the rates of WPI and CPI inflation, respectively. The time period t corresponds to one month. Finally, $E_{t-1}[\,]$ denotes the expectation of a variable conditional on information available at period t-1. We assume that the conditional expectations in equations [1] through [5] can be replaced by linear projections based on lags of the five endogenous variables.

A. Some Statistical Preliminaries

The sample period is January 1994 to April 2002. Ideally, we would measure the pass-through using only data since the floating in February 2001. Using only post-February 2001 data, however, would yield an insufficient number of observations. This sample period, therefore, includes the managed float regime prior to December 1999, the crawling peg stage of December 1999 to February 2001 and the floating period since February 2001.

Variables were transformed to be stationary. To determine the stationarity of the variables in the system, unit root tests are run on the logarithm levels of the series. Augmented Dickey-Fuller tests suggest modeling all the series as I(1) so that the VAR is estimated in first differences.[8]

Lag lengths to estimate the model are chosen to minimize the Akaike Information Criterion (AIC). Four lags of the first-differenced series are used in the estimation. This lag length minimizes the AIC of the VAR. Moreover, the results of our analysis are robust to estimating the VAR with different lag lengths.

B. Estimates of the Pass-Through Coefficients

Impulse response functions are used to assess the impact of exchange rate movements on domestic prices. Figure 2 shows the estimated orthogonalized impulse response functions for wholesale and consumer price inflation to a one standard deviation innovation in the nominal exchange rate. Since the focus is on the effects of an exchange rate shock on prices, the other impulse response functions are not reported.

We derive estimates of the cumulative pass-through coefficients from the impulse response functions. Estimates of the pass-through coefficients are obtained by dividing the cumulative impulse responses of each price index after j months by the cumulative response

[8] The same model was also estimated in levels. The pass-through coefficients derived from the impulse response functions of the model in levels were approximately the same as those derived from the accumulated impulse response functions of the model in differences. We only report results for the model estimated in first differences.

of the exchange rate to the exchange rate shock after j months.[9] These coefficients, therefore, show the model's predicted adjustment of prices to an exchange rate shock after accounting for the disturbances of the other endogenous variables in the model.

The impact of an exchange rate shock on domestic prices is over within a year, but is mostly felt in the first four months (Figure 3). The wholesale and consumer price inflation rates increase following the exchange rate shock and return to their initial levels after about 12 months. Indeed, the model estimates suggest that the exchange rate shock has a relatively rapid effect on wholesale and consumer prices. Despite the wide standard errors, the CPI and WPI impulse responses are significantly different from zero at the 5 percent probability level for the first four months. The coefficients, however, change little after the fourth month—they are no longer significantly different from zero at the 5 percent probability level—at which point 50 percent and 40 percent of the exchange rate change have already been reflected into wholesale and consumer prices, respectively.[10]

The pass-through to wholesale prices seems more pronounced compared to the pass-through to consumer prices, with as much as 60 percent of the exchange rate change being eventually reflected in domestic prices. By the end of the first month after the shock, the WPI and CPI have risen by 17 and 12 percent of the exchange rate shock, respectively. The pass-through coefficients increase until the eleventh month, by which time 60 and 45 percent of the depreciation shock seems to have passed through to wholesale and consumer prices, respectively.

C. Variance Decomposition

The variance decomposition allows us to examine the importance of exchange rate shocks in explaining WPI and CPI inflation fluctuations over the sample period. Although the pass-through coefficients provide information on the impact of the exchange rate on the levels of the WPI and the CPI, they do not indicate how important exchange rate

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[9] The pass-through coefficient is thus defined as:

[6] $$PT_{t,t+j} = P_{t,t+j} / E_{t,t+j}$$

where P_{t+j} is the cumulative change in the price level and E_{t+j} is the cumulative change in the nominal exchange rate between months t and $t+j$.

