

# **Export Supply and Import Demand Models for the Turkish Economy**

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# EXPORT SUPPLY AND IMPORT DEMAND MODELS FOR THE TURKISH ECONOMY

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## Abstract

This study estimates the export supply and import demand for the Turkish economy using both single equation and vector auto regression frameworks. The long run and short-run specifications of exports and imports have been estimated using the least squares estimators and a conventional set of explanatory variables. The long-run elasticity estimates of trade flows with respect to their regressors are also reported. Exports are determined by the unit labor costs, export prices and the national income in a statistically significant manner. On the other hand, imports are mostly affected by the real exchange rate and national income. The analysis reveals the real exchange rate as a significant determinant of imports and the trade deficit, but not of exports. In this way, a basic policy proposal for inducing higher exports is to take private and public measures for attaining higher productivity levels.

**Key Words:** Export supply, import demand, and trade forecasting.

**JEL Classification Codes:** C13, C51, and F17.

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## **1. Introduction**

Determinants of trade flows have always attracted researchers in both academic area and policy-making institutions. Such an interest basically stems from the close linkage between the current account and exchange rate performances in any given economy. Closeness of an economy to some equilibrium is largely affected by its current account and balance of payments position. This study is a fresh attempt to model the trade flows of Turkey, designated as the initial stage of the establishment of a balance of payments estimation block in the Central Bank of the Republic of Turkey (CBRT).

The main purpose of the functions that are estimated is to generate forecasts for the near-term. Such a focus on near-term forecasts is especially underlined once Turkey is growing after the devastating crisis of the year 2001. It is clear that for sustainability of this recent growth performance, improvement is required in both real and financial sectors of the economy. In that, the current account and exchange rate considerations remain as central issues. Especially on the imports front, growth of real income (output) and expansion of imports go hand-in-hand, since nearly 70 % of all imports are done for the procurement of intermediate manufactured inputs and raw materials. Combined with the path of exports, import flows yield the overall trade outcome.

Some recent public debate regarding the role of the real exchange rate in determining the export performance form a side-purpose of this study. So this study provides a simple resolution to this debate, as well.

Firstly, we search for a statistical representation of real exports and imports using up-to-date data so as to reflect the effects of the latest developments in the Turkish economy. In a simple statistical framework and using a fairly parsimonious set of explanatory variables, we demonstrate that the trade flows of Turkey can be explained adequately. It is important to note that parsimony of the regressors is crucial to have a clear-cut view of the trade balance. Secondly, we assess the short-term dynamics of the trade flows.

Our single equation models indicated that imports can be explained by the real exchange rate and the national income and exports are mostly determined by unit labor cost, export prices and national income. Some recent change in the overall trend of series is evident and well-captured in and reflected on the estimates. Vector auto regression models of exports and imports yielded similar results as captured by the single equation framework and pointed out a nearly two-quarter horizon for the effects of the real exchange rate on the trade deficit to be realized.

Regarding the real exchange rate emerging as a central issue in the public and policy-making debates, it should be mentioned that the real exchange rate is revealed as a significant determinant of imports, but not of exports. At the same time, the VAR finding that the real exchange rate is a determinant of current account indicates that the effects of the real exchange rate on trade deficit basically operates through the imports, but not exports. These observations might suggest that a real exchange rate depreciation, e.g. a real depreciation of Turkish lira, will not induce a huge increase in exports but it will shrink the volume of imports significantly, hence reducing the size of the trade deficit. Therefore, on the exports front as the unit labor costs and export prices are basic determinants, public and private policy measures toward inducing productivity increases should be taken.

In the next section, a brief review of the leading literature as well as of some recent studies is provided. Section 3 provides the single equation estimates of the import and export flows. In section 4, we elaborate the trade flows in a vector auto regression setup, and Section 5 concludes the study and covers the further research agenda.

## **2. Literature in Brief**

In the literature, the investigations of the determinants of trade flows are basically directed toward assessing the effects of a currency depreciation on the current account. There are two major approaches to investigate the effects of a real devaluation on the trade balance of a country, namely the ‘elasticities’ and the ‘trade balance’ approaches. In this section, we will provide a non-exhausting list of the leading studies in the economics literature. In addition to this, some recent studies regarding the Turkish case of imports and exports will be reviewed.

From an econometric point of view, the elasticities approach is based on estimating the import and export demand functions. In most studies, export (import) volumes are regressed on effective exchange rates, relative export (import) price, and world (domestic)

real income. After estimating the export and import demand functions, economic inferences are being made. For instance, a well-known statement in the trade literature, called Marshall-Lerner-(Robinson) Condition says that ‘a depreciation or devaluation of a country’s currency will improve its current-account balance if the sum of the absolute values of the price elasticities of domestic and foreign demand for imports is greater than unity, provided that trade balance -which is assumed to be equal the current account balance- is zero initially. So, in order to see whether devaluation will help improving the trade balance, it is sufficient to estimate the import and export demand functions and to check whether the sum of the absolute price elasticities exceeds unity. This is a fairly static treatment of the behavior of trade flows and one can estimate more dynamic models to make J-curve type of arguments.<sup>1</sup>

Goldstein and Khan (1985) provides a survey of studies on income and price effects in foreign trade, with an excellent discussion of the specification and econometric issues in trade modeling, as well as a summary of various estimates of price and income elasticities and related policy issues. We will first discuss a small subset of recent studies.

Khan (1974), has investigated for the period 1951-1969 employing annual data for individual countries<sup>2</sup> using the following model specification:

$$\log M_{it}^d = a_0 + a_1 \log (PM_i/PD_i)_t + a_2 \log Y_{it} + U_t,$$

is the import demand function, where  $M_i$  is the quantity of imports of country  $i$ ,  $PM$  is the unit value of imports in country  $i$ ,  $PD_i$  is the domestic price level of country  $i$ ,  $Y_i$  is the real GNP of country  $i$ , and  $U_t$  is an error term associated with each observation.

$$\log X_{it}^d = b_0 + b_1 \log (PX_i/PW)_t + b_2 \log W_t + V_t$$

is the export demand function where  $X_i$  is the quantity of exports of country  $i$ ,  $PX_i$  is the unit value of exports of country  $i$ ,  $PW$  is world price level, and  $W$  is the real world income (proxied by OECD real GNP). Since each variable is defined in logarithmic terms, the estimated coefficients are the elasticities of imports and exports with respect to the corresponding variables. Having estimated these functions using OLS, Khan reported that the prices did play an important role in the determination of imports and exports of developing countries and Marshall-Lerner Condition is satisfied.<sup>3</sup>

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<sup>1</sup> As stated by Goldstein and Khan (1985) and Junz and Rhomberg (1973), the response of imports and exports to changes in other variables is not instantaneous due to recognition, decision, delivery, replacement, and production lags. So a dynamic treatment is required. However, the formulation of Marshall-Lerner Condition does not involve any dynamics.

<sup>2</sup> Included countries are Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Ghana, India, Morocco, Pakistan, Peru, the Philippines, Sri Lanka, Turkey, and Uruguay.

