

Exchange Rate Pass-Through in Turkey:  
It is Slow, but is it Really Low?

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## Abstract

Using a vector auto-regression (VAR) setup, we estimate the pass-through from exchange rates and import prices to domestic inflation in Turkey, and produce some stylized facts regarding the degree and the adjustment speed of the pass-through on several price measures. Estimations for two distinct periods—before and after the adoption of floating exchange rate regime—yield both good and bad news. The good news is, our impulse responses confirm the common conjecture that pass-through has weakened and slowed down after the adoption of floating exchange rate regime. The bad news is, surprisingly low pass-through in recent years partly owes to the fact that exchange rate shocks were not persistent in direction. In other words, total pass-through might have been sizable had the economy been hit by one-sided shocks such as a persistent depreciation.

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\* The views expressed are those of the authors and should not be attributed to the Central Bank of Turkey. We would like to thank Özge Akıncı and Ercan Karadaş for their valuable comments and suggestions.

## 1. Introduction

One of the main challenges for the inflation targeting countries has been to assess the impact of import price and exchange rate shocks on domestic price measures. This is often called as “exchange rate (or import prices) pass-through”. Especially in small, open and emerging economies, in which exchange rates are sensitive to capital flows, these types of shocks are often the main reason for missing inflation targets. It is thus of utmost importance to understand and quantify the exchange rate pass-through for any monetary authority with an explicit or implicit goal of price stability.

This study aims to quantify several features of exchange rate pass-through to inflation for the Turkish economy. By doing so, we hope to contribute to the understanding of the inflation dynamics for the Turkish economy—a prospective inflation-targeting country. Turkey’s shift to floating exchange rate regime after being hit by the severe 2001 crisis, makes this task challenging. For the regime shift coupled with increased central bank independence and enhanced price stability objective has changed the inflation dynamics.<sup>1</sup> The new policy framework has thus increased the importance of the quantification of the degree and the adjustment speed of the exchange rate pass-through to inflation since it allows for substantial fluctuations in the exchange rates yet puts the inflation “targets” at the core of attention.

There are two main studies on exchange rate pass-through in Turkey: Kara *et al* (2005) explore the change in the pass-through using a time varying and single equation methodology. This paper differs in at least two ways. First, we follow a multivariate modeling strategy. Second, we do not measure pass-through by the sum of coefficients of exchange rate in the inflation equation; we rather utilize impulse responses *a la* McCarthy’s (1999) VAR set up to compute the pass-through. This allows us to assess not only the pass-through within a specific time period, but also its dynamics through time. Moreover, this method also allows us to compute the long run pass-through—cumulative sum of all the future responses.

Leigh and Rossi (2002) use a similar method to ours to analyze pass-through in Turkey. However, their sample period covers the managed/crawling peg regimes as well as the floating exchange rate regime and these authors do not distinguish across regimes. Therefore, the stylized facts captured in that study may no longer be valid under the floating exchange rate regime. Our focus, instead, is on the *change* in the pass-through after the adoption of floating

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<sup>1</sup> See Kara, Küçük Tuğer, Özlale, Tuğer, Yavuz, and Yücel (2005) for a detailed discussion of the exchange rate regimes, price setting behavior and pass-through in emerging market economies. Saiki (2004) shows that a switch in monetary regime to inflation targeting is associated with a fall in the pass-through coefficient.

exchange rate regime. Accordingly, our analysis covers two distinct episodes, specifically before and after the floating exchange rate regime.<sup>2</sup> Moreover, we use alternative price measures such as private manufacturing inflation, core CPI, tradable/non-tradable CPI, and goods/services to assess the impact of import prices and exchange rate shocks on price indices.

Our findings confirm the conjecture that pass-through has weakened after the adoption of floating exchange rate regime.<sup>3</sup> However, we also find that completion of the pass-through takes much more time, and cumulative effects of one-sided shocks on domestic prices can still be sizeable. In other words, exchange rate shocks may still dominate inflation dynamics if they are persistent enough. Rest of the paper is organized as follows. The following section presents a preliminary assessment of inflation and exchange rate behavior in Turkey. The third section briefly describes a VAR model based on McCarthy's (1999) methodology and makes some clarifications about its implementation. Section 4 provides the empirical results for Turkish economy by comparing various impulse responses based on two different sample periods. Finally, section 5 presents a summary and concludes.

## 2. Some Preliminaries

Before proceeding with the empirical analysis, we introduce some statistical facts to provide a first blush at the exchange rate dynamics and the relationship between inflation and exchange rates in Turkey. These basic analyses may provide some insights for a model-based approach. Following the float of Turkish Lira, exchange rate variability as measured by the variance of the US dollar increased noticeably (Figure 1). Moreover, transition probabilities (Table 1) confirm the observation that short-term movements in exchange rates were highly erratic during the float whereas pre-float period was mostly characterized by persistent upward movements.<sup>4</sup> This, in turn, may have altered the perceptions of economic agents whether any observed change in the exchange rates is permanent or transitory. For example, price setters, upon an exchange rate or import price shock, could delay changing prices until they are sure of