[10] Given that the impulse responses have large standard errors, the standard errors on the estimated pass-through coefficients are also large. For instance, for the first period, the spot estimate of the CPI pass-through coefficient is 12.5 percent. However, the 95 percent confidence interval includes a value as low as 3.9 percent and as high as 24.7 percent. For later periods, the 95 percent confidence intervals are even wider. We do not report them.

shocks have been in inflation fluctuations. The variance decomposition decomposes variation in WPI and CPI inflation into the shocks to the endogenous variables in the VAR.[11]

Exchange rate shocks appear to be important in explaining the fluctuations in WPI inflation. Table 1 reports the percentage of the WPI inflation forecast variance attributable to the various shocks. Exchange rate shocks explain about 40 percent of the WPI inflation variance. The remainder of the variance of WPI inflation is largely explained by its own innovations (about 30 percent) and by innovations to the other variables

The impact of the exchange rate on CPI fluctuations is less than it is for the WPI, which is not surprising given the larger share of tradable goods in the WPI. As Table 2 suggests, exchange rate shocks explain about 30 percent of the variance of CPI inflation. The remainder of the variance of CPI inflation is mostly explained by its own innovations (about 35 percent) and by innovations to WPI inflation (20 percent), and to the other variables.

D. Historical Decomposition

Historical decomposition provides further information about the contribution of exchange rate shocks to inflation since the floating of the Turkish lira in February 2001 (Figure 4). The historical values of CPI and WPI inflation are decomposed into a base projection and the accumulated effects of current and past exchange rate innovations. One can thus see to what extent movements in inflation were due to exchange rate shocks. In Figure 4, the solid lines show the actual paths of month-on-month inflation rates (WPI in panel A and CPI in panel B). The short-dashed line shows the base projection made using shocks in all variables up to January 2001 and assuming no further shocks occur thereafter. The long-dashed line shows the sum of the base projections and the effect of the exchange rate innovations in the model after January 2001. Actual inflation was above the model's base projection in the whole of 2001. By contrast, in early 2002, actual inflation was below the model's base projection. As the long dashed line shows, a large part of the difference between actual inflation and the base forecast can be attributed to exchange rate shocks.

IV. Conditional Price Forecasts

The pass-through coefficients can be used to forecast the cumulative changes in the WPI and the CPI due solely to exchange rate movements. As an illustration of how this framework can be used to forecast price inflation stemming exclusively from past exchange

[11] For the variance decomposition, we first make forecasts of WPI and CPI inflation for various forecasting horizons using the VAR. Then, we compute the variance of the forecast errors for each horizon. Finally, the variance of the forecast error for each horizon is decomposed into the shocks to the five endogenous variables. A variable, such as the exchange rate, is considered to explain inflation fluctuations well if it explains a high proportion of the forecast error variance.

rate movements, this section focuses on two different scenarios. In the backward-looking scenario, the aim is to quantify the impact on domestic prices of the depreciation that occurred during the February 2001 crisis. Accordingly, the forecasts are conditional on no further changes to the exchange rate or any other variable in the VAR after March 2001 and exclude any movements in the exchange rate or in any other variable in the VAR before February 2001. In the forward-looking scenario, the aim is to measure the underlying inflation pressures resulting from movements in the exchange rate up until September 2002. Accordingly, we consider the impact of movements in the exchange rate over the last 11 months on the CPI and WPI over the following year, assuming no further changes in the exchange rate or any other variable in the VAR model after September 2002.[12] In both scenarios, the exchange rate shock is defined as the unexpected part of any observed change in the exchange rate.[13]

The impact of the exchange rate depreciation following the floating of the Turkish lira in February 2001 on domestic prices was large (Figure 5). During February and March 2001, the cumulative unexpected change in the exchange rate is calculated to be 38 percent. As expected on the basis of our estimates of the pass-through coefficients, prices had completely adjusted to the depreciation that occurred at the time of the floating by January 2002. The cumulative increase in the WPI due solely to movements in the exchange rate is projected to be 23 percent over that period. For the CPI, the projected increase is 17 percent. It is worth noting, however, that actual inflation in the 12 months after the floating has been higher than that predicted by the VAR model throughout 2001 and 2002. This finding is intuitive given that there were further exchange rate shocks in 2001 and in 2002, whereas the projections based on the VAR model are made assuming no further shocks. Moreover, in addition to the exchange rate, other factors, both on the supply and demand side, contributed to price increases over this period. These include, for instance, increases in administrative prices as well as in food and agricultural prices associated with the drought in the second and third quarter of 2001.[14]

