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Exchange Rate and Turkish Agricultural Trade Balance with EU (15)

Mehmet Yazici* and M. Qamarul Islam**

Abstract

This paper investigates the short-run and long-run impact of exchange rate on the trade balance of Turkish Agriculture with EU (15) countries. The bounds testing approach to the cointegration and the error correction modeling is employed. A new strategy in the model selection phase is adopted and the optimal model is selected from the set of those models that satisfy both diagnostic tests and cointegration. Thus, unlike the previous literature utilizing this approach, it is ensured that a statistically reliable and cointegrated model is picked up for estimation. Estimation results based on the data for 1988-I to 2008-IV period indicate that in the short-run real exchange rate variable affects agriculture trade balance in trade with EU(15) and depreciation of Turkish Lira improves the trade balance. As for the long-run impact of the exchange rate, depreciation of domestic currency has a statistically significant negative effect on trade balance of agriculture.

Keywords: *Bounds Testing Approach, Depreciation, J-curve, Trade Balance, Agriculture Sector*

Introduction

The exchange rate, mainly because of being able to generate the effect of both an export subsidy and an import quota, has attracted the attention of economists for a long time. Initial studies of exchange rate such as Kreinin (1967), Khan (1974) and Warner and Kreinin (1983) concentrated on testing whether Marshall-Lerner condition was satisfied or not.¹ It was later observed that in spite of the satisfaction of the Marshall-Lerner condition, the trade balance worsened. To explain this apparent contradiction, the J-curve phenomenon was put forward by Magee (1973). This phenomenon was based on the observation that prices respond to exchange rate changes instantaneously but volumes don't respond right away but with some lags. Therefore, as a result of devaluation, the trade balance first worsens (price effect dominates) and then after the passage of sometime the volume effect takes over and the trade balance begins to improve. After the introduction of J-curve phenomenon by Magee (1973) and the realization that looking at Marsall-Lerner condition is an indirect way and takes into consideration only the long run, researchers begun to relate the trade balance directly to exchange rate, in addition to some other variables. Examples of this type of work include Bahmani-Oskooee (1985), Marwah and Klein (1996), Wilson (2001) and Lal and Lowinger (2002).²

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The impact of exchange rate changes on agricultural trade balance is investigated in the literature but in a few papers, which, to the best of our knowledge, are Carter and Pick (1989), Doroodian *et al.* (1999), Yazici (2008) and Baek *et al.* (2009). Carter and Pick (1989) examines the J-curve effect in the US agricultural sector by assuming a 10% depreciation of the dollar and finds that the first segment of the J-curve (deterioration part) exists for the US agricultural trade balance. Doroodian *et al.* (1999) investigates the J-curve hypothesis for both US agricultural and manufacturing sectors using the Shiller lag model and finds J-curve effect in agricultural sector but not in manufacturing. Yazici (2008) examines and compares, using Almon lag technique, the response to exchange rate changes of trade balances with the rest of the world of three Turkish sectors; agriculture, manufacturing and mining. Yazici (2008) finds that in the short-run in response to domestic currency depreciation agricultural trade balance first improves, then worsens and then improves again and in the long-run agricultural trade balance worsens as a result of depreciation of domestic currency. Baek *et al.* (2009) studies the effects of exchange rate changes on the bilateral agricultural trade balance of US with its 15 major trading partners and finds that the exchange rate plays a crucial role in the determination of US bilateral agricultural trade. Among these papers, Yazici (2008) is the closest one to ours in the sense that it also looks at the Turkish agricultural trade balance. Despite this similarity, there are two main differences: Yazici (2008) looks into Turkey's agricultural trade in the context of world trade, not trade with EU (15) and a different econometric method, Almon lag technique, is employed by Yazici (2008).

In our paper we employ the bounds testing approach, recently developed by Peseran *et al.* (2001) and one of econometric techniques widely used in the empirical investigation (see, for example, Arora *et al.* 2003 and Bahmani-Oskooee and Ratha 2004b). This approach is commonly employed due to the following advantages it offers; i) Unlike other cointegration techniques such as Johansen-Juselius (1990) method, the bounds testing approach can be applied regardless of whether model variables have the same order of integration or not and hence the need for pretesting to find out whether or not model variables have the same order of integration is eliminated, ii) It has better small sample properties (Mah 2002), iii) the short-run and long-run parameters of the model can be estimated simultaneously.