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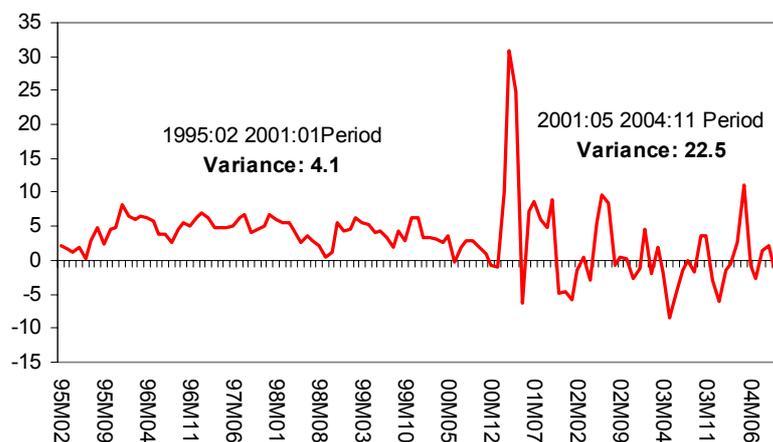
<sup>2</sup> The first sub sample starts from the second half of 1990's and ends with the formal adoption of the floating exchange rate regime. The second sub sample covers the floating exchange rate period from May 2001 (announcement of the new program) to September 2004.

<sup>3</sup> Gagnon and Ihrig (2004) also find that a low-inflation environment reduced pass-through to the CPI in the 1990s.

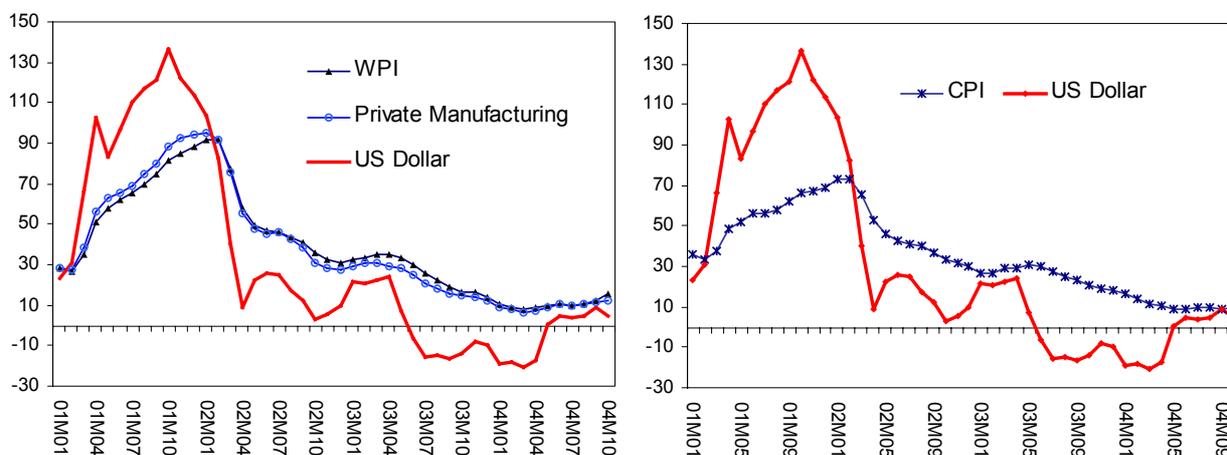
<sup>4</sup> Likewise, Kara *et. al.* (2005) demonstrated that after the adoption of the floating regime, periods of depreciation in the exchange rate have been followed by the periods of appreciation, which is in contrast with the periods of continued depreciation of Turkish Lira in 1990s.

the duration and the extent of the movements.<sup>5</sup> Figure 2 also confirms this statement: fluctuations in the exchange rate are much larger than the fluctuations in the consumer, wholesale or private manufacturing prices.<sup>6</sup>

**Figure 1: Nominal Exchange Rate, 1995-2004 (Monthly % Change)**



**Figure 2: Prices and TL/US Dollar for Turkey, 2001-2004 (Annual % Change)**



<sup>5</sup> Central Bank of Turkey states two reasons behind the decrease in exchange rate pass-through (Monetary Policy Report, 2004-II). In addition to greater exchange rate volatility, structural change in the relation between exchange rate and inflation seems to be another reason. For the details of changes in the inflation dynamics, see Monetary Policy Report, 2004-I, Box II.1.

<sup>6</sup> McCarthy (1999) states that greater exchange rate volatility can make importers more wary about changing prices and industries may sacrifice their profit margins by not changing their prices in response to an exchange rate shocks, thus reducing measured pass-through.

**Table 1: Transition Probabilities**

Sample	1994:01-2001:04		2001:2004:12	
<b>Dec.</b>	<b>Dec.</b>	<b>Inc.</b>	<b>Dec.</b>	<b>Inc.</b>
<b>Inc.</b>	2.3	3.4	34.1	20.5
	3.4	<b>90.8</b>	22.7	22.7

Note: We consider our data having a discrete state space and discrete parameter space which are  $E = \{\text{Dec.}, \text{Inc.}\}$  and  $\Omega = \{T: t=1994, \dots, 2004\}$  respectively. We divide the parameter space into equal lengths of one month and each month corresponds to one step. State Dec. is defined as the decrease of nominal exchange rate, whereas Inc. describes the increase of nominal exchange rate. As an example, bold figure shows that, 90.8 percent of the time for 1994:01-2001:04 periods, an increase in the current month is followed by an increase in the next month.