By contrast, inflation resulting solely from past exchange rate movements is predicted to be fairly low over the next year. Again as expected on the basis of our estimates of the pass-through coefficients, prices will have completed their adjustment to movements in the exchange rate that occurred prior to September 2002 by September 2003. The cumulative increase in the WPI since end-September 2002 due solely to the exchange

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[12] Only 11 months are considered since this is the time span over which the exchange rate impact on prices is estimated to be completely reflected in prices.

[13] The unexpected part of an exchange rate shock is defined as the shock minus the expected exchange rate change based on the vector autoregression model.

[14] See the Central Bank of the Republic of Turkey *Monetary Policy Report*, April 2002, pp.1–3.

rate changes over the previous 11 months is projected to be 1.1 percent. The corresponding cumulative increase in the CPI is projected to be 0.7 percent. Once again, these forecasts measure only the impact of past (not future) exchange rate movements and do not reflect the impact of changes in any other macroeconomic variable.

V. Concluding Remarks

This paper uses a recursive VAR model, suggested by McCarthy (1999), to measure the pass-through effect from the nominal exchange rate to wholesale and consumer prices since the floating of the Turkish lira in February 2001. The paper also assesses future pressures on domestic prices that are produced exclusively by past exchange rate movements. Based on our estimates of the pass-through coefficients, several conclusions can be drawn.

The VAR analysis suggests that the pass-through from the exchange rate to prices in Turkey is over in about a year, but mostly in the first four months. The pass-through is well underway by the fourth month and completed by the eleventh month. Indeed, the pass-through coefficients change little after the fourth month. A relatively rapid pass-through effect seems plausible for several reasons. There is a high level of dollarization and currency substitution in Turkey with many prices indexed either formally or informally to the lira-dollar exchange rate. The persistence of high inflationary expectations also contributes to a sharp devaluation translating rapidly into price hikes by firms. Also, Turkey's oligopolistic industrial structure may accelerate and strengthen the pass-through by enabling wholesalers to pass external shocks rapidly on to retailers. In light of the quick pass-through, unless the monetary policy transmission mechanism is also rapid, there seems to be little scope for the CBT to offset the impact on domestic prices of exchange rate movements.

The pass-through to wholesale prices is more pronounced compared to the pass-through to consumer prices. By the eleventh month, about 60 percent of the initial exchange rate shock has passed through to wholesale prices and about 45 percent of the shock has passed through to consumer prices. After the fourth month, 50 percent and 40 percent of the initial exchange rate change has been already passed onto the WPI and CPI, respectively. Overall, the pass-through to wholesale prices seems more pronounced compared to the pass-through to consumer prices. Again there are several possible reasons for this. The WPI contains a larger share of tradable goods (about 70 percent) than the CPI (about 45 percent). Also, it is conceivable that much of the absorption of exchange rate shocks has occurred along the supply chain and has translated into a contraction of profit margins. The weak aggregate demand conditions in 1999 and since the 2001 crisis may have further contributed to a compression of profit margins. A recovery in overall demand in 2003 could, then, result in a significantly larger actual pass-through to consumer prices.