The papers that have employed the bounds testing approach first select the optimum model using a certain model selection criterion such as Akaike Information Criterion (AIC) and then apply the cointegration and diagnostic tests to the selected model. Whatever results come up regarding the cointegration and diagnostics are reported in the end. However, some or all of the diagnostics may not be satisfied and/or cointegration may not exist in the selected model, thus making the reported model unreliable. In this paper we follow a new strategy in the model selection phase. Specifically, we first apply the cointegration and diagnostic tests to all possible models, given a maximum lag length, and then determine the subset of models satisfying both the cointegration and the diagnostics. Finally, we apply model selection criterion to this subset in order to come up with the optimal model for estimation. Unlike the previous work, our strategy of model selection ensures that the estimated optimum model is cointegrated and passes the diagnostics, thus enabling us to have reliable statistical inferences from the model estimated.

The purpose of this paper is to examine the short-run and long-run impact of exchange rate changes on the trade balance of Turkey's agriculture with EU (15) countries using bounds testing approach with a new strategy in model selection phase incorporated.

The rest of the paper is organized as follows. In the following section the sources of data are described and their time series characteristics are displayed, then the trade balance model is set out, the next section presents the empirical results, and the last section contains the key findings and the concluding remarks.

DESCRIPTION AND TIME SERIES CHARACTERISTICS OF DATA

The frequency of the data is quarterly and it covers the period from 1988:I to 2008:IV. All data are indexed using 2000 quarterly average as the base and also they all are seasonally adjusted. We have obtained them from three sources; IMF-IFS Country Tables, Statistics Office of Turkey and Eurostat. Data for export and import values are taken from Statistics Office of Turkey. Data for Real Gross Domestic Product (GDP), Industrial Production Index except for Greece, GDP Deflator and Consumer Price Index (CPI) are compiled from IMF-IFS Country tables. Source for Industrial Production Index of Greece is Eurostat.

In this paper four variables are used in estimation: Agriculture trade balance (TB) defined as the ratio of agriculture exports of Turkey to EU(15) countries over Turkey's agriculture imports from EU(15) countries, Turkey's real income (Y_{TR}), Real income of EU(15) countries (Y_{EU}) constructed as the weighted average of real income of these countries where weights are agriculture-sector specific and assigned based on each country's share in total agriculture trade of Turkey and Real effective exchange rate (RER) between Turkey and currencies of EU(15) countries where nominal exchange rate is defined as the amount of Turkish Lira per trading partner's currency. Real effective exchange rate (RER) we use in this study is also sector specific like Real GDP of EU(15) in the sense that when constructing RER, the share of a EU(15) country in Turkey's total agriculture trade is assigned as the weight for the country in question.³

How these variables behave over sample period are illustrated in Figure 1 through Figure 5.⁴ Figure 1 shows real exports and imports over time. First thing to note about them is that over the entire sample period real exports are always greater than real imports implying a surplus in agriculture trade balance of Turkey with EU(15) as also seen in Figure 5. Another feature of real exports and imports series is that both are neither displaying an increasing or a decreasing pattern over time. They both are fluctuating but fluctuation is more in exports than in imports. As for EU (15)'s real income and Turkey's real income, they are illustrated in Figure 2 and Figure 3, respectively. As expected, both real incomes are increasing over time. However, compared to EU(15)'s real income, Turkey's real income series has a lower starting value and a higher ending value indicating that Turkish real income changes more rapidly over time. As far as real effective exchange rate series is concerned, even though it shows increases from time to time, overall it has a declining trend, which means Turkish lira has appreciated over time with respect to Euro, as shown in Figure 4. Finally, trade balance series, given the fact that real imports remain relatively stable, roughly mimics real exports series.

Figure 1: Turkish Real Agriculture Exports to and Imports from EU(15)