Table 2 shows the cross correlations between the exchange rate and a range of inflation measures<sup>7</sup> for the two different sample periods. First sample period, February 1995-April 2001, is characterized by the managed floating regime. On the other hand, second sample, May 2001-September 2004, covers the floating exchange rate regime period<sup>8</sup>. Main findings are as follows:

First of all there is a clear correlation between inflation measures and the exchange rate developments. Among the CPI based measures, good prices seem to be more sensitive to the exchange rate developments. Table 2 also suggest a intuitive sequence of the price developments through the supply chain, where the effect of the exchange rate first passes to private manufacturing inflation and then the consumer price measures.

For the managed floating period, as expected, the effect of the exchange rate change on private manufacturing prices is evidently more pronounced compared to the CPI based measures and the highest correlation is in the contemporaneous month. There is no significant correlation after two months. The pass-through seems to be quick and large.

On the other hand, after the introduction of the floating exchange rate regime, correlation is extended to the first 3 months and even to longer leads. These preliminary findings already suggest that the duration of the pass-through is longer in the floating exchange rate regime.<sup>9</sup> What is more, as shown in the second part of Table 2, there is no contemporaneous effect of

<sup>7</sup> In general, to make a more fundamental analysis of pass-through effect, we choose to work with “core” inflation type of series. For example, wholesale prices include some exogenous components like agriculture and administered prices, which often do not move with respect to conventional dynamics and hence which may distort our findings. Accordingly we exclude these components and work with private manufacturing price inflation for wholesale prices. We follow a similar strategy with the consumer prices. Definition of the core CPI along with other data descriptions is presented in the Appendix.

<sup>8</sup> First and second sample periods have 75 and 41 observations respectively.

<sup>9</sup> Monetary Policy Report (2003-II) of Central Bank of Turkey also documents similar findings in a special box.

the exchange rate developments on consumer price measures and the sequence of price developments in supply chain still holds.

**Table 2: Cross Correlations between Nominal Exchange Rate and Inflation Measures**

<b>Sample: 1995:02 2001:04</b>					
Lead (k) in Months	Private Manufacturing	Goods (CPI)	CPI	Tradable CPI	Core CPI
0	<b>0.7934</b>	0.513	0.4115	0.4482	0.1675
1	0.7139	<b>0.5222</b>	<b>0.4682</b>	<b>0.4488</b>	<b>0.3106</b>
2	0.2083	0.1872	0.1856	0.1745	0.1251
3	-0.0252	0.0184	0.0258	0.0362	0.0116
4	-0.027	-0.0329	-0.0236	-0.0127	0.0161
5	0.0267	-0.0238	-0.0031	-0.0105	0.064

<b>Sample: 2001:05 2004:09</b>					
0	0.3835	-0.0258	0.0064	-0.0978	0.136
1	<b>0.4319</b>	0.1614	0.1982	0.1262	0.2942
2	0.3511	0.3137	0.3462	0.2935	0.3491
3	0.2671	<b>0.4676</b>	<b>0.4539</b>	<b>0.4523</b>	<b>0.3935</b>
4	0.1102	0.2996	0.2757	0.2797	0.1321
5	-0.0354	0.1581	0.1682	0.1714	0.0065
6	0.057	0.1967	0.2063	0.2001	0.1103
7	0.0436	0.1292	0.1219	0.1217	0.1075
8	0.0281	0.0072	-0.0072	0.0006	0.0417
9	0.0965	0.0016	-0.0019	0.0289	0.0545

Note: Change in the exchange rate in month t and change in price measures in month t+k. Bold figures indicate the highest correlation in each column.

As a second exercise, we employ Granger causality test between the exchange rate changes and the inflation measures for the two sub-sample periods (Table 3). Lag lengths are determined on the basis of LR test and several information criteria and the findings from the cross correlation exercise. To cut a long story short, the results show that there is a significant Granger causality running from the exchange rate to inflation measures for the pre-float period, whereas a change in the exchange rate does not Granger cause inflation measures when running the test for the floating period.

These results reveal that the inflation and the exchange rate behavior seem to have changed in recent years. Successive implementation of disinflation program after May 2001, together with the change in the exchange rate policy are the most likely reasons for this altered behavior.

Needles to say, it should be too simplistic to base these judgments on simple correlation evidence. More comprehensive analysis on this issue is introduced in the subsequent section.

**Table 3: Granger Causality Test Results between Nominal Exchange Rate and Inflation Measures**

Sample	Private Manufacturing	Goods (CPI)	CPI	Tradable CPI	Core CPI
<b>1995:02 2001:04</b>					
Lag 2	0.000	0.000	0.000	0.000	0.003
<b>2001:05 2004:09</b>					
Lag 2	0.155	0.868	0.805	0.796	0.625
Lag 3	0.500	0.493	0.602	0.490	0.581

Note: Figures presented in the Table are p-values. Null hypothesis is that a change in the nominal exchange rate does not Granger cause inflation.

