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### Abstract

This paper examines the sensitivity of relative prices in the Turkish manufacturing industry to fluctuations in exchange rates. In our theoretical model, domestic and foreign firms produce substitutable goods for the domestic market. Some portions of domestic firm's inputs are assumed to be imported. Results show that in the absence of imported input usage in domestic production, relative domestic prices decreases after a devaluation of domestic currency. However, if domestic industry imports some of its inputs and the share of imported inputs in total domestic production cost is substantial, relative domestic prices may increase with devaluation. The other variables affecting the relative prices exchange rate relationship are degree of differentiation of the products, the number of domestic and foreign firms in the market, size of the market and the cost of foreign firms. Empirical results from Turkish Manufacturing industry support most of our theoretical findings.

**JEL Classifications** : D43, F31, L16

**Key Words** : exchange rate pass-through, inflation, Turkey

## 1. INTRODUCTION

In this study the objective is to examine structural causes of the Turkish inflation. In particular we aim to put a particular emphasis on the exchange rate pass-through mechanism and the impacts of the market structure and the high imported input dependence of Turkish manufacturing sector on this transmission mechanism. There are considerable amount of studies in the literature in this area. On the theoretical side, Dornbusch's (1987) seminal paper is the leading study in the literature. He investigates the determinants and extent of exchange rate pass through under different market structures. Using a Salop's type circular city differentiated product model, he indicates that relative prices of domestic goods increase with the appreciation of domestic currency, and the extent of this decrease is influenced by the degree of competition and the relative number of domestic and foreign firms. On the empirical side of the literature, most of the studies examine the subject for developed and relatively large economies (e.g. Yang, 1997; Menon, 1995; Athukorala and Menon, 1995; Feenstra, 1989; Feinberg, 1986, 1989, 1991). There has been less research on developing small economies (e.g. Günçavdi and Orbay, 1998; Lee, 1997).

Our focus in this study is on the Turkish economy. In order to analyze the effects of exchange rate fluctuation on relative domestic prices, we set up a simple theoretical model consisting two countries (one domestic and other foreign country representing the rest of the world). In accordance with the economic structure of the Turkish economy, we assume that production in the domestic country has a certain imported input component. It is also assumed that firms in the domestic country operate with a less efficient technology than the foreign counterparts. In our differentiated product model domestic and foreign firms determine their production levels simultaneously a la Cournot. The results show that with sufficiently small imported input dependency, depreciation of domestic currency leads to a decline in the ratio of domestic good prices to the price of imported brands. However, high import dependency of domestic production may change lead to a reverse relationship, i.e. depreciation may increase the relative domestic good prices. Degree of differentiation of the domestic and foreign products, the number of domestic and foreign firms in the market, size of the market and the cost of foreign firms are the other important variables affecting the direction and the magnitude of the relationship between relative domestic prices and exchange rates.

In the second part of our study, we test the theoretical findings with the data from Turkish economy. We use the past 114 years of data (1982-1995) for each of 29 Turkish manufacturing industries, defined at 3 digit *ISIC* level. The empirical model includes the exchange rate variable, and some other multiplicative terms of exchange rates with the market structure variable, the share of imported inputs and a proxy for the degree of differentiation of the products. By doing so, we derive the responsiveness of relative domestic good prices to exchange rates as a function of the industry specific factors. Results show that as indicated in our model

exchange rate fluctuations are important determinants of the relative domestic price changes and the direction of this relationship depends on the share of imported input usage. In particular, devaluation of Turkish lira is among the culprits inflationary pressure on relative domestic price in industries with high imported input dependency.

This paper is organized as follows. Section 2 includes our theoretical model. Empirical results are presented in Section 3. Concluding remarks are given in Section 4.

## 2. THE THEORETICAL MODEL

The theoretical model here is built upon our earlier models (see Günçavdi and Orbay, 2000). In a two-country world (namely a developing home country and a developed foreign country), the model assume that there are  $n$  firms for a given industry in the developing home country, and  $n^*$  firms in the developed foreign one. We also assume that the home country possesses relatively inefficient production technologies and high import dependence in production. For simplicity we assume no transportation costs.