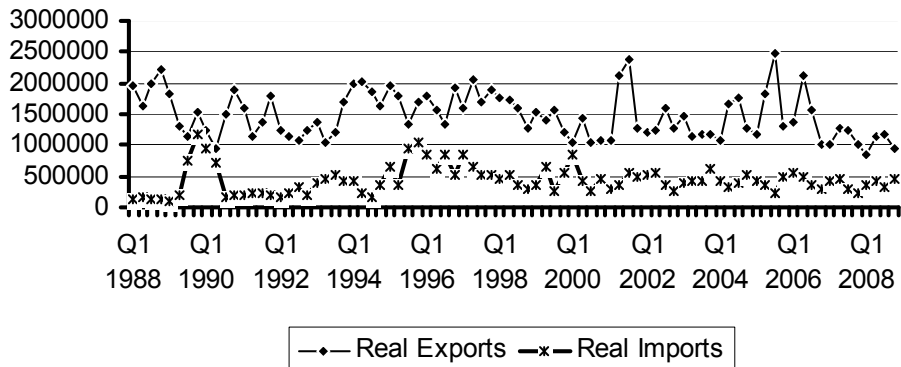


Figure 2: Agriculture Trade Weighted EU(15) Real Income

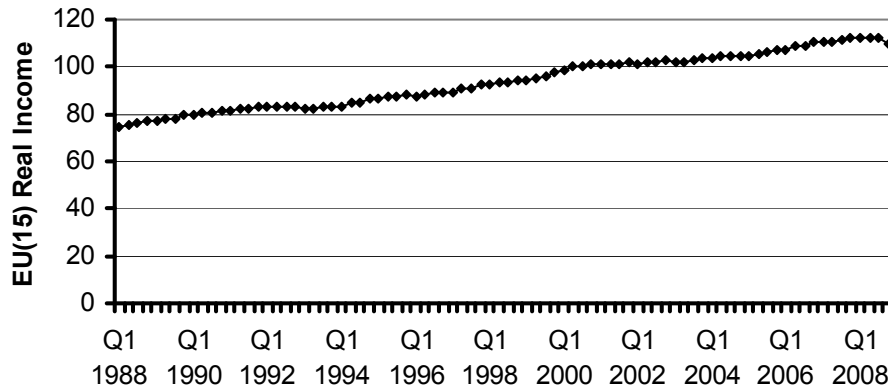
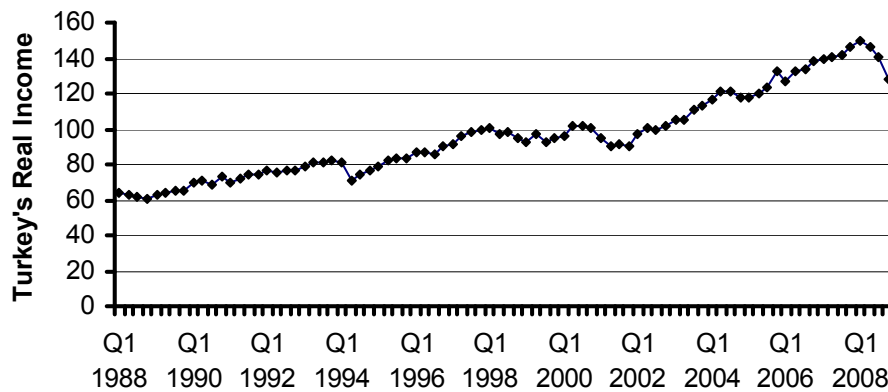
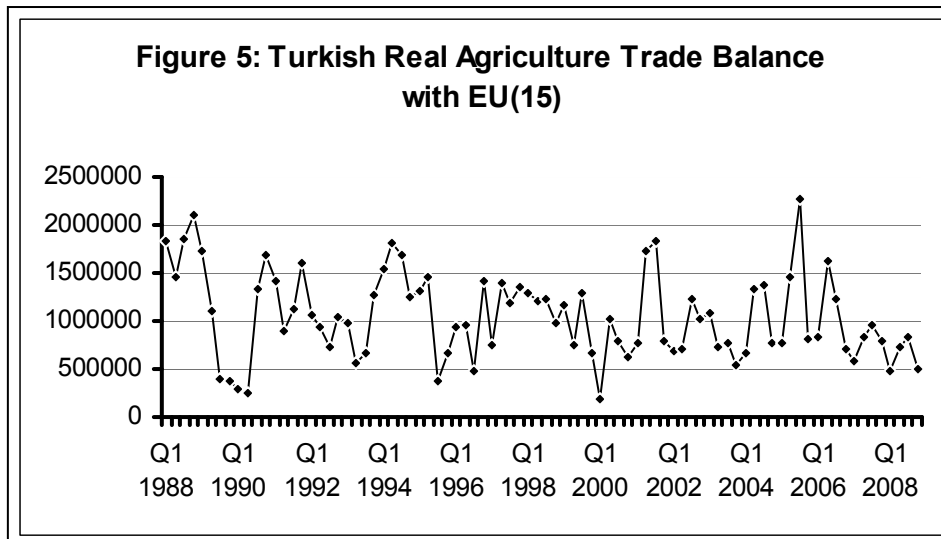
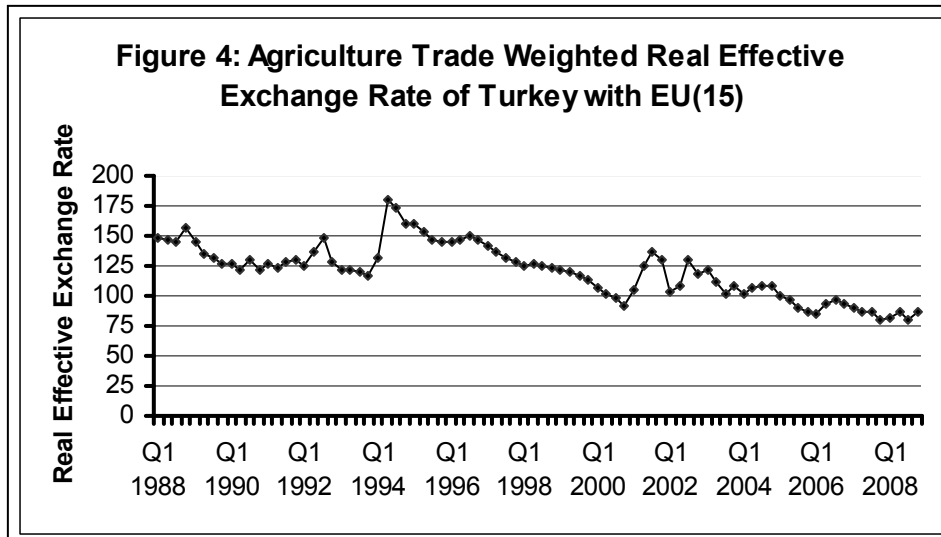