<sup>3</sup> In Khan (1974), all import and export quantity and unit value data were obtained from the IMF/IFS various issues, except for two countries: For Argentina, data from Central Bank of Argentina, Comercio Exterior, and for Pakistan, data from the Institute of Development Economics were used. Nominal GNP data were taken from

Warner and Kreinin (1983) have also employed a similar model, but their approach is different from Khan (1974) in two respects: Firstly, there are two distinct investigation periods, the periods of fixed and flexible exchange rate regimes, to analyze the behavior of the model in the two periods. Secondly, Warner and Kreinin estimated the import demand functions as Khan (1974) did, but they also repeated the estimation after excluding the petroleum products. Quarterly data for the periods 1957:1-1970:4 (fixed exchange rate period) and 1972:1-1980:4 (floating exchange rate period) separately <sup>4</sup> have been employed to estimate the model. Warner and Kreinin model of import and export demand functions is as follows:

Import demand function in Warner and Kreinin (1983) for the 1957:1-1970:4 period is given by:

$$\ln M = c + a_1 \ln Y + a_2 \ln (PM/PD)$$

$$\ln M = c + b_1 \ln Y + b_2 \ln PD + b_3 \ln PM$$

Import demand function for the 1972:1-1980:4 period:

$$\ln M = c + a_1 \ln Y + a_2 \ln PM/PD$$

$$\ln M = c + b_1 \ln Y + b_2 \ln PD + b_3 \ln PM$$

$$\ln M = c + c_1 \ln Y + c_2 \ln PD + c_3 \ln PM^{FC} + c_4 \ln E$$

where,  $PM^{FC}$  is the import price in foreign currencies,  $M$  is the volume of imports on a per capita basis,  $Y$  is the real GNP on a per capita basis,  $PD$  is domestic prices,  $PM/PD$  denotes the relative prices, and  $E$  stands for the exchange rate. As all the variables are expressed in logarithms, the parameters of this model are again interpreted as the elasticities of the dependent variable with respect to the independent variables. Exchange rate was included in the model only for the floating exchange rates period and it was calculated as an import-weighted effective exchange rate.

The export demand equation of Warner and Kreinin was described by:

$$\ln X_i = c + a_1 \ln YW_i + a_2 \ln PX_i^{LC} + a_3 \ln E_i + a_4 \ln E_i^P + a_5 \ln P_{comp}^{FC}$$

where  $X_i$  is the volume of the country's exports,  $YW_i$  is the weighted average GDP of 23 major importing countries facing country  $i$ ,  $PX_i^{LC}$  is the export unit value index of the country  $i$ , 1974=100,  $E_i$  is the effective exchange rate index of country  $i$ 's currency (1975=1),  $E_i^P$  is the expected rate of change in the exchange rate, which is proxied by  $E_i^P = [0.7(\log E_t - \log E_{t-1}) +$

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IMF/IFS and real GNP data were taken from the UN, Statistical Yearbook, implicit deflator being generated. World income and prices were defined as real GNP reported by the OECD and the OECD GNP deflator respectively. All data are USD denominated.

<sup>4</sup> Included countries are the United States, Germany, France, Japan, the United Kingdom, Canada, Italy, Netherlands, Belgium, Sweden, Denmark, Switzerland, Norway, Finland, Austria, Spain, Ireland, Austria, and the New Zealand.

0.3(logE<sub>t-1</sub>-logE<sub>t-2</sub>)], following Wilson and Takacs (1979).  $P^{FC}_{comp}$  is the average export price of 64 competing countries expressed in foreign currencies, weighted by each competing country's exports into each of the markets. Having estimated the demand for imports and exports<sup>5</sup> using OLS technique, Warner and Kreinin reported that the introduction of floating exchange rates appeared to have affected the volume of imports in several major countries, but the direction of change varied between them. The exchange rate and the export price of competing countries are found to be powerful determinants of a country's exports.

Bahmani-Oskooee (1986) used quarterly data for 1973-1980 period<sup>6</sup> and provided the estimates of aggregate import and export demand functions for seven developing countries. They also provided estimates of price and exchange rate response patterns by introducing a distributed lag structure on the relative prices and on effective exchange rate, applying the Almon procedure. Since the dynamics of the determination of the trade flows are involved, Bahmani-Oskooee (1986) presented a more realistic setup. The equations used in this study are:

$$\ln M_t^d = a + b \ln Y_t + c \ln (PM/PD)_t + h \ln E_t + u_t \quad (\text{Import Demand})$$

where, M is the quantity of imports, PM is the import price, PD is the domestic price level, Y is the real GNP, and E is the export weighted effective exchange rate. After introducing lags the equation becomes:

$$\ln M_t^d = a + b \ln Y_t + \sum_{i=0}^{n1} c_i (PM / PD)_{t-i} + \sum_{i=0}^{n2} h_i \ln E_{t-i} + u_t$$

$$\ln X_t^d = a + b \ln YW_t + c \ln (PX / PXW)_t + d \ln E_t + v_t \quad (\text{Export Demand})$$

where, X is the quantity of exports, YW is the weighted average of real GNP of a country's trading partners, PX is the export price, PXW is the weighted average of the export prices of a country's trading partners, and E is the export-weighted effective exchange rate. Having introduced the lags, it becomes:

$$\ln X_t^d = a + b \ln YW_t + \sum_{i=0}^{n1} c_i (PX / PXW)_{t-i} + \sum_{i=0}^{n2} d_i \ln E_{t-i} + v_t$$

Based on the estimates of these models<sup>7</sup>, Orcutt's earlier conjecture that trade flows adjust differently to different price stimuli was supported. Namely, according to Bahmani-

<sup>5</sup> Warner and Kreinin used mainly the data from IMF/IFS. Data from Direction of International Trade was also used to obtain the weights for the effective exchange rates. The value and unit value indices were obtained from OECD Trade Series A and B, and domestic oil production data were taken from OECD National Income Accounts.

<sup>6</sup> Included countries are Brazil, Greece, India, Israel, Korea, South Africa, and Thailand.

<sup>7</sup> Data were taken from IMF Direction of Trade Statistics, IMF/IFS, and OECD Statistics of Foreign Trade, Series A.

Oskooee (1986)'s findings, trade flows are more responsive to changes in the relative prices than to changes in the exchange rates in the long-run.

The two of the most recent studies in this area are Bahmani-Oskooee and Niroomand (1998) and Bahmani-Oskooee (1998). As far as the data and variable definitions are considered, these two follow the previous literature without any modifications, while both studies employ the Johansen (1988) and Johansen-Juselius (1990) cointegration analyses. The main idea behind the cointegration analysis is that if a linear combination of a set of nonstationary variables is stationary, those variables are said to be cointegrated. The Johansen-Juselius technique is based on the maximum-likelihood estimation procedure and allows for feedback effects among a set of variables. It basically provides two test statistics for determining the number of cointegrating vectors in addition to their estimates. An important feature we observe in Bahmani-Oskooee and Niroomand (1998) and Bahmani-Oskooee (1998) is the emphasis put on the match between the long-run characteristics of the Marshall-Lerner Condition and the cointegration analysis. It should also be added that, this study is the first to apply Johansen-Juselius technique to estimate the trade elasticities.

Bahmani-Oskooee and Niroomand (1998)<sup>8</sup> has the following model specification, for a study period of 1960-1992 annually:

$$\log M_t = a + b \log (PM/PD)_t + c \log Y_t + e_t \quad (\text{import demand function})$$

where, M is the volume of imports, nominal imports are deflated by import price index, PM is import prices, index of unit value of imports, PD is the domestic price level, index of domestic price level measured by CPI, Y is the domestic income, real GDP or GNP.

$$\log X_t = a' + b' \log (PX/PXW)_t + c' \log YW_t + e'_t \quad (\text{export demand function})$$

where X is the volume of exports, i.e. nominal exports are deflated by export price index, PX is export prices, index of unit value of exports, PXW is the world export price level, dollar denominated export unit value index of the IMF's industrial country aggregate, YW is the world income, i.e. the world income proxied by the index of industrial production in industrial countries, all variables having the same base year of 1985. Estimating the equations for 30 countries, the authors concluded that for almost all cases devaluations could improve the trade balance.