### 3. The Model

In order to investigate the pass-through effect, we use a monthly VAR model based on McCarthy (1999).<sup>10</sup> Our core model consists of four variables and displays a triangular-causal system. Variables are ordered as follows: output gap,<sup>11</sup> import prices denominated in Turkish Lira (so as to capture also exchange-rate shocks), private manufacturing prices, and core CPI measure. We assume that demand shocks are identified from the dynamics of the output gap, whereas external shocks are identified from the joint effect of the exchange rate and the import prices after taking into account the contemporaneous effect of the demand shocks. Hence, we do not identify between an exchange rate shock and an import price shock. Finally, the price measures contain sequential shocks that can be attributed to the various stages of the supply chain. The shocks are identified from the VAR residuals by using the Cholesky decomposition of the variance-covariance matrix of the reduced form residuals. Under these considerations, the model can be written as:

$$\tilde{y}_t = E_{t-1}(\tilde{y}_t) + \varepsilon_t^d$$

$$\Delta e_t = E_{t-1}(\Delta e_t) + \alpha_1 \varepsilon_t^d + \varepsilon_t^{\Delta e}$$

$$\pi_t^{PMI} = E_{t-1}(\pi_t^{PMI}) + \beta_1 \varepsilon_t^d + \beta_2 \varepsilon_t^{\Delta e} + \varepsilon_t^{PMI}$$

$$\pi_t^{core\_CPI} = E_{t-1}(\pi_t^{core\_CPI}) + \delta_1 \varepsilon_t^d + \delta_2 \varepsilon_t^{\Delta e} + \delta_3 \varepsilon_t^{PMI} + \varepsilon_t^{core\_CPI}$$

<sup>10</sup> McCarthy (1999) investigates the impact of exchange rates and import prices on producer and consumer prices for the selected 9 industrialized country by estimating a six-variable VAR model with the following ordering of the variables: oil price inflation denominated in local currency, output gap, nominal exchange rate, import price inflation, PPI and CPI inflations.

<sup>11</sup> See Sarıkaya, Öğünç, Ece, Kara and Özlale (2004) for the details of quarterly output gap estimates. Monthly output gap estimates are derived along with Fernandez (1981) methodology.

where  $\tilde{y}_t$  is the output gap,  $\Delta e_t$  is the first difference of the logarithm of import prices denominated in Turkish Lira, and  $\pi_t^{PMI}$  and  $\pi_t^{core-CPI}$  are the private manufacturing and the core CPI inflations;  $\varepsilon_t^d, \varepsilon_t^{\Delta e}, \varepsilon_t^{PMI}, \varepsilon_t^{core-CPI}$  are demand, external, core WPI and CPI inflation shocks respectively. Finally,  $E_{t-1}(\bullet)$  refers to the expectation of the variable based on the information set available at the end of period  $t-1$ . Under the assumption that the model captures the essential dynamics of inflation, shocks are assumed to be serially uncorrelated and orthogonal across equations. Furthermore, expectations are introduced into the model by linear projections of the lags of the variables in the system.

Our model differs from McCarthy (1999) in several ways. First of all, in the original model of McCarthy, a separate equation for oil price inflation denominated in the local currency is used to account for the supply side. We do not incorporate a distinct channel for international oil prices, since the oil-based prices are administered prices in Turkey and for some products, private consumption tax comprises over 80 percent of the price and therefore, the impact of international oil price developments can often be distorted by the changes in special consumption taxes.<sup>12</sup>

Secondly, we use import prices denominated in Turkish Lira as the main variable of interest. This is mainly because Turkey is a small and highly open economy where pricing to market is not common. Depreciation of the Turkish Lira changes the domestic prices of both imported consumption goods and intermediate goods in a short period of time. Since imported inputs are mainly used in both intermediate and final good production processes where these inputs do not usually have close substitutes, the higher depreciation lead to the higher production costs, which in turn translates into higher domestic prices. By this way, both the influence of import prices (including oil prices) and the depreciation of domestic currency are jointly taken into account. Therefore, our notion of pass-through is a broad concept, which comprises all cost pressures resulting from import prices and exchange rates.

Finally, we prefer to use the core inflation measures rather than the headline inflation since we seek to achieve a more “fundamental” measure of pass-through. Short-term noisy movements in consumer prices that can arise from purely exogenous affects, such as weather conditions and changes in tax policy, can blur the inflation dynamics. Recall that we have only three

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<sup>12</sup> One can use direct market prices (in Turkish Lira, incorporates the effect of tax regulations), but these prices are also highly correlated with exchange rate developments due to automatic price mechanism, so identification problem is still a critical consideration.

years of data in the post-crisis period. We thus need well-behaved series to capture empirical regularities between our variables. In this respect, we employ a core measure of CPI, which excludes unprocessed food and publicly controlled prices that are 26.7 percent of the CPI. As to WPI, we employ private manufacturing sector prices.<sup>13</sup>

## 4. Empirical Findings

### *Core Model*

We estimate the core model for the two sample periods separately and compare the impulse responses over one and a half year horizon for these two periods.<sup>14</sup> Following Rabanal and Schwartz (2001), we compute the pass-through coefficient as the ratio of cumulative impulse responses of each price index after  $j$  months to the cumulative response of the import prices to an import price shock after  $j$  months.<sup>15</sup> Figure 3 shows the estimated cumulative pass-through for private manufacturing and core CPI inflation following a one standard deviation innovation in the import price inflation.<sup>16</sup> Recall that in our model import prices are denominated in domestic currency. Since exchange rate fluctuations are dominant in Turkey, we will use the term exchange rate shock and import price shock interchangeably in the rest of the text.<sup>17</sup>

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<sup>13</sup> These prices reflect general market behavior and constitute 53.9 percent of the total WPI.