Figure 3: Turkey's Real Income over Time





MODEL

Real Trade Balance model we use in the estimation is based on the following theoretical framework.

Nominal Trade Balance (B) in domestic currency is equal to export revenue minus import expenditure:

$$B = P_x S_x - EP_x^* D_m \tag{1}$$

Where P_x is domestic price of exports, S_x is domestic supply of exports, E is nominal exchange rate defined as domestic currency price of foreign currency, P_x^* is foreign price of foreign exports and D_m is domestic import demand.

Since in equilibrium domestic export supply (S_x) is equal to foreign import demand (D_m^*), we can replace S_x with D_m^* in nominal trade balance equation. Also because demand for imports depends on real income and relative price of imported goods to

domestically produced goods (under the assumption that foreign and domestic goods are substitutes for each other), nominal trade balance can be rewritten as

$$B = P_x D_m^*(P_x / P^* E, Y^*) - EP_x^* D_m(EP_x^* / P, Y) \quad (2)$$

Where Y^* is foreign real income, P^* is foreign general price level, P is domestic general price level and Y is domestic real income.

Relative price of imports at home and abroad can be expressed in terms of real exchange rate ($RER = EP^* / P$) as follows

$$\frac{EP_x^*}{P} = \left(\frac{EP^*}{P}\right) \frac{P_x^*}{P^*} = RER \frac{P_x^*}{P^*} \quad \text{and} \quad \frac{P_x}{P^* E} = \left(\frac{P}{P^* E}\right) \frac{P_x}{P} = \frac{1}{RER} \frac{P_x}{P} \quad (3)$$

Real Trade Balance in domestic currency ($TB=B/P$) is equal to

$$TB = \frac{P_x}{P} D_m^*\left(\frac{1}{RER} \frac{P_x}{P}, Y^*\right) - \frac{EP_x^*}{P} D_m\left(RER \frac{P_x^*}{P^*}, Y\right) \quad (4)$$

$$TB = \frac{P_x}{P} D_m^*\left(\frac{1}{RER} \frac{P_x}{P}, Y^*\right) - \frac{EP_x^*}{P} \frac{P_x^*}{P^*} D_m\left(RER \frac{P_x^*}{P^*}, Y\right) \quad (5)$$

Assuming that export price level and general price level both at home and abroad are equal to each other so that ($P_x/P = 1$ and $P_x^*/P^* = 1$), Real Trade Balance (TB) can be rewritten as

$$TB = D_m^*\left(\frac{1}{RER}, Y^*\right) - RER D_m(RER, Y) \quad (6)$$

This equation shows that Real Trade Balance depends on real exchange rate, real domestic income and real foreign income. Therefore, we can restate Real Trade Balance equation in the following general form.

$$TB = TB(RER, Y, Y^*) \quad (7)$$

Taking the natural logarithm of both sides and using a log-linear approximation for right-hand side, we obtain the following trade balance model for estimation:

$$\ln TB_t = a + b \ln Y_{TR,t} + c \ln Y_{EU,t} + d \ln RER_t + eD_t + \varepsilon_t \quad (8)$$

Where Y_{TR} is the real domestic income, Y_{EU} is the real foreign income and RER is the real effective exchange rate (RER). To take into account the effect of customs union agreement between Turkey and EU as of January 1, 1996, we have added a dummy variable (D) to the model, which takes on value 0 for quarters prior to the first quarter of 1996 and value 1 afterwards.