Bahmani-Oskooee (1998)<sup>9</sup> uses quarterly data<sup>10</sup> for the period 1973-1990 with a slight modification of the import and export demand equations in Bahmani-Oskooee and

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<sup>8</sup> Included countries are Australia, Austria, Belgium, Canada, Colombia, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Mauritius, Morocco, Netherlands, Norway, New Zealand, the Philippines, South Africa, Spain, Sweden, Syria, Tunisia, the UK, the USA, and Venezuela.

Niroomand (1998) through the addition of nominal effective exchange rate variable as a regressor.

Having provided the basic literature using the elasticities approach, we can emphasize the major common points of these strand of studies. Firstly, all major studies regress import volumes on relative import prices and real domestic income; and export volumes on relative export prices and real world income. While doing this, the underlying framework is the imperfect substitutes model of the trade literature. As it was discussed in Goldstein and Khan (1985) in detail, if domestic and foreign goods were perfect substitutes, then we should observe either of the goods having market share of unity, and each country acts as an importer or exporter of a traded good but not both. Theoretically, price and income elasticities are expected to have negative and positive signs respectively. We expect the import volume to shrink as the relative import price increases and expand as domestic real GDP increases, similar argument being valid for exports when we replace the names of the variables with their counterparts in the general export model specification. An important assumption is the perfect elasticities of import and export supplies, allowing us to restrict our attention to only demand side. It should be obvious that the picture gets complicated when we drop this assumption.

Secondly, all elasticities approach models given above, focus on aggregate data for volume variables, such as import/export volumes and real incomes. Here two related questions can be posed as in Goldstein and Khan (1985) and Theil (1954). First, is it really necessary to estimate the disaggregated relationships and then to collect them together to get an aggregate estimate? Second, if our answer to the first question is positive, how this task should be carried out? The answer to the former was formulated in the Goldstein and Khan (1985) survey. They argued that when the effect of the determining variables is exactly the same in aggregate and disaggregated models, or if there is a stable relationship between the components and aggregate explanatory variables, then we can be indifferent between aggregate and disaggregated equations. For more detail, one may refer to Grunfeld and Griliches (1960) and Aigner and Goldfeld (1974).

Third, all studies discussed earlier, except Bahmani-Oskooee (1986), use a static framework. Use of static models in trade econometrics is consistent with the formulation of Marshall-Lerner stability condition, which did not involve any dynamics.

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<sup>9</sup> Included countries are Greece, Korea, Pakistan, the Philippines, Singapore, and South Africa.

<sup>10</sup> All data were taken from IMF/IFS.

Finally, we may safely conclude that one only may find agreement on whether Marshall-Lerner stability condition is satisfied. The satisfaction of the condition is dependent on the type of formulation employed, variables involved, and sample period. Therefore, each econometric case of trade flows can be perceived as an island in itself.

A brief discussion of the studies using the trade balance approach will also be provided for completeness and good understanding of the basic estimation problem regarding the determinants of trade flows.<sup>11</sup> The standard formulation in these studies is such that, the trade balance variable (magnitude being either a monetary value or an index) is regressed on exchange rate, real income, and other related macroeconomic variables. This formulation facilitates a more direct estimation of the effects of changes in the independent variables on the dependent variable, without any need to examine the Marshall-Lerner Condition. This aspect of these models can be considered as an advantage, but use of a trade balance formulation usually generates less information on the determinants of the trade flows.

Miles (1979)<sup>12</sup> examines the relationship between devaluation and trade balance and the balance of payments for 16 devaluations of 14 countries in the 1960s, individually and on pooled data, using seemingly unrelated and pooled cross-section time series regression techniques. The equations involved are:

$$\Delta(TB/Y)_i = a_0 + a_1\Delta(g_i - g_R) + a_2 \Delta(M_i - M_R) + a_3 \Delta(G_i - G_R) + a_4 \Delta ER_i$$

(trade balance equation)

$$\Delta(BP/Y)_i = b_0 + b_1\Delta(g_i - g_R) + b_2 \Delta(M_i - M_R) + b_3 \Delta ER_i$$

(balance of payment equation),

where,  $TB_i$  is the level of trade balance in country  $i$ , f.o.b. exports of goods minus c.i.f. imports,  $BP_i$  is the level of the balance of payments in country  $i$ , proxied by the official settlements definition, and  $Y_i$  is the level of output in country  $i$ , i.e. the GNP measured in domestic currency.  $g_i$  and  $g_R$  are the growth rates of income in country  $i$  and the rest-of-world  $R$ , respectively.  $M_i$  and  $M_R$  are the ratios of the average level of high-powered money to output.  $G_i$  and  $G_R$  are the ratios of government consumption to output.  $ER_i$  the exchange rate of country  $i$ , all 'rest of the world' variables are constructed using a nominal-GNP-weighted average of the variable in various countries.

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<sup>11</sup> It should be obvious to the reader that, elasticities and trade balance approaches are the indirect and direct representation of a solution methodology for the same problem, i.e. the investigation of the relationship between devaluations and trade balance movements.

<sup>12</sup> Included countries are the United Kingdom, Denmark, France, Finland, Ireland, Iceland, Spain, New Zealand, Costa Rica, Ecuador, Guyana, Israel, Sri Lanka, the Philippines.

Estimating this model<sup>13</sup>, Miles concluded first that "a devaluation did not improve the trade balance but improved the balance of payments", and second, he found the non-existence of a relationship between a devaluation and real variables.

Himarios (1985)<sup>14</sup> identified some of the deficiencies in Miles's methodology and tests. Re-specifying the trade balance equation, Himarios showed that devaluations did affect the trade balance, in the traditionally predicted direction. Himarios (1989)<sup>15</sup> examined 60 devaluation episodes during the periods 1953-1973 and 1975-1984, where the estimates of his model were satisfactory for both fixed exchange rate and flexible exchange rate periods. This study revealed some evidence supporting the view that devaluation can be a useful tool in affecting changes in real variables and the structure of the economy.

Bahmani-Oskooee (1985)<sup>16</sup> uses the following specification for 1973-1980 period using quarterly data<sup>17</sup>:

$$TB_t = a_0 + a_1 Y_t + a_2 YW_t + a_3 M_t + a_4 MW_t + \sum_{i=0}^n b_i (E/P)_{t-i} + u_t$$

where, TB is the trade balance, i.e. index of domestic currency value of exports minus imports, YW is the world income, expressed as an export weighted index, M is the domestic high-powered money, expressed as an index, MW is the rest of the world high-powered money, Y is the level of the real output, E is the exchange rate, i.e. an index of export weighted effective exchange rate, and P stands for the domestic price level, index of wholesale prices. Having estimated the model, evidence supporting the J-curve hypothesis was obtained.

An interesting application, despite its simple appearance, is Bahmani-Oskooee (1991).<sup>18</sup> Using quarterly data for the period 1973-1988<sup>19</sup>, it was stated that for most countries devaluation improved the trade balance. The cointegration equations are:

$$(EX/IM)_t = a + b (P^*E/P)_t + e_t$$

$$(P^*E/P)_t = a' + b' (EX/IM)_t + e_t'$$

where, P\* is the foreign price level, E is the nominal effective exchange rate (import weighted), P is domestic price level, P\*E/P stands for the real effective exchange rate, EX is the volume of exports, IM is the volume of imports, and EX/IM is a measure of trade balance.

<sup>13</sup> All yearly observations were taken from IMF/IFS.

<sup>14</sup> Included countries are Costa Rica, Ecuador, Finland, France, Iceland, Israel, the Philippines, Spain, Sri Lanka, and the UK

<sup>15</sup> Included countries are Ecuador, Egypt, France, Greece, India, Indonesia, Italy, Korea, Mexico, Norway, South Africa, Sri Lanka, Sudan, Thailand, and Zambia.