<sup>14</sup> Note that we don't estimate model with levels, although there can be possibility of cointegration among the levels of the aforementioned variables; we ignore this possibility due to the short data period limitations.

<sup>15</sup> Specifically, it is denoted by the following ratio:  $PT_{t,t+j} = P_{t,t+j} / E_{t,t+j}$  where  $P_{t,t+j}$  is the cumulative change in the price level and  $E_{t,t+j}$  is the cumulative change in the import price between months  $t$  and  $t+j$ .

<sup>16</sup> For the first sub-sample, VAR(2) model is estimated based on likelihood ratio (LR) and several information criteria, which produce consistent results with cross correlation findings. On the other hand, for the second sub-sample period, though lag length of 2 is suggested by LR and some information criteria, we estimated a VAR(3) by giving priority to the cross correlation findings. Moreover, we used stationary form of the variables based on Augmented Dickey-Fuller test results.

<sup>17</sup> Since the main focus is to compute the effects of import price shocks on prices, we do not report responses for the other variables and shocks. The authors upon request can provide the rest of the impulse responses.

**Figure 3: Estimated Cumulative Pass-through (Private Manufacturing vs. Core CPI)**

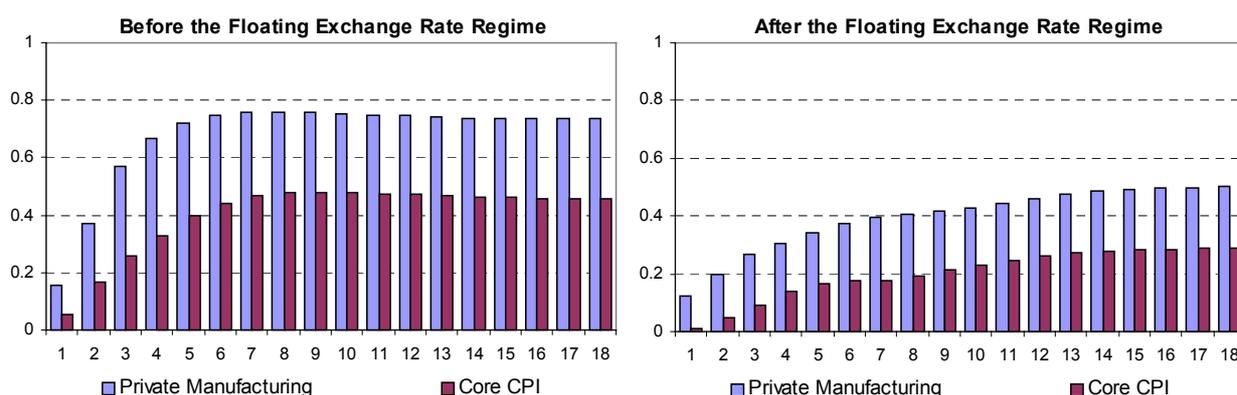
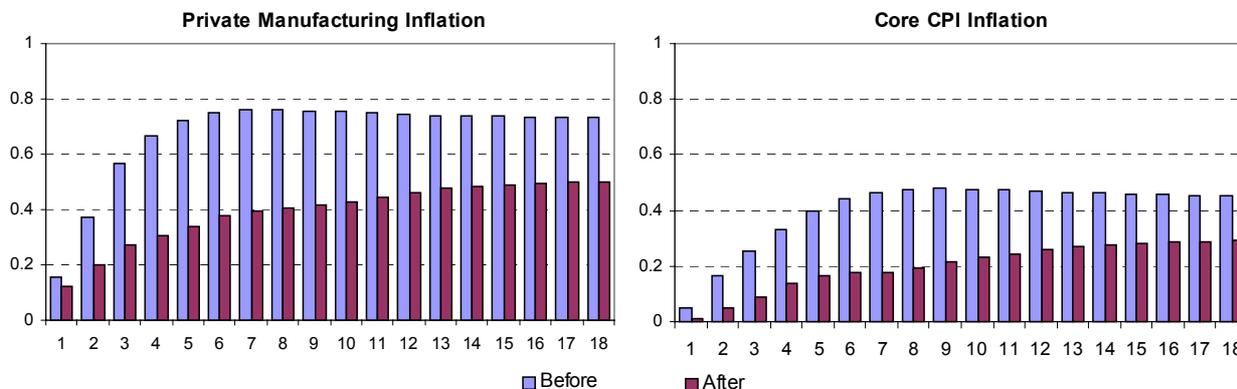


Figure 3 reveals that pass-through to private manufacturing inflation is much higher compared to core CPI inflation for both sub-sample periods. This finding is not surprising since most of the sub-sectors of the private manufacturing sector use imported inputs and thus contain relatively high portion of tradable goods. For that reason, their pricing behavior is highly dependent on the movements in import prices and exchange rates. Consumer prices, on the other hand, contain also non-tradable goods, which are not that sensitive to external price developments.