As far as the expected signs of the variable coefficients are concerned, given the fact that an increase in real domestic income will stimulate the imports from abroad, the domestic income is expected to affect the trade balance negatively and therefore to have a negative coefficient. If, on the other hand, the increase in the domestic income results from an increase in the production of import-substitutes, the impact on the trade balance of the domestic income will be positive. By similar reasoning, an increase in the trading partner's real income will increase the exports and therefore the trade balance will improve. As in the case of domestic income, however, if the rise in the partner's income is due to the increase in the production of its import-substitutes, the effect of the trading partner's income on the trade balance will be negative. As for the effect of the real exchange rate, given the fact that the exchange rate is defined as the amount of domestic currency per foreign currency, a rise in the real exchange rate (depreciation) will lead to an improvement in the trade balance by making the exports cheaper for foreigners and imports more expensive for that country, thus yielding a positive coefficient.

Equation (8) represents the long-run relationship among the variables. We, however, are not only interested in long-run effect on the agricultural trade balance of exchange rate changes but also in the short run impact. Therefore, we need to incorporate the short-run dynamics into Equation (8). We do this, following Peseran et al. (2001), by employing Autoregressive Distributed Lag Method (ARDL). In this case, Equation (8) is expressed in error-correction modeling format as follows;

$$\Delta \ln TB_t = \alpha + \sum_{j=0}^k \beta_j \Delta \ln Y_{TR,t-j} + \sum_{j=0}^l \gamma_j \Delta \ln Y_{EU,t-j} + \sum_{j=0}^m \lambda_j \Delta \ln RER_{t-j} + \sum_{j=1}^n \theta_j \Delta \ln TB_{t-j} + \delta_1 \ln Y_{TR,t-1} + \delta_2 \ln Y_{EU,t-1} + \delta_3 \ln RER_{t-1} + \delta_4 \ln TB_{t-1} + \delta_5 D_t + u_t \tag{9}$$

In the bounds testing approach cointegration among the model variables is established using F-test. The null hypothesis of no cointegration ($H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$) is tested against the alternative of cointegration ($H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$). Under the assumption of the null hypothesis, the distribution of F-statistic, however, is non-standard. Therefore, in testing the above hypothesis we use new critical values provided by Peseran et al. (2001). If the calculated F-statistic exceeds the upper bound critical value, we reject the null hypothesis and conclude that variables are cointegrated.⁵