On the supply side of the model, a typical firm  $i$  in the home country operates under a Cobb-Douglas production technology with a constant-returns-to-scale, and uses both domestic,  $k_i$ , and imported,  $k_i^*$ , inputs:

$$x_i(k_i, k_i^*) = (k_i)^{1-s} (k_i^*)^s, \quad i = 1, \dots, n \quad (1)$$

where  $x_i$  is the output level of the  $i^{\text{th}}$  firm, and  $s$  is the share of imported inputs in total costs. Using the production function in equation (1), the indirect cost function accruing to the domestic firm can be written as follows.

$$c_i(r, r^*, e, x_i) = Ar^{1-s} (er^*)^s (x_i), \quad (2)$$

where  $A = ((1-s)/s)^s$ ,  $e$  is the exchange rate and  $r, r^*$  are the unit costs of domestic and foreign inputs respectively. The firms in the foreign country are assumed to use only their own domestic inputs and cost function of the  $i^{\text{th}}$  foreign firm can be represented in the following form.

$$c_i^*(y_i) = c^* y_i, \quad i = 1, \dots, n^* \quad (3)$$

where  $y_i$  is the of output level of the foreign firm produced for the developing country. As stated before, we assume that foreign firms possess cost advantages over domestic ones mainly because they operate with more efficient technology and encounter lower input prices. This assumption therefore implies that foreign firms' unit cost of production is lower than the unit cost of the domestic firm;

that is  $ec^* < Ar^{1-s} (er^*)^s$ .

On the demand side of the model, we assume linear demand functions for both types of products, domestic and foreign, respectively as follows.

$$p(x,y) = a - bx - dy, \quad (4a)$$

$$p^*(x,y) = a - by - dx, \quad a, b, d > 0 \quad (4b)$$

where  $x = \sum_{i=1}^n x_i$  and  $y = \sum_{i=1}^n y_i$ .

The values of  $b$  and  $d$  respectively show the degree of differentiation of the domestic and imported goods. As  $b$  and  $d$  become closer, degree of differentiation decreases. Profit functions of domestic and foreign firms can, in turn, be written, respectively, as

$$\pi_i = p(x,y)x_i - c_i(r, r^*, e, x_i), \quad i = 1, \dots, n \quad (5a)$$

$$\pi_i^* = p^*(x,y)y_i - ec_i^*(y_i), \quad i = 1, \dots, n \quad (5b)$$

We assume that firms compete *a la* Cournot. Thus, they choose their quantities of production simultaneously. In order to compute Cournot equilibrium outputs, first, we obtain the reaction function of each firm from first-order conditions. Simultaneous solution of the reaction functions yields the following equilibrium levels of outputs of domestic and foreign firms,

$$\bar{x}_i = \frac{a(b + (b-1)n^*) - bAr^{(1-s)}(er^*)^s(1+n^*) + ec^*dn^*}{b^2(1+n)(1+n^*) - d^2nn^*} \quad (6a)$$

$$\bar{y}_i = \frac{a(b + (b-d)n) - bec^*(1+n) + dAr^{(1-s)}(er^*)^s n}{b^2(1+n)(1+n^*) - d^2nn^*} \quad (6b)$$

where  $N = (1+n)(1+n^*)$ . Substituting (6) into (4) yields the equilibrium prices for the domestic and foreign products, respectively, as follows.

$$\bar{p} = \frac{af(f + (f-1)n^*) + (nf^2 + (f^2-1)nn^*)Ar^{(1-s)}(er^*)^s + ec^*fn^*}{f^2N - nn^*}, \quad (7a)$$

$$\bar{p}^* = \frac{a(f^2 + f(f-1)n) + (n^*f^2 + (f^2-1)nn^*)ec^* + Ar^{(1-s)}(er^*)^s bfn}{f^2N - nn^*}. \quad (7b)$$

where  $f = b/d$  shows degree of differentiation of domestic and foreign goods and  $f > 1$ . The relative domestic prices are

$$\frac{d\bar{p}}{d\bar{p}^*} = \frac{af(f + (f-1)n^*) + (nf^2 + (f^2-1)nn^*)Ar^{(1-s)}(er^*)^s + ec^*fn^*}{af(f + (f-1)n) + (n^*f^2 + (f^2-1)nn^*)ec^* + Ar^{(1-s)}(er^*)^sfn} \quad (8)$$