The estimated pass-through in Turkey is both shorter and larger than that estimated in other key emerging market countries. Rabanal and Schwartz (2000) show that in the case of Brazil the pass-through was complete within 20 months. After this period, 22 percent and 66 percent of the initial exchange rate depreciation was reflected on the CPI and WPI, respectively. Burstein, Eichenbaum, and Rebelo (2002) find that "CPI inflation is

very low in the aftermath of a devaluation. For example, in Korea the U.S. dollar/Won exchange rate depreciated by 41.2 percent between September 1997 and September 1998. In sharp contrast, CPI inflation was only 6.6 percent." The same authors report that in Thailand the U.S. dollar/baht rate depreciated by 49.7 percent between June 1997 and June 1998. Over the same period, consumer prices increased by just 10.1 percent. Finally, Bhundia (2002) finds that, in the case of South Africa, eight quarters after a 1 percent shock to the nominal exchange rate only about 12 percent of the shock is passed through consumer prices.

While the impact of the exchange rate depreciation following the floating of the Turkish lira in February 2001 on domestic prices was large, inflation resulting solely from past exchange rate movements is predicted to be fairly low over the next year. The cumulative increase in the WPI due solely to the exchange rate shock after February 2001 is projected to be 23 percent over the following year. For the CPI, the projected increase is 17 percent. By contrast, the cumulative increase in the WPI since end-September 2002 due solely to the exchange rate movements over the previous 11 months is projected to be 1.1 percent. The corresponding cumulative increase in the CPI is projected to be 0.7 percent.

Forecasts of inflation based on estimates of the pass-through coefficients are, however, intended to provide only some partial information about underlying price pressures. These forecasts capture price pressures stemming exclusively from exchange rate changes. This information should then be complemented with that obtained from other sources (structural and short-term models, asset prices, leading indicators) to arrive at a view of the inflation outlook and the appropriate monetary policy stance, which remains in any case a matter of judgment.

TABLE 1. VARIANCE DECOMPOSITION OF WPI INFLATION

Percentage of forecast error variance attributed to:					
Forecast Horizon	Oil prices	IP Growth	Exchange rate	WPI	CPI
2	6.32	2.75	42.79	43.97	4.18
8	7.52	15.62	38.25	30.24	8.37
12	7.77	15.31	37.64	30.96	8.32
24	7.74	15.45	37.66	30.85	8.29

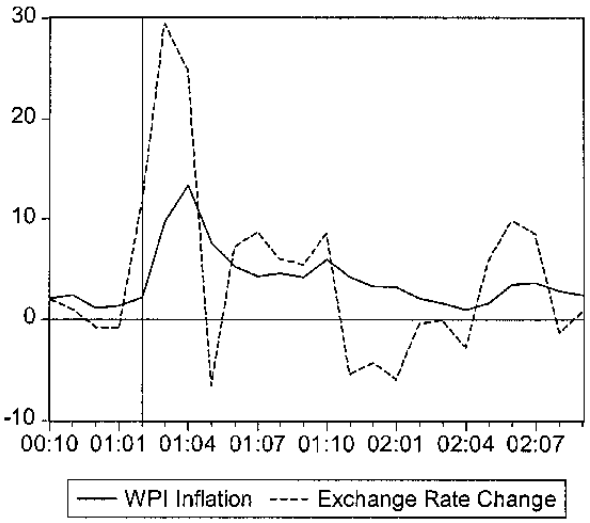
TABLE 2. VARIANCE DECOMPOSITION OF CPI INFLATION

Percentage of forecast error variance attributed to:					
Forecast Horizon	Oil prices	IP Growth	Exchange rate	WPI	CPI
2	0.46	0.84	31.49	30.79	36.42
8	6.37	7.18	30.74	20.35	35.37
12	6.41	7.28	30.35	21.08	34.88
24	6.40	7.38	30.41	21.05	34.76