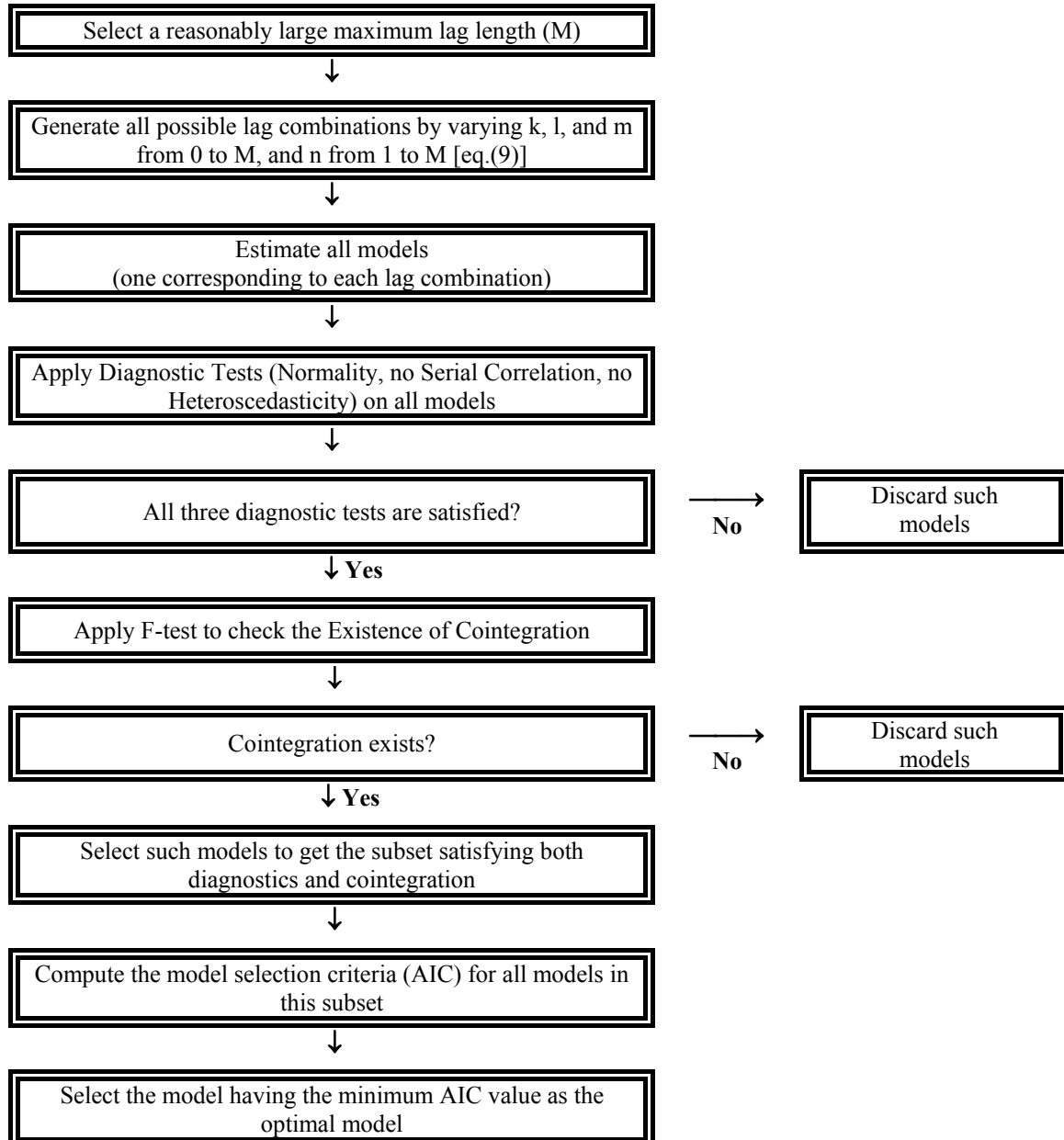
RESULTS AND DISCUSSION

In the present paper, we follow a new strategy in finding the model for the estimation. We believe that in order for inferences to be statistically reliable and therefore meaningful, the estimated model, from which test statistics for inferences are obtained, must well behave, i.e. it must satisfy the basic assumptions of OLS. Therefore, instead of applying a model selection criterion to the set of all possible models, as done in previous literature, we apply the criterion to that subset which both satisfy diagnostics and indicate a cointegration.

Having adopted this new strategy for model selection, we have proceeded in the following manner.⁶ First the maximum lag length on each first differenced variable in equation (9) is set as 8. The model corresponding to each possible lag combination has

been estimated and then those combinations that satisfy the diagnostic tests of normality, no serial correlation and no heteroscedasticity at least at 10 % level have been selected. For each of these selected combinations, it is checked whether there exists a cointegration or not, based on F-test. In case no cointegration is established for a combination, it is discarded. Then, in order to determine the optimal model, AIC has been applied to the set of those lag combinations that satisfy diagnostic tests and at the same time indicate a cointegration. Steps described here in order to find the optimal model are shown more explicitly in the following flow chart diagram.

Chart 1. Diagram of Flow Chart for Model Selection Process



Once we have followed this procedure, we have come up with optimal lag combination ($k=0, l=0, m=1, n=6$).⁷ We have then proceeded to estimate the model in

equation (9) corresponding to this optimal lag combination based on quarterly data for the period of 1988:I-2010:IV.

Table 1: Short-Run Estimates and Diagnostic Tests for Agriculture Trade Balance. Dependent Variable: $\Delta \ln TB_t$

Regressors	Coefficient	t-value
Constant	11.465	1.418
$\Delta \ln Y_{TR,t}$	-1.588	-0.851
$\Delta \ln Y_{EU,t}$	15.964*	1.622
$\Delta \ln RER_t$	0.157	0.185
$\Delta \ln RER_{t-1}$	1.866**	2.340
$\Delta \ln TB_{t-1}$	0.670**	2.614
$\Delta \ln TB_{t-2}$	0.361*	1.685
$\Delta \ln TB_{t-3}$	0.411**	2.332
$\Delta \ln TB_{t-4}$	0.410***	2.826
$\Delta \ln TB_{t-5}$	0.155	1.281
$\Delta \ln TB_{t-6}$	0.160	1.505
D_t	-0.551**	-2.059
Diagnostic Tests	Value of Statistic	p-value
Normality ¹	2.7	0.26
No Serial Correl. ²	7.4	0.12
No Heteroscedas. ³	1.5	0.22
F (15,59)	4.84	0.00
F (Wald) ⁴	4.95	
Adj. R ²	0.44	

Notes: *P<0.10, **P<0.05 and ***P<0.01. 1: Jarque-Bera test statistic with a $\chi^2(2)$ distribution. 2: LM test statistic with a $\chi^2(4)$ distribution. 3: LM test statistic with a $\chi^2(1)$ distribution. 4: The upper bound critical value for the F-statistic at 10% significance level is 3.77 (Peseran *et al.* (2001), Table CI, Case III, p.300).