The sensitivity of the relative domestic prices to the exchange rate fluctuation can be computed as follows:

$$\eta = \frac{d\bar{p}}{d\bar{p}^*} \frac{e}{\bar{p}^*} = \frac{h^2 \left| h(f-1)(af(sCn - ec^*n^*) - (1-s)Cec^*(1+f)nn^*) \right|}{\bar{p} \bar{p}^*} \quad (9)$$

where  $h = f^2N - nn^*$  and  $C = Ar^{(1-s)}(er^*)^s$  ( $C$  is the unit cost of domestic firms). As stated in the previous section, the exchange rate elasticity of prices is referred to exchange rate pass-through in the related literature. Equation (9) indicates that the direction of the exchange rate pass-through on relative domestic prices depends on the sign of the term

$(af(sCn - ec^*n^*) - (1-s)Cec^*(1+f)nn^*)$ . It is clear that when  $s$  is zero  $\eta < 0$  i.e. in the case of no imported input usage the relative domestic prices will decrease as a result of a depreciation of the domestic currency. This result is consistent with the previous literature (see Dornbusch (1987)). However, when  $s$  is positive, then it is possible to observe a reverse relationship between the relative domestic prices and exchange rates. More specifically, when  $sCn$  is large, which is in fact the sum of the imported share of unit cost of domestic firms, it is plausible to observe that  $\eta > 0$ . It must be noted here that sufficiently large  $sCn$  is only a necessary condition, it is not sufficient. Sufficiency depends on the magnitude of the other variables such as, degree of differentiation of the products, ( $f$ ), the size of the market ( $a$ ), sum of the cost of foreign firms. Having discussed the results of our theoretical model, the following hypothesis can be arisen to test the importance of fluctuations in exchange rates in the domestic price formation in Turkey.

**H1:** In the case of substantial imported inputs usage in production, relative domestic good prices may increase as a response to a depreciation of Turkish Lira against foreign currencies.

**H2:** Degree of differentiation of the products, the number of domestic and foreign firms, size of the market and the cost of foreign firms are important variables (in addition to the share of imported input usage), affecting the direction and the magnitude of the relationship between relative domestic prices and exchange rates.

In the following section, we will test these expectations empirically for the Turkish manufacturing data.

### 3. AN EMPIRICAL ANALYSIS

Having presented theoretical discussion above, this section lays emphasis upon empirical testing of the link between movements in foreign exchange (*EXCH*) and the relative domestic price (*RDP*). Our aim is also to analyse the importance of the industry-specific factors, in particular, the imported input dependency that may influence the pass-through mechanism between *EXCH* and *RDP*. Before turning to the empirical testing, it must be noted the limitation of the data in our sample. Following the theoretical discussion in the previous section, testing the role of imported inputs in production on exchange rate pass-through mechanism poses a crucial importance. The data from annual surveys of manufacturing industry in Turkey contains no information on imported inputs in production at 3-digit disaggregation level. Due to the lack of continuous imported input data for the period of 1983-1993, we employ

a simple procedure to measure the import dependence of the domestic production of each industry as follows. Using input-output tables available for 1985 and 1990, we classified each industry according to its dependence on imported inputs, and generate three different dummy variables, namely  $D1$ ,  $D2$  and  $D3$ , each corresponding to the degree of import dependence starting from low dependent industry and ending with high dependent one.  $D1$ ,  $D2$  and  $D3$  take the value of unity for low dependent, dependent and high dependent industries respectively.

Following the theoretical model in the previous section, we pay special attention on some industry specific factors such as market structure, the degree of product differentiation and the share of imported inputs in domestic production. Our aim is to see how the sensitivity of the pass-through mechanism is affected by these factors, using the past 12 years of the data (1982 to 1993) for each of 27 Turkish manufacturing industries, defined at the 3-digit ISIC level. Although the data is available for the period of 1980-1993, the sample period in our empirical investigation corresponds to the liberalised exchange rate period starting from 1982.