**Figure 4: Estimated Cumulative Pass-through (Before vs. After the Floating Exchange Rate Regime)**



To conduct a closer “before and after” analysis, Figure 4 replicates Figure 3, illustrating the pass-through for each price index on a separate graph. It can be easily inferred that the impact of an exchange rate shock on both inflation measures has considerably changed both in magnitude and duration following the adoption of the floating exchange rate regime. According to the first sub-sample period, 74 percent of the exchange rate changes are passed through the private manufacturing inflation within six months,<sup>18</sup> whereas for the second sub-sample it is 50 percent in fifteen months after the shock. Put differently, pass-through is not

<sup>18</sup> Private manufacturing and core CPI impulse responses are different from zero at the 5 percent significance level for the first four and three months correspondingly.

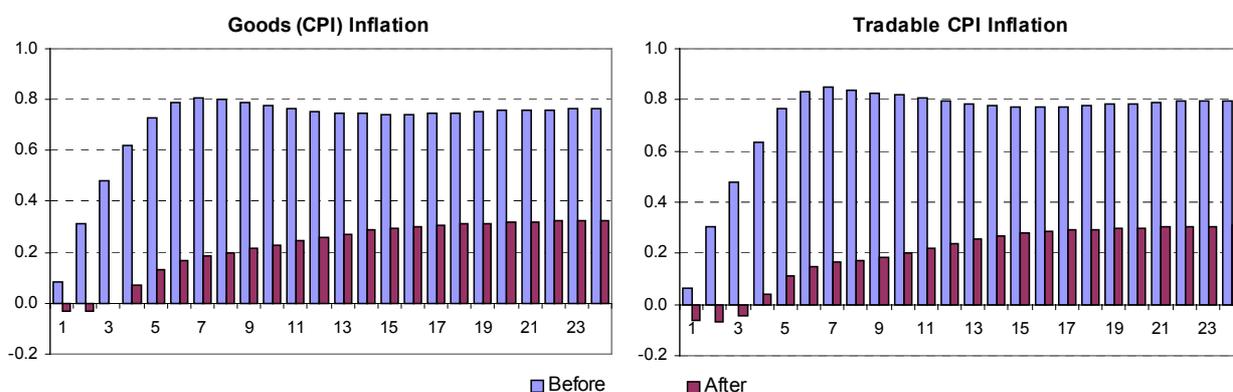
only lower (from 74 to 50 percent) but it is slower (completion takes two quarters before the float, 5 quarters in the floating exchange rate period). In fact, albeit the cumulative pass-through to private manufacturing inflation seems to have diminished, it is still considerable. Similar arguments hold for core CPI inflation dynamics. The fact that long-run cumulative pass-through in core CPI measure has declined to 30 percent in the float period from 45 percent of the pre-float period is notable. Completion of the pass-through takes about 6 months in the first sub-sample period, whereas it takes more than one year in the floating exchange rate regime.<sup>19</sup>

All in all, the conclusion is clear: pass-through is weaker and has slowed down in Turkey, however it is still considerable. Our findings suggest, for example, a 10 percent persistent (one sided) depreciation of Turkish Lira will eventually cause a 3 percent hike in core CPI inflation.

### Tradables

We have already documented the change in the pass-through for the broad CPI index. However we have not said anything about the relative prices. In this subsection, we estimate a second model that has the same setting with core model except core CPI measure is replaced by tradable (goods) and then non-tradable (services) CPI figures.<sup>20</sup>

**Figure 5: Estimated Cumulative Pass-through Goods and Tradable CPI (Before vs. After the Floating Exchange Rate Regime)**



We start with tradable and good inflation. Although content of good and tradable indices are almost identical, both are plotted for convenience as the literature uses either of them. Figure 5 reveals that pass-through for good and tradable inflation is more pronounced compared to core CPI and private manufacturing prices in the pre-float period. Long run pass-through is almost

<sup>19</sup> These model suggestions are in line with the recent observations. For example, on May 2004, Turkish Lira depreciated around 11 percent on a monthly basis but started to appreciate again in June; neither private manufacturing nor the consumer prices had displayed any significant movement.

<sup>20</sup> 30 and 42 percent of the CPI is composed of service sector and non-tradable prices respectively, whereas the remaining ones constitute the good and tradable prices.

80 percent for both price measures, and it is completed within six months. On the other hand, similar to our earlier findings, pass-through seems to have weakened after the adoption of floating exchange rate regime. Cumulative pass-through to tradable and good prices increases monotonically over time, reaching roughly 30 and 32 percents after one and half year. What is striking here is that unlike the pre-float period where pass-through is almost complete in 6 months, almost no impact of exchange shock can be observed for the first 3 or 4 months during the float period.

A similar exercise is repeated for service and non-tradable prices<sup>21</sup> and both sub-sample estimates point out the fact that all responses are within the error bands implying that there is no significant pass-through from nominal exchange rate changes to service and non-tradable inflation, which is in line with the conventional wisdom.<sup>22</sup>

### ***Public Manufacturing Prices***

Though public manufacturing prices constitutes relatively small fraction of (17.2 percent) wholesale prices, pricing behavior in this sector also carries important information for future prices since public manufacturing goods are direct inputs to private manufacturing and retail sector. Moreover, pricing decisions of the public sector in response to a cost shock can be different than the private sector since the former do not face much competition. For that reason, we believe that investigating the exchange rate pass-through to these prices together with the impact of public manufacturing prices on other prices can be a valuable exercise.