<sup>16</sup> Included countries are Greece, India, Korea, and Thailand.

<sup>17</sup> Data were taken from IMF/IFS, IMF Direction of Trade Statistics, OECD Statistics of Foreign Trade Series A.

<sup>18</sup> Included countries are Argentina, Bahamas, Bangladesh, Greece, India, Korea, the Philippines, and Thailand.

<sup>19</sup> Data were taken from IMF/IFS and IMF Direction of Trade Statistics.

Such definition of the trade balance is unit-free, and insensitive to nominal-real distinction. It is clear that an increase in EX/IM reflects a trade balance improvement.

Two more of recent studies, Arize (1994) and Shirvani and Wilbratte (1997), using the cointegration approach, indicated that devaluations do improve the trade balance in the long run. On the other hand, Rose (1991)<sup>20</sup> which employed the non-parametric Locally Weighted Regression (LWR) technique to estimate the trade equations,<sup>21</sup> concluded that there was no significant relationship between trade balance and other variables involved.

Regarding the Turkish case of the import demand function, Kotan and Saygili (1999) elaborated on two different model specifications, namely those of the Engle-Granger cointegration and Bernanke-Sims structural vector auto regressions. They state that in the long run, income level, rate of nominal depreciation, inflation rate and international reserves significantly affect the level of imports. In the short run, inflation growth and growth in international reserves lose their significance, though. Rate of depreciation becomes a more important factor in the short run. On the structural VAR front they concluded that anticipated changes in the real depreciation rate and unanticipated changes in the income growth and real depreciation rate had significant effects on import demand growth. The variable set of Kotan and Saygili (1999) is different from the studies mentioned before in the sense that they employed nominal rate of depreciation and CPI inflation, rather than using a more direct measure of relative import prices. Another important point is related to the use of foreign exchange reserves as a regressor, which definitely increased the explanatory power of the proposed model. However, in a forecasting setup, such a treatment might complicate the prediction process as the modeler should generate a separate forecast path for the reserves.

Another recent study investigates the structural stability of export function for the Turkish economy (Sahinbeyoglu and Ulasan, 1999). Their estimation results indicate that in analyzing exports for the post-1994 period, traditional exports equations are not sufficient for forecasting and policy simulations, and variables like uncertainty indicators or investment have crucial roles in explaining exports. Still the estimated elasticities prove to be stable enough to perform adequately.

To the best of our knowledge, the most recent study on the trade flows of Turkey investigates the case of exports in structural vector auto regressions and error correction mechanism frameworks (Sarıkaya, 2004). Sarıkaya (2004) reveals that the export growth can be sustained even when real exchange rate is appreciating, provided that there is a decline in

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<sup>20</sup> Included countries are the UK, Canada, Germany, Japan, and the US.

<sup>21</sup> Rose employed a set of parametric techniques as well.

the real unit labor cost and/or an improvement in productivity. This finding should be stressed as it demonstrates a channel for export growth other than the conventional one of the real exchange rate.

### **3. Single Equation Models**

#### **3.1. Data and Variables**

We have estimated our models using quarterly data covering the period from 1987:I to 2003:IV. Data are obtained from the Central Bank of the Republic of Turkey (CBRT), State Planning Organization (SPO), and the State Institute of Statistics (SIS). The data set consists of the following items: Exports, LX, and imports, LM are defined as the natural logarithms of the corresponding export and import quantity indices with the base year of 1994. Real domestic output is denoted with LY and defined as the natural logarithm of the real GDP index with the base year of 1994.<sup>22</sup> As for real exchange rate, the natural logarithm of the CPI-based index, LRER, is used.<sup>23</sup> Export prices, LPX, are defined as the logarithm of the export price index (1994=100). The unit labor costs, LULC, is defined as the natural logarithm of the unit labor cost index (1994=100). The descriptive statistics for our variable set is provided in Appendix C, Table C1.

We have also used a set of dummy variables in our equations so as to account for seasonal variations in the estimated relationships. D1, D2, and D3 correspond to the first three quarters of a year.

We have first tested for unit-roots in our variables following the usual convention. The tests are performed both in level and first difference forms using both an intercept and a trend. The ADF test results for our variables are presented in Appendix C, Table C2. Table C2 suggests that we fail to reject the hypothesis of a unit-root at 5% level of significance for each variable in our data set. However, the existence of a unit-root is rejected for the first differences of our variables. Therefore, each variable in our data set is integrated of order one.

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<sup>22</sup> For obtaining the real GDP index (1994=100), we simply divided the real GDP series at constant 1987 prices by the 1994 average.

<sup>23</sup> The computation of the CPI based RER index uses the IMF weights for nineteen countries including Austria, Brazil, Belgium, Canada, China, France, Germany, Greece, Iran, Italy, Japan, Korea, the Netherlands, Spain, Sweden, Switzerland, Taiwan, the UK, and the US.

Visual inspection of the LX and LM series suggests that there may be structural breaks inherent to these series. Consequently, we applied the unit-root tests due to Perron (1989) in order to test for the null hypothesis that the examined series has a unit-root with possibly non-zero drift against the alternative that the process is trend-stationary. For the case of exports, our visual inspection suggests a change in the slope of trend-exports after the first quarter of 2002. To apply the Perron (1989) tests we have defined DT\*20021 dummy variable which takes the value of 0 until 2002:1 and after that date behaves like a trend dummy. On the other hand, the imports series seems to have changes in both its intercept and slope after the first quarter of 2001. In order to account for this the dummy variables DU20011 and DT20011 are defined following the definitions of Perron (1989). According to the Perron (1989) test results, both export and import series include unit-roots with one-time break in their trends. Figure D1 of Appendix D illustrates these cases.

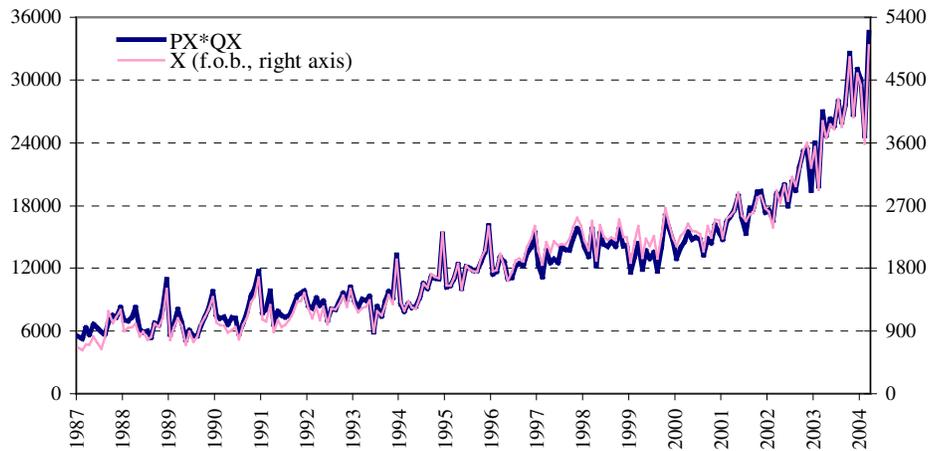
An important point in the forecasting process in converting forecasts obtained through trade indices into USD trade data. At this stage, the strong relationship between the product of price with quantity indices and actual USD trade figures is considered. In fact, the correlation between the product of export price index with export volume index (PX\*QX) and actual exports (X f.o.b.) is 99.3% in monthly data covering the period 1987-2004(Mar.), whereas the correlation coefficient is 98.8% in the case of imports (PM\*QM & M c.i.f.). The mentioned parallelism can be clearly seen in the following graphs as well.