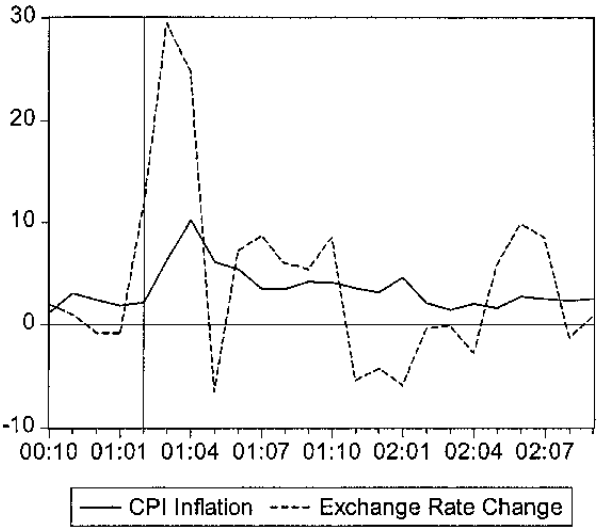
FIGURE 1. MONTHLY CHANGES IN PRICES AND THE NOMINAL EXCHANGE RATE[1]

(In percent)

Wholesale Prices and Exchange Rate



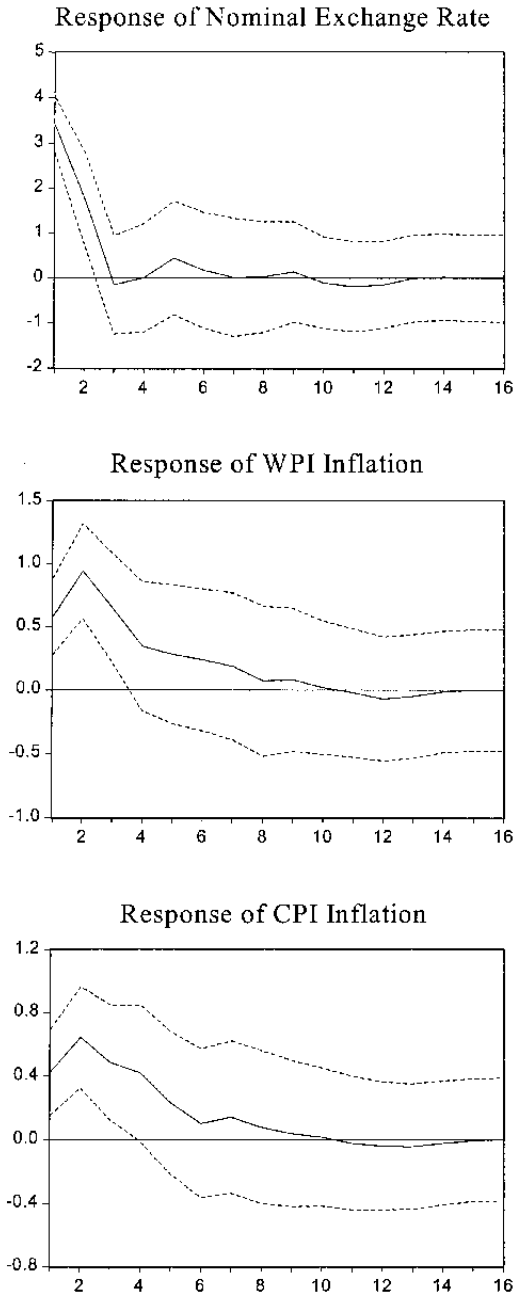
Consumer Prices and Exchange Rate



Source: IMF *EDSS* database.

[1] The price series are seasonally adjusted. The nominal exchange rate is the monthly average of the nominal Turkish lira to U.S. dollar rate.

FIGURE 2. IMPULSE RESPONSES TO A ONE STANDARD DEVIATION INNOVATION IN THE NOMINAL EXCHANGE RATE ± 2 STANDARD ERRORS[1]



[1] The dotted lines show two standard error bands calculated by Monte-Carlo simulations with 1000 repetitions.