Short-run estimation results for the trade balance of Turkish agriculture with EU (15) are reported in Table 1. Looking at Table 1 reveals that the real exchange rate and EU (15) real income carry some significant coefficients. Turkey’s real income does not have a statistically significant coefficient. This means that both real exchange rate and real income of EU (15) matter in the short run for the trade balance of Turkish agriculture and both affect positively but domestic real income does not significantly affect Turkish agricultural trade balance. As for the customs union, this agreement has a significant negative impact in the short run implying that it has led to the deterioration of trade balance of Turkish agriculture.

Long-run estimation results for Turkish agriculture trade balance are presented in Table 2.⁸ We see from Table 2 that neither domestic income nor foreign income has a statistically significant coefficient even though they both have the expected signs. This means that neither real income matters in the long-run for agriculture trade balance of Turkey with EU (15). Given its significant coefficient, only long-run determinant of Turkish agricultural trade balance is the real effective exchange rate variable. Size of coefficient of real exchange rate variable (-0.597) tells us that agricultural trade balance is inelastic with respect to exchange rate. Negative sign of the exchange rate coefficient

indicates that real depreciation of Turkish lira with respect to currencies of EU (15) countries deteriorates the Turkish agricultural trade balance. This finding can be explained by the fact that Marshall-Lerner condition is not satisfied for Turkish agriculture in this setting. Such a result is not surprising given the fact that agricultural products are mostly necessities and therefore they have low demand elasticities. Deteriorating effect on agriculture trade balance of domestic currency depreciation in the long run is consistent with the finding by Yazici (2008). As far as the effect of customs union agreement is concerned, dummy variable for this agreement does not carry a statistically significant coefficient. This means that short-run deteriorating effect of customs union is temporary and it does not last into long run.

Table 2: Long-Run Estimates for Agricultural Trade Balance
Dependent Variable: $\ln TB_t$

Regressors	Coefficient	t-value
Constant	8.20	1.206
$\ln Y_{TR,t}$	-0.276	-0.211
$\ln Y_{EU,t}$	0.221	0.571
$\ln RER_t$	-0.597***	-3.563
D_t	-0.394	-0.729

Notes: *P<0.10, **P<0.05 and ***P<0.01.

To find out whether estimated coefficients are stable or not, we have applied stability tests developed by Brown et al. (1974) known as cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests based on recursive regression residuals. These tests are conducted by means of graphs and results are shown in Figures 6 and 7.⁹ In both tests plots of CUSUM and CUSUMSQ statistics remain inside the critical bounds of 5 % significance. This suggests that the parameters of trade balance equation are stable over sample period so that estimated coefficients can be considered stable enough for forecasting and policy analysis.