Considering this relationship, as the volume data for exports and imports are estimated and price indices are prolonged through the forecast period under particular assumptions, the growth rates of the product of the forecasted indices can be applied to the USD trade data. A key point to be noticed is that, export and import indices do not include non-monetary gold trade whereas USD trade figures announced by SIS include it since 2002 data. Hence, it is crucial to first subtract that gold trade from the original USD data, applying the abovementioned process (converting indices forecasts into USD trade forecasts), and finally adding gold trade estimates to the output.

Another essential point to be considered is that the forecast results will strongly depend on GDP growth assumption for the investigated period due to its elasticity both in export and import models as presented in the next section. If one is interested in quarterly forecasts as well, besides yearly assumption, quarterly GDP growth rate assumptions must also be dealt with care. In case of real exchange rate or unit labor cost, the investigator would have some more space for minor change in assumptions thanks to their inelasticities.

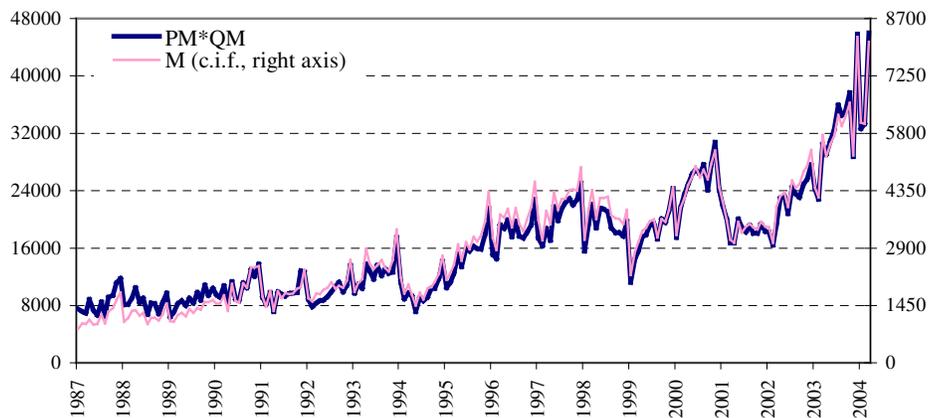
However, considerable changes in real exchange rate or unit labor cost assumptions would obviously be influential in the forecast results.

**Figure 1:**  
**The Relation between Exports in USD and the product of Export Price and Quantity indices**  
**(monthly, million USD exports f.o.b. against 1994=100 indices)**



Source: State Institute of Statistics.

**Figure 2:**  
**The Relation between Imports in USD and the product of Import Price and Quantity indices**  
**(monthly, million USD imports c.i.f. against 1994=100 indices)**



Source: State Institute of Statistics.

## 3.2. Export Supply and Import Demand Models

### *Export Supply Model*

We have estimated the real exports of Turkey as an export supply equation. Estimation was carried out in two stages being in parallel with the Engle and Granger's cointegration approach. Since we could not reject the null hypothesis of a unit-root for any of our variables of concern, this approach has a great deal of applicability.

In the first stage, the exports are regressed against the real income, unit labor cost, export prices, and the dummy variables of concern. The estimated residuals obtained from the long-run equation are stationary at 1% level of significance. According to the Engle and Granger methodology, given that all variables were found to be integrated order of one and residuals are stationary, we can conclude that there is a cointegrating or long-run relationship between exports and GDP, unit labor cost and export prices. Marking the outcome of this equation as our long-run specification, in the second stage we have estimated a short-run relationship in the error-correction form. The results of these steps can be seen in Appendix A. Table A1 suggests that exports increases in real income and decreases in unit labor costs and export prices. According to Table A2, our long-run model keeps its plausibility when it is expressed as an error correction equation. All these estimates are statistically significant.<sup>24</sup>

### *Import Demand Model*

We have estimated the import demand equation using the same framework as we have employed in the case of exports. In the first stage, the imports are regressed against the real income, the real exchange rate, and the dummy variables. The estimation results are given in Appendix B, where Table B1 and Table B2 show the long-run and short-run specifications, respectively. An increase in real income and/or real exchange rate induces higher level of imports.

The residual obtained from the long-run equation is stationary even in 1% significance levels. Thus, it can be concluded that there is a cointegrating or long-run relationship between imports, GDP and real effective exchange rate. The error-correction estimate of imports, presented in Table B2, is supportive of the long-run specification in the sense that all

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<sup>24</sup> The level of significance considered is 5% unless otherwise stated.

economic variables included have significant signs and the short-term dynamics demonstrate the behavior of the correction toward long-run trend clearly.

### 3.3. Elasticity Estimates

Based on our model estimates presented in the previous subsection, the long-run and short-run elasticities of exports and imports with respect to their regressors are summarized in Table 1 below. In this respect, the long-run relationship of exports with respect to real domestic income and export price is elastic, whereas the unit labor cost is inelastic. According to the estimated cointegration relationships, the long-run elasticity of imports with respect to domestic income, namely GDP is 2.0 and with respect to RER is 0.4. These results are parallel with the thought that the imports is elastic in domestic income.

The short-run elasticities of exports with respect to real income and export price are highly lower than long-run elasticities as expected. On the other hand short-run elasticity of unit labor cost is a bit higher than the long-run elasticity.

**Table 1: Export and Import Elasticity Estimates**

	EXPORTS		IMPORTS	
	LONG-RUN	SHORT-RUN	LONG-RUN	SHORT-RUN
<b>Real income</b>	1.859	0.366	1.999	1.188
<b>Unit labor cost</b>	-0.180	-0.191	-	-
<b>Export prices</b>	-1.111	-0.509	-	-
<b>Real exchange rate</b>	-	-	0.402	0.527

## 4. Vector Auto Regressions (VAR) Analysis

In the previous section, we have presented fairly simple and handy single equation models of export and import flows for the Turkish economy. Although these models can effectively be utilized in forecasting and the subsequent decision-making, one can remain skeptical about the possibility of some omitted dynamic linkages between the variables of concern. That is, it might still be the case that the feedback among the variables is not one-way, rather each variable affects the others at certain number of lags. Such skepticism is

handled in this section by estimating the vector auto regression specifications for exports and imports.

We have constructed and estimated unrestricted VAR models for exports, imports, and the trade deficit. The motivation behind estimating a separate VAR for trade balance stemmed from a desire of cross-checking of our results. The definitions of data employed in this section are identical to those of the previous one, hence making the qualitative findings quite compatible.

### **Case of Exports**

The contemporaneous relationship among variables in the VAR setup is according to the ordering of LULC, LRER, LXQ and LY. Such an ordering suggests that the most exogenous variable in the system is the unit labor costs, i.e. it is not affected contemporaneously by any of the other variables but it affects them. The position of the real exchange rate is determined then. Based on the information provided by LULC and LRER, the quantity of exports reveals. Finally, the national income comes out of the system. Beyond the contemporaneous interactions, each variable is affected by three lags of the vector of all variables.

Figure 3, which shows the impulse response functions from this VAR setup, suggests that exports are responsive to unit labor costs and national income. However, the effects of the real exchange rate are not statistically significant.<sup>25</sup> Even in a simple framework of VAR with no structural restrictions, the real exchange rate does not prove to be a dynamic determinant of export flows of the Turkish economy, consequently raising some curiosity regarding the effects of export prices in a similar VAR setup.