FIGURE 3. ESTIMATED CUMULATIVE PASS-THROUGH COEFFICIENTS

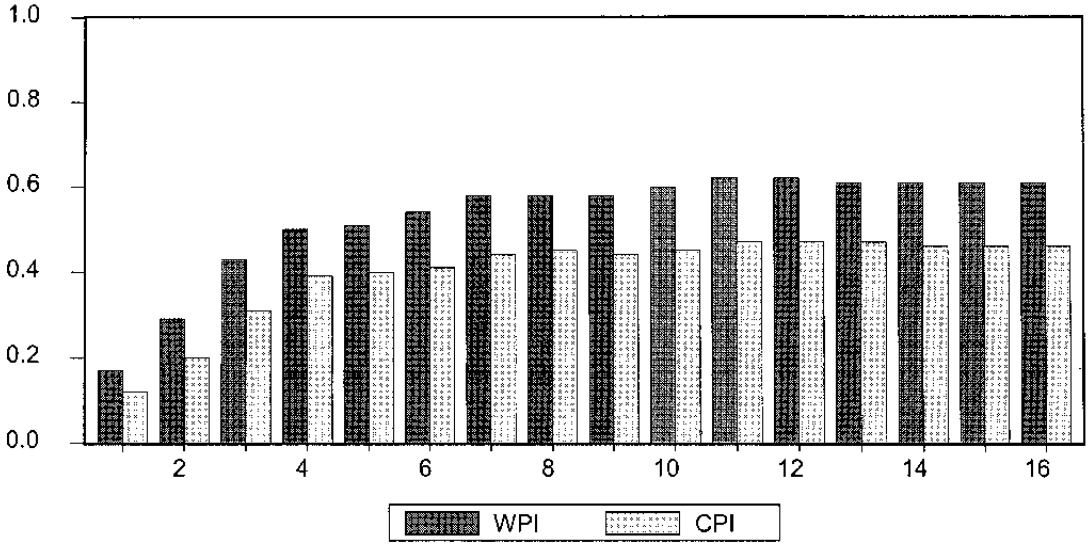
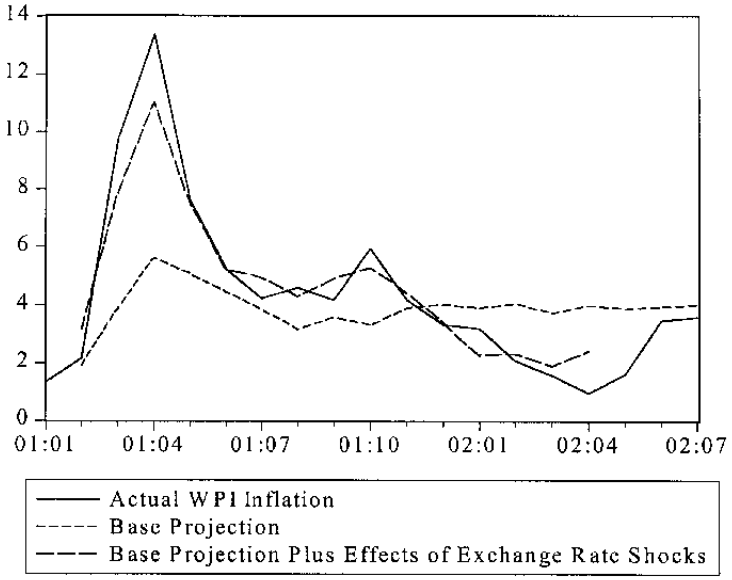


FIGURE 4. HISTORICAL DECOMPOSITION

(Month-on-month changes, in percent)