Herfindahl Index, calculated by Güneş (1998), is chosen as a proxy variable to capture the effects of market structure. A measure of four-firm seller concentration ratio is also reported in Güneş (1998), but its correlation with the Herfindahl Index is almost 0.97 (see Table 2). The real exchange rate used in our empirical investigation is measured by the index of the trade weighted real effective exchange rate of two important trade partners of Turkey, namely the USA and Germany. In order to capture the effects of general macroeconomic conditions, gross domestic product ( $GDP$ ), which may proxy to some extent the demand condition in the economy, is included in the estimation procedure. Following the empirical literature in intra-industry trade, a working measure of the extent of intra-industry trade ( $IIT$ ) is constructed as an index of trade overlap as follows.

$$IIT_i = 1 - \frac{|X_i - M_i|}{X_i + M_i} \quad (10)$$

where  $X_i$  and  $M_i$  are the values of exports and imports in industry  $i$ , respectively. A higher value of the index is posited to indicate a higher degree of product differentiation in an industry. The definitions and the sources of all variables are given in Table 1.

**TABLE 1 : THE DEFINITION AND SOURCES OF VARIABLES**

Variables	
$RDP_{it}$	The ratio of the domestic output prices to the import price for 3 – digit ISIC industry $i$ , year $t$ , taken from various Annual Manufacturing Industry Statistics.  Source : State Institute of Statistics (SIS).
$EXCH_t$	Trade Weighted Effective Real Exchange Rate Index, calculated from currency baskets consisting of US Dollar and German Mark. The weights in the basket for both currencies differ between the periods of 1982-1986 and of 1987-1993. The weights for the former period are 0.5 for US Dollar and 0.5 for German mark whereas they are 0.75 for US Dollar and 0.25 for German Mark in the second period.  Source: The Quarterly Bulletin of the Central Bank of Turkey.
$M_{it}$	The values of imports for industry $i$ , year $t$ , Sources: <i>State Institute of Statistics (SIS)</i>
$X_{it}$	The Value of Exports for industry $i$ , year $t$ , Sources: <i>State Institute of Statistics (SIS)</i> .
$S_j$	We classified each industry according to its dependence on imported inputs based on using input-output tables available for 1985 and 1990, and generate three different dummy variables, namely $D1$ , $D2$ and $D3$ , each corresponding to the

	degree of import dependence starting from low dependent industry and ending with high dependent one. $D_1$ , $D_2$ and $D_3$ take the value of unity for low dependent, dependent and high dependent industries respectively.
$H_{it}$	The Herfindahl Index (sum of squared market shares) for industry $i$ , year $t$ is used to measure the market structure in each sector.  Source: Günes, M. (1998), Türk İmalat Sanayinde Yogunlasma Oranlarini Belirleyen Faktörler 1980-1994, State Institute of Statistics, Ankara.
$GDP_t$	Real Gross Domestic Product (1987=100). Source: State Planning Organisation (1997), Economic and Social Indicators (1950-1997), in Turkish.

The empirical model is quite simple and follows Günçavdı and Orbay (1998), Lee (1997) and Feinberg (1986, 1991). Pooled cross-section/time-series data are used to estimate the exchange rate elasticity of domestic prices and differences across industries in the estimated elasticity are explained by industry-specific variables, intended to proxy market structure ( $H$ ), degree of differentiation of products ( $ITT$ ) and the share of imported inputs in domestic production ( $S$ ). We estimate the coefficients and standard errors of the industry variables from interaction terms with the exchange rate. Empirical supports for the hypothesis above are found out from the estimation of following regressions on 336 pooled cross-section/time series observations ( $i=1, \dots, 27$ ;  $t=1982, \dots, 1993$ ) using the least square dummy variable ( $LSDV$ ) method (see, Baltagi, 1995, Green, 1993; Hsiao, 1986,).

$$rdp_{it} = a_0 + a_1 gdp_t + a_2 exch_t + a_3 h_{it} exch_t + a_4 ITT_{it} exch_t + a_5 s_{it} exch_t + \varepsilon_{it}, \quad i=1, \dots, 27 \quad (11)$$

where small cases indicate the logarithms of all relevant variables. Assuming that differences across industries are fixed, equation (11) include a set of industry specific **dummy** variables. The effects of changes in macroeconomic conditions are captured by the coefficient of  $gdp$  ( $a_1$ ), which is kept constant across industries, and is expected to be positive. From equation (11), exchange rate pass-through can be written as a function of these industry specific factors by differentiating (11) with respect to the exchange rate variable as follows.

$$\eta_i = a_2 + a_3 h_{it} + a_4 ITT_{it} + a_5 s_{it} \quad (12)$$

where  $\eta_i$  shows the exchange rate pass-through for industry  $i$  (i.e. the exchange rate elasticity of relative domestic prices). Equation (12) indicates that exchange rate pass-through varies over time and across industries.