Effects of export prices are revealed by using a similar VAR with export prices replacing the real exchange rate in the contemporaneous VAR ordering, again using a lag length of 3 quarters. Resulting Figure 4 suggests that the significant impact of unit labor costs continues, but the response of exports to national income is only near-significant. Response of exports to export prices are significant at 10% level of significance.<sup>26</sup>

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<sup>25</sup> The responses are those due to 1-standard deviation positive innovations to the affecting variables. For instance, in the case of the real exchange rate, a 1-standard deviation positive shock is given to the real exchange rate and the effects of this shock on the exports are observed through the impulse response function.

<sup>26</sup> It should be noted that the figures of this section provides the error bands at 5% level of significance. Bands drawn at 10% level of significance will be more narrowly apart.

### **Case of Imports**

The contemporaneous VAR ordering in the case of imports is such that the real exchange rate has the most exogenous behavior. It affects the imports and national income, in that order. Figure 5 presents the impulse response functions of this VAR setting and suggests that a real exchange rate innovation, i.e. a real appreciation of domestic currency, increases the imports for 2 quarters, in a statistically significant manner. A positive innovation to national income increases the imports for three quarters. This is especially relevant once we consider the fact that more than 70% of imports are done for the purpose of intermediate input procurement.

### **Examination of the Trade Balance**

The impulse responses are used to seek the dynamic effects of structural shocks on foreign trade deficit. The responses of trade deficit<sup>27</sup> to the income and real exchange rate shocks are in line with the import exercise applied above. In this context, positive real exchange rate and income shocks create an increase in trade deficit through lowering import prices and domestic absorption.

As shown in Figure 6, the impulse responses to shocks, being major determinants of the movements in imports and trade deficit, have important consequences apart from their magnitudes. Firstly, these shocks have contemporaneous effects on foreign trade deficit. Secondly, figures indicate that a large and significant portion of the responses to real exchange rate and income shock is realized following two quarters after the shock takes place. Finally, the rate of increase of foreign trade in response to real exchange rate and income shocks are approximately same.

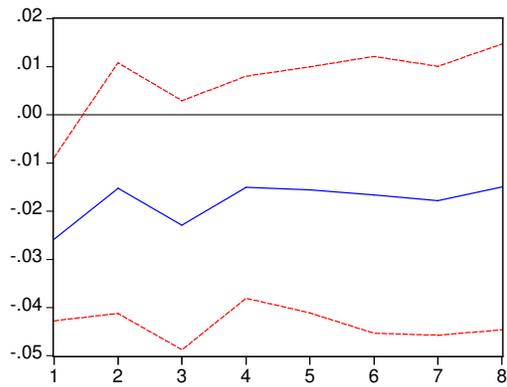
All in all, the presented VAR results are indicative of the importance of real exchange rate in determining the trade deficit, basically by determining the extents of imports. However, its impact on exports are statistically quite limited, i.e. real exchange rate is not revealed to be a significant determinant of exports. In the case of exports, the unit labor costs and export prices do play the major roles.

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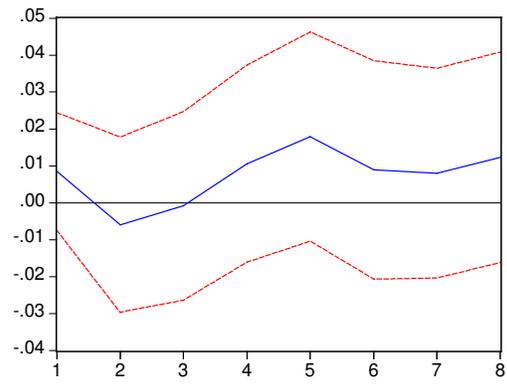
<sup>27</sup> The trade deficit is taken as the negative of the conventional definition for computational convenience.

**Figure 3: Impulse Response Functions\***

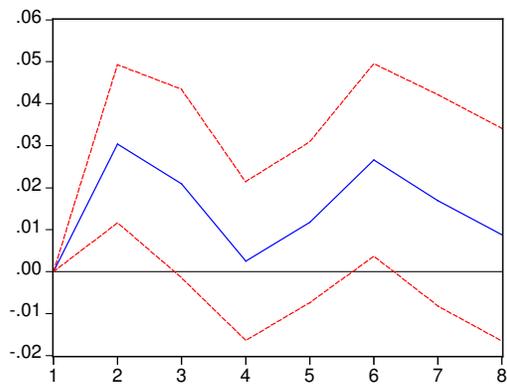
**Response of Exports to Unit Labor Cost**