A) Historical Decomposition of WPI Inflation



B) Historical Decomposition of CPI Inflation

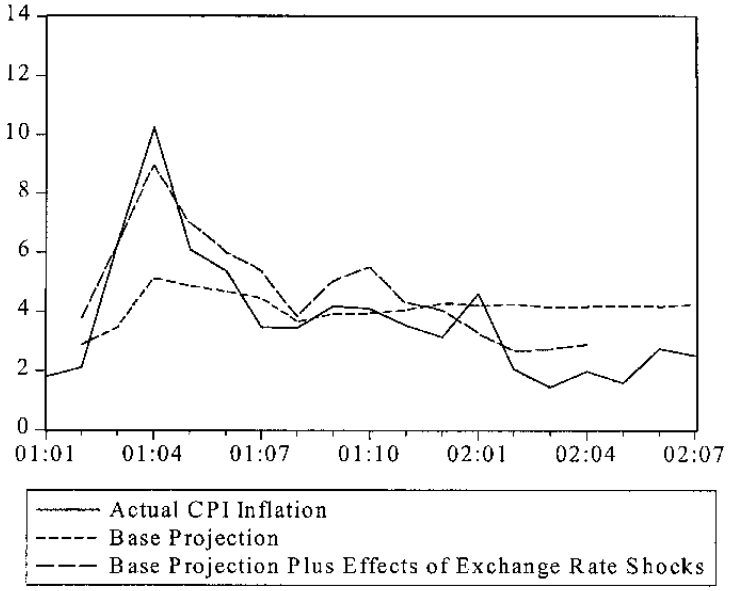
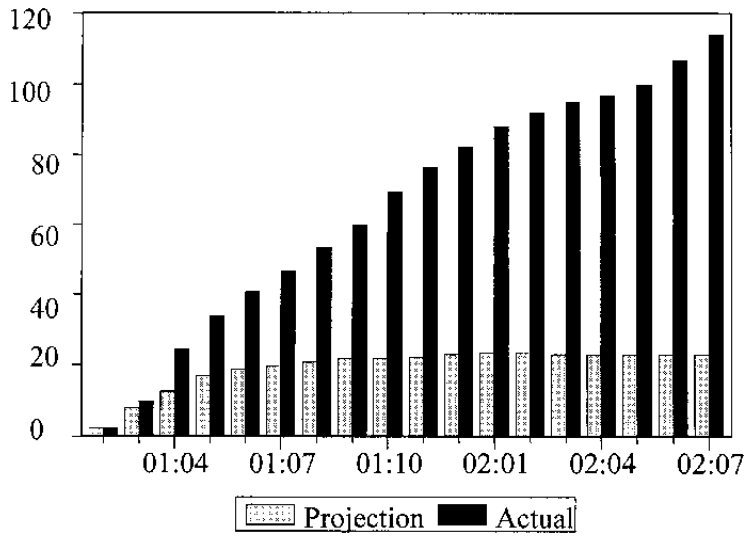


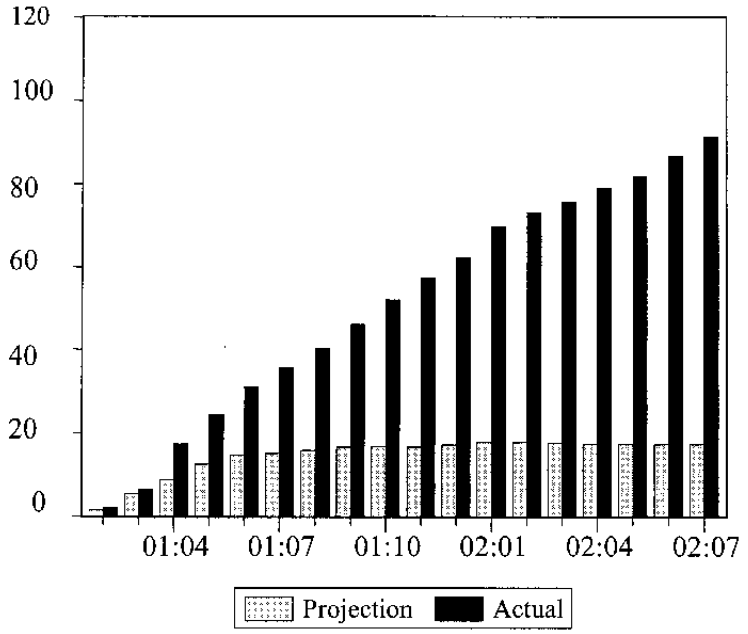
FIGURE 5. PROJECTED AND ACTUAL PATHS OF THE WPI AND THE CPI AFTER THE FLOATING

(Cumulative increase since January 2001, in percent)

A) WPI



B) CPI



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