The results of estimates are reported in Table 2. They show that one of the main determinant of relative domestic price movements in Turkey from 1982 to 1993 was the real external value of the Turkish Lira. Column (1) shows the estimate of equation (11), in which the variable  $exch$  is significant with negative sign. When we look at the signs of the multiplicative terms we observe that, market concentration effect is not significant. However, the coefficients of multiplicative term of degree of product differentiation and the dummy variable for the sectors with high imported input dependency ( $D_3$ ) are both significant with positive signs. We re-estimated the equation eliminating the insignificant market structure variable and presented the results in column (2).

<b>TABLE 2 : ESTIMATION RESULTS</b>		
<i>Variable</i>	(1)	(2)
<i>Demand</i>	<b>0.721</b> <b>(2.977)</b>	<b>0.711</b> <b>(2.96)</b>
<b>Real Exchange Rate</b>	<b>-0.125</b> <b>(-2.288)</b>	<b>-0.119</b> <b>(-2.289)</b>
<i>Market Concentration*Real Exchange Rate</i>	-0.060 (-0.351)	----
<i>Degree of product differentiation* Real Exchange Rate</i>	<b>0.165</b> <b>(3.722)</b>	<b>0.420</b> <b>(3.864)</b>
<i>Dummy1*Real Exchange Rate</i>	-0.189 (-1.335)	-0.190 (-1.343)
<i>Dummy2*Real Exchange Rate</i>	-0.172 (-1.150)	-0.171 (-1.145)
<i>Dummy3*Real Exchange Rate</i>	<b>0.278</b> <b>(1.950)</b>	<b>0.284</b> <b>(2.013)</b>
R <sup>2</sup>	0.232	0.231
# of observations	304	304
Figures in brackets show the t-statistics of variables.		

As we stated in previous section, a devaluation of domestic currency may increase the relative domestic prices in the case of high imported input dependency. Our empirical results strongly support this hypothesis. The negative sign of the coefficient of *exch* indicates that devaluation of Turkish Lira (TL) causes relative domestic prices to decrease. However, the positive sign of the multiplicative term of  $D_3$  shows that high imported input dependency of some sectors limits this effect. Moreover, the net effect of the devaluation of TL on *RDP* turns out to be positive in those sectors. The degree of product differentiation also limits the exchange rates effect on *RDP*.

These results are important, because they are the indication of the fact that, devaluation of domestic currency in Turkey, may increase the inflationary pressure on many of the domestic industries due to their high imported input dependency. As it is known, current exchange rate based stabilization programme, government tries to control inflation by controlling the value of TL against foreign currencies. Our findings strongly supports the hypothesis that exchange rates and related industry specific prices are

important determinants of relative domestic prices, and hence, this programme will certainly reduce the inflationary pressure on domestic producers in Turkey.

#### **4. CONCLUSION**

In this article, we developed a theoretical model aiming to analyze the link between fluctuations in exchange rate and realtive domestic prices in an economy where domestic industries use imported inputs. Our theoretical model shows that extent of exchange rate pass-through on relative domestic prices is closely related with the degree of substitutability between imported and domestic goods, market structure, the share of imported inputs, the size of the market and the cost of foreign firms. In particular, the extent of imported usage is the crucial determinant of the direction of the relationship between exchange rates and relative domestic prices. For instance, if the imported input usage of a domestic industry is low, depreciation of domestic currency causes relative domestic prices to decrease. However, high imported input dependency of domestic industries limits this effect and, it is in fact possible to observe an increase in relative domestic prices as a response to a devaluation.

These findings are tested by using the 3-digit data on Turkish manufacturing sector covering the time period 1982-1993. Empirical results strongly support theoretical findings. The relative domestic prices in Turkey, in fact, increases as a response to a devaluation of TL in industries which has high imported input dependency. Considering the fact that, Turkish industry in general is quite dependent on imported inputs, it is possible to say that a large portion of Turkish manufacturing industry will benefit from exchange rate based stabilization programme of Turkish government in terms of inflationary pressure.

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