**Response of Exports to Real Exchange Rate**

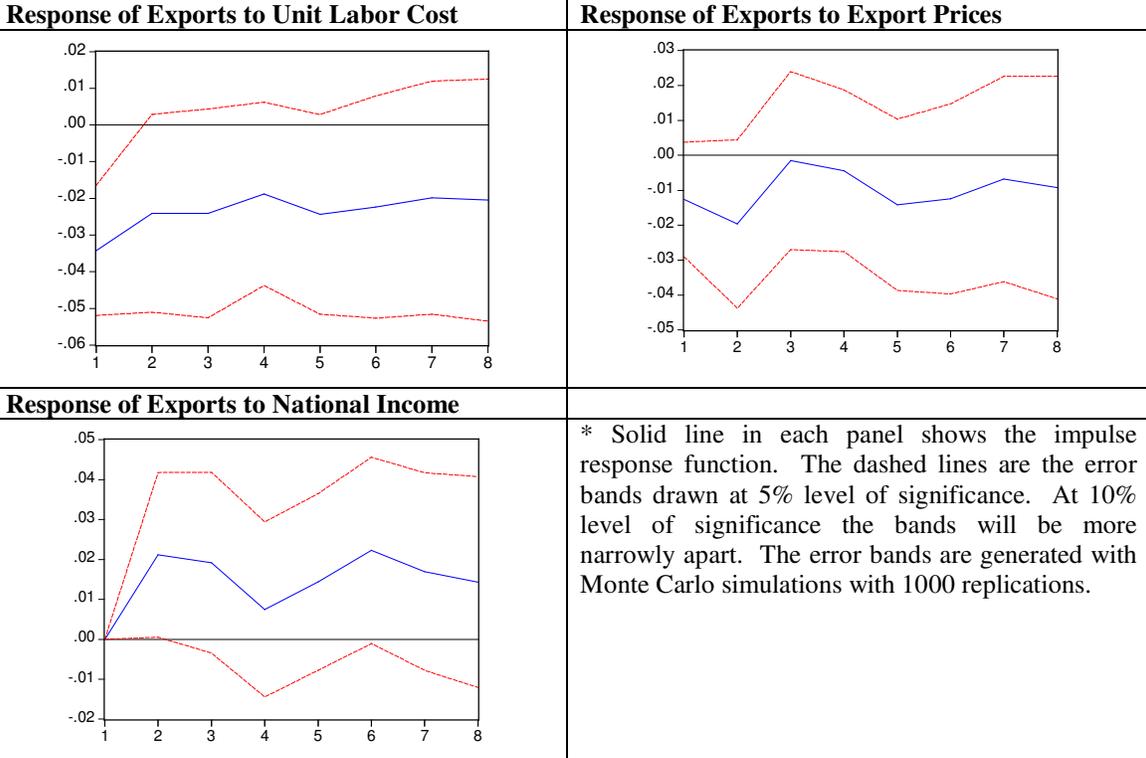


**Response of Exports to National Income**

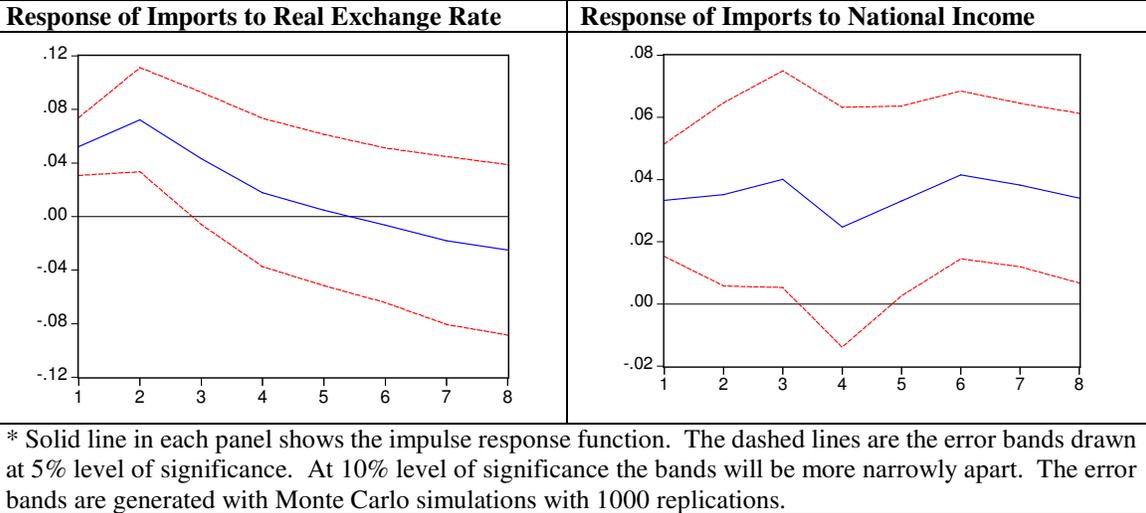


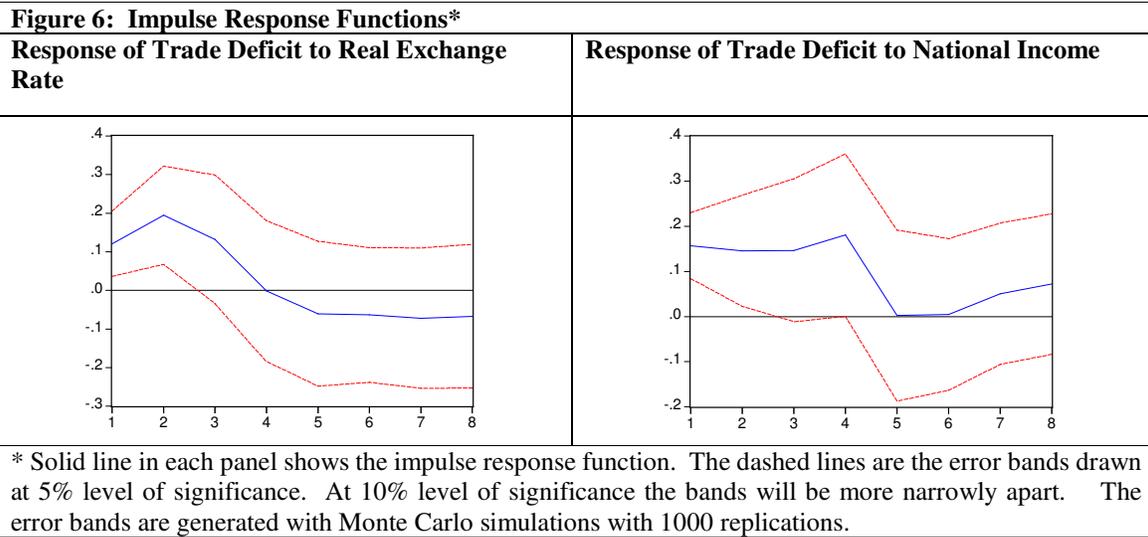
\* Solid line in each panel shows the impulse response function. The dashed lines are the error bands drawn at 5% level of significance. At 10% level of significance the bands will be more narrowly apart. The error bands are generated with Monte Carlo simulations with 1000 replications.

**Figure 4: Impulse Response Functions\***



**Figure 5: Impulse Response Functions\***





## 5. Concluding Remarks and Further Research

We have assessed the determinants of real trade flows for Turkey, fundamentally for forecasting purposes. Firstly, we have estimated single equation models, the results of which indicated that imports can be explained to a wide extent by the real exchange rate and the national income and exports are mostly determined by unit labor cost, export prices and national income. In both cases, some recent change in the overall trend of series is evident and well-captured in and reflected on the estimates. Secondly, we elaborated unrestricted vector auto regression models of exports and imports, using the same set of regressors as we have employed in the single equation models. These models yielded similar results as captured by the single equation framework and pointed out a two-quarter horizon for the effects of the real exchange rate on the trade deficit to be realized.

Regarding the central importance of the real exchange rate in the public and policy-making debates, it should specifically be mentioned that the real exchange rate is revealed to be a statistically significant determinant of imports, but not of exports. At the same time, the VAR finding that the real exchange rate is a determinant of current account indicates that the effects of the real exchange rate on trade deficit basically works through the imports. These observations might suggest that a real exchange rate depreciation, e.g. a real depreciation of Turkish lira, will not induce a huge increase in exports but it will shrink the volume of

imports significantly, hence reducing the size of the trade deficit. On the exports front, as the unit labor costs and export prices are basic determinants, public and private policy measures toward inducing productivity increases should be taken.

Further research agenda should extend in several dimensions. Firstly, disaggregated imports and exports should be taken into consideration in an initial attempt to figure out their determinants. Secondly, a forecasting module must be established upon these disaggregated models. Third, it is crucial to model the main items of the balance of payments other than the merchandise trade for having a better picture of the statistical properties of the balance of payments statistics.

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## Appendices

### Appendix A: Estimates of the Export Supply Equation

**Table A1: Long-run Specification of Exports**  
**Dependent Variable: LXQ**  
**Sample: 1987:1 2003:4**

Variable	Coefficient	t-Statistic		
C	2.080074	2.187246	<b>R<sup>2</sup></b>	0.950078
LY	1.859797	24.12171	<b>Log likelihood</b>	59.38736
LULC	-0.179551	-2.476595	<b>DW stat.</b>	1.120376
LPX	-1.111355	-5.474971	<b>F-stat.</b>	163.1259
DT*20021	0.069214	7.265419	<b>Prob(F-stat)</b>	0.000000
D1	0.304061	7.943345	<b>AIC</b>	-1.511393
D2	-0.004152	-0.113224	<b>SC</b>	-1.250274
D3	-0.672272	-14.26495		

**Table A2: Short-run specification of Exports**  
**Dependent Variable: DLXQ**  
**Sample: 1987:2 2003:4**

Variable	Coefficient	t-Statistic		
C	0.274760	4.502455	<b>R<sup>2</sup></b>	0.813909
DLY	0.365929	1.775495	<b>Log likelihood</b>	87.15697
DLULC	-0.191038	-2.491471	<b>DW stat.</b>	1.802333
DLULC(-4)	-0.184182	-2.641934	<b>F-stat.</b>	22.74328
DLPX	-0.508601	-1.664299	<b>Prob(F-stat)</b>	0.000000
DLPX(-2)	0.613606	2.350435	<b>AIC</b>	-2.417682
DTSTAR20021	0.004154	0.587325	<b>SC</b>	-2.043484
D1	-0.284678	-8.969658		
D2	-0.347174	-3.620768		
D3	-0.378568	-2.895260		
<b>Error correction term*</b>	-0.370485	-4.554149		

\* Error correction term is the first lag of the residuals of the long-run specification.