To this end, Figure 6 shows the estimated cumulative pass-through to public manufacturing prices for both sub-sample periods.<sup>23</sup> The long-run pass-through to public manufacturing inflation diminished from 70 percent to 50 percent, which is still sizeable. What is more, unlike the other cases we investigated above, the pass-through is very fast—even in the floating exchange rate period. It is almost completed within about 4 months *for both periods*. These findings suggest that public price setting behavior involves a rule-of-thumb behavior

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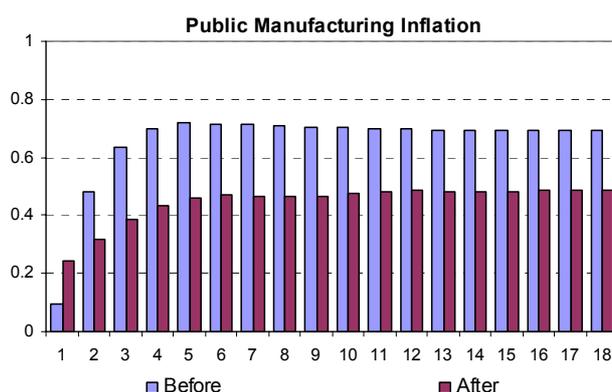
<sup>21</sup> We have used a three variable model, in which the ordering of the variables is output gap, nominal exchange rate and service (or non-tradable) prices.

<sup>22</sup> Given that Turkish Lira has been appreciating since the second quarter of 2003, and that pass-through of exchange rate changes to tradable inflation is higher than the pass-through to non-tradables, the declining relative prices of goods (tradables) with respect to services (non-tradable) items since the second half of 2003 should not bear any surprise.

<sup>23</sup> The model has the following ordering of the endogenous variables: output gap, import prices denominated in TL, public manufacturing inflation, private manufacturing inflation, and core CPI inflation. For both sub-samples, different from the other models, VAR(2) model is estimated based on likelihood ratio (LR), several information criteria and the cross correlation findings. Furthermore, cross correlations between import prices in denominated in Turkish Lira and public manufacturing inflation show that while highest correlation is in the first month for the first sub-sample period, it is in the contemporaneous month for the second one.

and is quite different from the private sector. This results, indeed, is not surprising since (i) Petroleum and refinery products, chemicals and metal industry sectors roughly constitute 62 percent of the public manufacturing sector and their prices are mainly determined in the international markets;<sup>24</sup> (ii) Turkey, being a small and open economy, is a price taker in international markets for these goods; and (iii) Public sector is almost a monopoly in distributing these products.

**Figure 6: Estimated Cumulative Pass-through to Public Manufacturing Inflation (Before vs. After the Floating Exchange Rate Regime)**



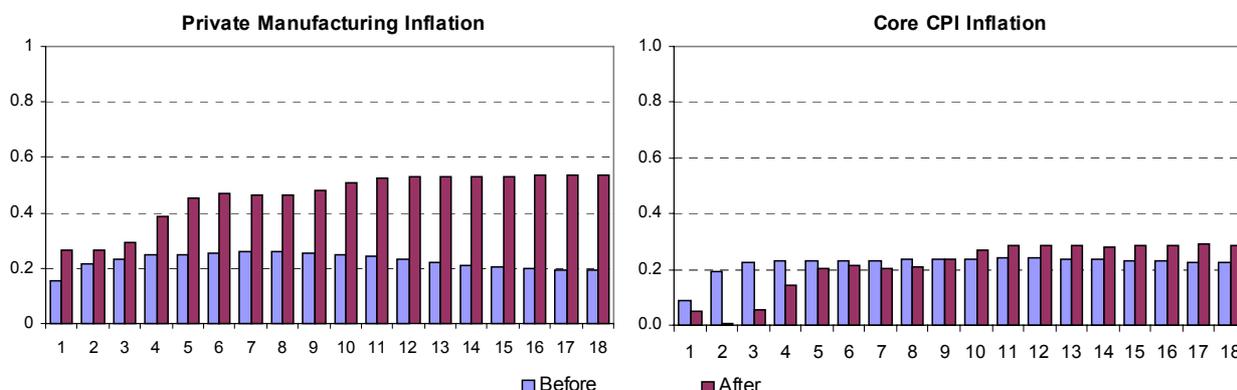
Since public manufacturing price inflation means an increase in the cost of production for the other sectors, it would be interesting exercise to estimate the pass-through from public manufacturing prices to private manufacturing and core CPI (Figure 7).<sup>25</sup> Figure 7 depicts that in the first sub-sample period, the cumulative pass-through from public manufacturing price changes to other price changes is limited; that is roughly 22 percent of the public price changes are reflected into the private manufacturing and consumer inflation within three months. More, interestingly, the pass-through from public manufacturing price changes to private manufacturing prices seems to have increased after the introduction of floating exchange rate regime.<sup>26</sup> A possible explanation for this finding may be related to the change in the information content of the public prices after the adoption of the floating exchange rate regime. Reduction in the degree of exchange rate-indexation, and thus shifting to a more optimizing price setting behavior may have increased the relative importance of direct input costs such as the public manufacturing products. Indeed, this mechanism also suggests that this could be arising simply from an identification problem due to high indexation behavior in the pre-float period.

<sup>24</sup> There is automatic pricing mechanism for refinery products in which sector prices are revised frequently.

<sup>25</sup> Based on the same model.

<sup>26</sup> This finding is robust to alternative model specifications.