## Appendix B: Estimates of the Import Demand Equation

**Table B1: Long-run Specification of Imports**

**Dependent Variable: LMQ**

**Sample: 1987:1 2003:4**

Variable	Coefficient	t-Statistic		
C	-6.213625	-9.180948	<b>R<sup>2</sup></b>	0.937256
LY	1.999429	15.89601	<b>Log likelihood</b>	53.59080
LRER	0.402059	2.483487	<b>DW stat.</b>	0.635141
DU20011	-1.064078	-2.260305	<b>F-stat.</b>	128.0389
DT20011	0.019084	2.535505	<b>Prob(F-stat)</b>	0.000000
D1	0.278597	7.008743	<b>AIC</b>	-1.340906
D2	0.090095	2.689059	<b>SC</b>	-1.079787
D3	-0.617608	-12.22517		

**Table B2: Short-run Specification of Imports**

**Dependent Variable: DLMQ**

**Sample: 1987:3 2003:4**

Variable	Coefficient	t-Statistic		
C	0.089865	1.069125	<b>R<sup>2</sup></b>	0.826066
DLY	1.187844	5.476985	<b>Log likelihood</b>	88.87285
DLY(-1)	0.595505	3.142695	<b>DW stat.</b>	1.946799
DLY(-2)	0.517980	1.960343	<b>F-stat.</b>	25.64632
DLRER	0.527419	4.443022	<b>Prob(F-stat)</b>	0.000000
DU20011	0.191203	0.596218	<b>AIC</b>	-2.396088
DT20011	-0.002589	-0.517323	<b>SC</b>	-2.028114
D1	-0.036104	-0.268779		
D2	0.123952	0.838897		
D3	-0.477550	-3.346824		
<b>Error correction term*</b>	<b>-0.257625</b>	<b>-2.730898</b>		

\* Error correction term is the first lag of the residuals of the long-run specification.

## Appendix C: Descriptive Statistics and the ADF Test Results

**Table C1: Descriptive Statistics**

	<b>LXQ</b>	<b>LMQ</b>	<b>LY</b>	<b>LRER</b>	<b>LPX</b>	<b>LULC</b>
<b>Mean</b>	4.745	4.978	4.655	4.784	4.584	4.641
<b>Median</b>	4.684	4.974	4.669	4.788	4.596	4.636
<b>Maximum</b>	5.750	5.899	5.168	5.074	4.746	5.355
<b>Minimum</b>	4.080	4.297	4.077	4.474	4.398	3.948
<b>Std. Dev.</b>	0.455	0.442	0.259	0.136	0.086	0.289
<b>Skewness</b>	0.450	0.203	-0.097	-0.041	-0.305	-0.050
<b>Kurtosis</b>	2.177	1.791	2.402	2.398	2.242	2.858
<b>Jarque-Bera</b>	4.212	4.610	1.120	1.043	2.688	0.085
<b>Sample size</b>	68	68	68	68	68	68

**Table C2: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test**

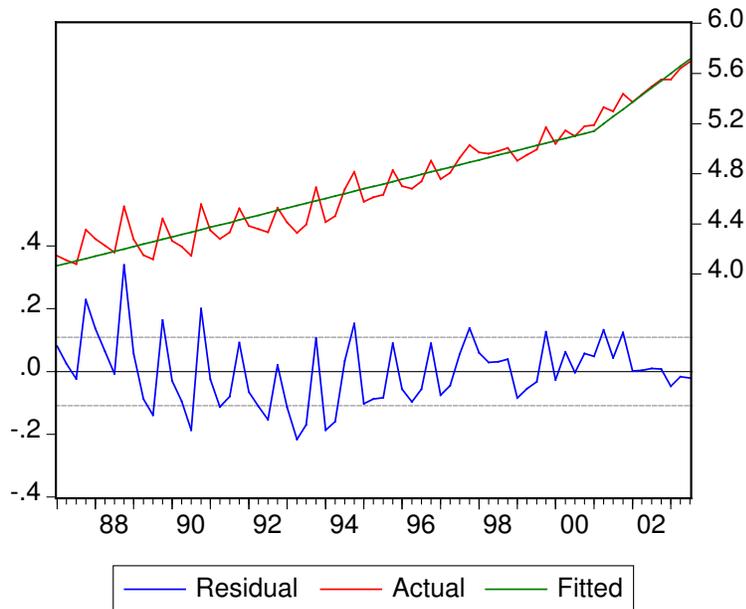
<b>Variables</b>		<b>ADF</b>		<b>PP</b>		<b>Conclusion</b>
		<b>Constant, No Trend</b>	<b>Constant, Trend</b>	<b>Constant, No Trend</b>	<b>Constant, Trend</b>	
LXQ	Level	-2.27	-0.85	1.05	-4.76**	I(1)
	First Diff.	-3.93**	-4.81**	-18.58**	-22.31**	I(0)
LMQ	Level	-0.54	-3.27	-0.41	-3.84*	I(1)
	First Diff.	-5.22**	-5.29**	-12.66**	-13.01**	I(0)
LY	Level	-0.63	-3.29	-5.98**	-9.2**	I(1)
	First Diff.	-3.68**	-3.63*	-30.05**	-29.9**	I(0)
LULC	Level	-2.51	-3.17	-2.47	-2.54	I(1)
	First Diff.	-3.20*	-11.58**	-11.26**	-11.47**	I(0)
LRER	Level	-2.02	-2.92	-1.87	-3.00	I(1)
	First Diff.	-7.38**	-7.32**	-8.04**	-7.91**	I(0)
LPX	Level	-1.72	-2.49	-1.87	-2.62	I(1)
	First Diff.	-7.66**	-7.52**	-7.66**	-7.52**	I(0)

Notes: The significance levels at 1 percent and 5 percent are indicated by two asterisks and one asterisk, respectively. The optimal lag order is selected by using Schwarz, Akaike and Hannan-Quinn criteria.

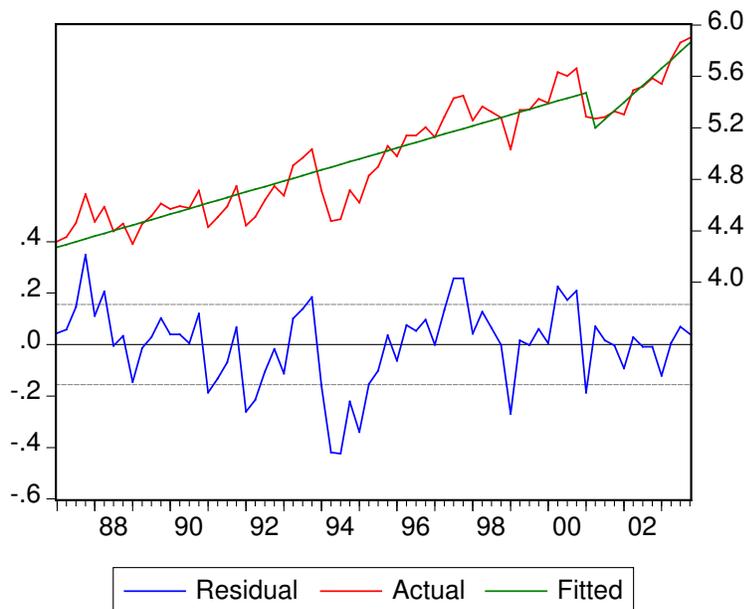
**Appendix D: Perron (1989) Tests for LX and LM**

**Figure D1 Actual-Fitted-Residual Graphs for the Perron (1989) Test Equations**

**Case of Exports**



**Case of Imports**



Explanations: In this figure the exports and imports are fitted on the time trends and Perron (1989) type of dummy variables to capture the one-time breaks in the data series. A visual inspection of the figures gives support to the claim that there are recent breaks in both exports and imports. In the case of exports only the slope changes, whereas the case of imports presents changes in both level and the slope, at the point of break.