**Figure 7: Estimated Cumulative Pass-through from Public Manufacturing Inflation to Private Manufacturing and Core CPI Inflation (Before vs. After the Floating Exchange Rate Regime)**



## 5. Summary and Concluding Remarks

Table 4 summarizes the main results. Except for the public manufacturing inflation, most of the pass-through for the pre-float period is completed within 4 months, which is coherent with the finding of Leigh and Rossi (2002). However, completion of the pass-through takes more time—almost a year—after the floating exchange rate regime. One exception is the public manufacturing prices in which the time to pass-through is the same—cumulative pass-through is almost completed within about 4 months—for both periods, confirming that rule-of thumb automatic price indexation is still common for this sector.

**Table 4: Pass-through: Summary of Findings**

	<b>SPEED: How long does it take before 80 percent of the total long-run exchange rate pass-through is completed (Months)</b>		<b>EXTENT: What percent of the exchange rate changes are reflected into the inflation by the end of the 24 months (%)</b>	
	<b>Before</b>	<b>After</b>	<b>Before</b>	<b>After</b>
<b>Private Manufacturing</b>	3-4	8	74	51
<b>Core CPI</b>	4-5	10-11	46	30
<b>Tradable CPI</b>	4	12-13	80	31
<b>Public Manufacturing</b>	2-3	3	70	49

Furthermore, the findings presented in the table evidently put forward that there is a noticeable decline in the long run exchange rate pass-through after the adoption of the floating exchange rate regime. The extent of weakening, however, might be different among various inflation

measures; for example, decline in CPI based measures seems to be more pronounced compared to WPI based measures. Notwithstanding the overall decline, pass-through is still sizable, implying that exchange rate and import prices remain to be critical variables for inflation dynamics. We have also computed the transition probabilities to demonstrate highly erratic short term movements in exchange rates during the float, which is in contrast with persistent upward movements in the preceding regimes of controlled exchange rates. Combining this latter result with the above findings, we conclude that lower-than-expected pass-through in recent years partly owes to the fact that exchange rate shocks were not persistent in direction. In other words, total pass-through might have been sizable had the economy been hit by one-sided shocks such as a persistent depreciation. To sum up, recent policy framework—inflation targeting and floating exchange rate regime—seems to have weakened the pass-through, however the long run impact is still considerable and should not be overlooked in the prospective inflation-targeting regime.

Three final remarks are in order. First of all, it is worth reminding that we have only three and a half years of observation under the floating exchange rate regime. Needless to say, a more thorough analysis will be possible as we accumulate longer observations for the floating exchange rate regime. Moreover, it is likely that the price setting behavior continue to change as agents learn under new policy regime of floating exchange rates. The reader should definitely take these factors into account when interpreting our results.

Secondly, one should recall that import prices in our model are denominated in domestic currency. We have argued that, in an environment where exchange rate movements are more frequent and substantial than the fluctuations in world prices, our definition of “import price” shocks can be attributed mostly to exchange rate shocks. However, it should be also noted that during a period of relatively stable exchange rates, import price innovations in our model would possibly originate from movements in world prices. In that sense, our findings also suggest that, persistent upward movements in world commodity prices may affect baseline inflation considerably in the long run.

Thirdly, it is also important to remind that actual output was below its potential through the second sample period. Although our model captures the impact of output gap through a separate equation, it may still be hard to identify the effect of the output gap on pass-through for the period of interest since output—in our computation—is *always* below the potential. In this case, econometric estimates may understate the true impact. Therefore, there is also a risk

that as the output gap closes, actual pass-through from the exchange rate developments to prices, especially to consumer prices, may even be stronger than the estimated figures.

As for future research, it may be interesting to complement our empirical approach by an optimization based stochastic general equilibrium model where the pricing behavior is modeled explicitly. Our VAR evidence could then be utilized to calibrate the parameters of the deep parameters of the model. One could also introduce a shift in the policy regime by adding behavioral reaction functions for the policy maker, and see if our definition of pass-through displays quantitatively significant changes across policy regimes. It could also be interesting to explore the impact of a change in the fraction of forward-looking agents on the pass-through. These issues would definitely be worthwhile to explore.

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## **Appendix: Data Description**

CPI, WPI, private and public manufacturing price indexes are based on 1994=100 index. In addition, tradable and non-tradable CPI together with goods and service indexes are calculated based on the definition of Research Department of CBRT. Other data descriptions are as follows:

*Exchange rate:* Monthly average of nominal Turkish Lira to US dollar exchange rate.

*Output gap:* Quarterly estimates of the output gap are received from the study of Sarikaya et al. (2004). Monthly distribution of the output gap estimates is derived along with Fernandez (1981) methodology.

*Import price inflation:* Monthly average of import price index denominated in the Turkish Lira, (1994=100).

*Core CPI:* CPI (1994=100) excluding unprocessed food and publicly controlled prices.

*Unprocessed foods:* Fish, fresh fruit and vegetables, dried fruit and vegetables, tuber plants.

*Publicly controlled prices:* Sugar, tea, alcoholic beverages, cigarettes, water for housing, tobacco, electricity, gasoline, liquid fuels, other fuels, oils, postal services, telephone services, medical services, dental services, medical analysis services, medical treatment, basic hospital services, intra-urban transportation services, financial services, other services.