Figure 6: Plot of Cumulative Sum of Recursive Residuals

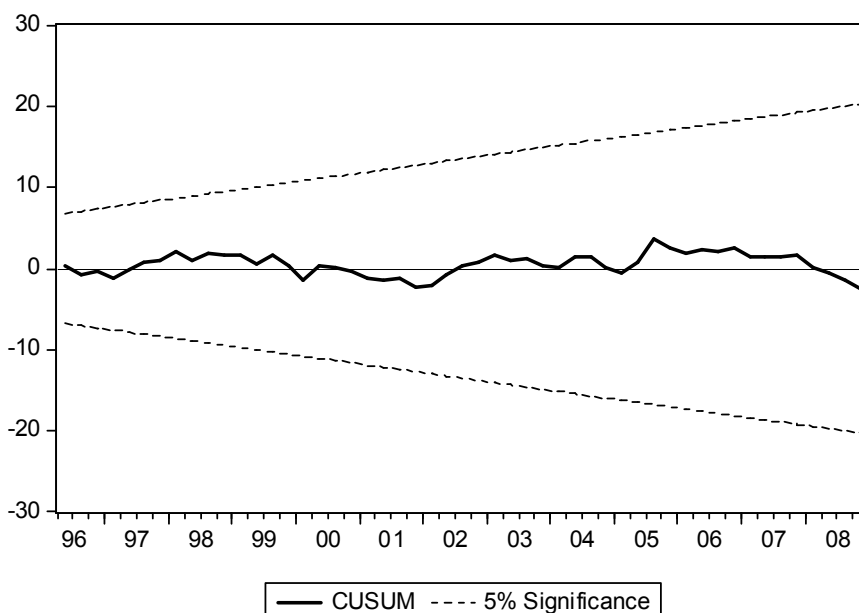
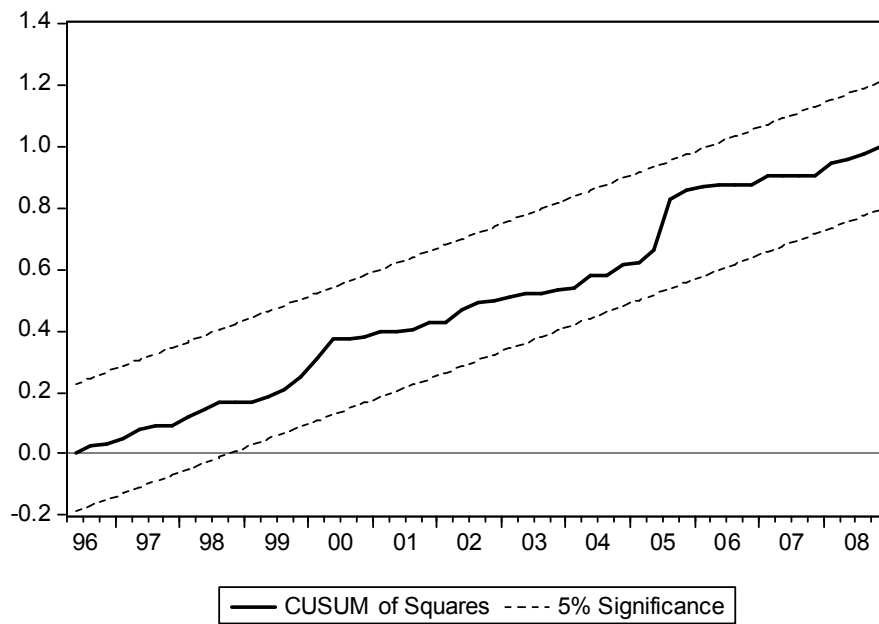


Figure 7: Plot of Cumulative Sum Of Squares of Recursive Residuals



CONCLUSION

This paper has estimated Turkish agricultural trade balance in trade with EU(15) countries to investigate particularly the impact of the exchange rate on the trade balance using bounds testing approach with a new strategy adopted in model selection phase based on the quarterly time series data over 1988:I-2010:IV period.

One of contributions of the present paper is to consider an important sector of Turkish economy, agriculture, in the context of trade with an important trading partner, EU(15) countries, using the most up-to-date data. Another important contribution of this paper, as explained in detail earlier, is the adoption of a new strategy in the model selection stage of the bounds testing approach. More specifically, the optimal model for the estimation is selected from the set of those models that satisfy both diagnostic requirements and the cointegration, thus the statistical reliability of inferences obtained from the estimation and the cointegration are ensured.

Results indicate that in the short-run the real exchange rate variable affects agriculture trade balance in trade with EU (15) and trade balance is affected positively by the depreciation of domestic currency. As for the long-run impact of the exchange rate, depreciation of Turkish lira has a statistically significant negative effect on trade balance of agriculture. This finding suggests that to improve the trade balance through exchange rate policy domestic currency should be appreciated with respect to currencies of EU (15) countries. Short-run improvement of agricultural trade balance together with long-run deterioration as a result of domestic currency depreciation indicates that there exists an inverse j-curve effect in Turkish agriculture. As far as the customs union agreement is concerned, it has a deteriorating effect on the agricultural trade balance in the short-run but that effect does not last into long-run.

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Footnotes

¹ Marshall-Lerner condition states that in order for devaluation to improve the trade balance, the sum of export demand and import demand elasticities must exceed one in absolute value.

² For a more detailed review of the relevant studies, see Bahmani-Oskooee and Ratha (2004a).

³ Weights used (in the order of importance) are 0.331 (Germany), 0.161 (Italy), 0.104 (France), 0.091 (Greece), 0.088 (Holland), 0.061 (UK), 0.048 (Belgium plus Luxemburg), 0.04 (Spain), 0.038 (Austria), 0.01 (Denmark), 0.01 (Sweden), 0.012 (Portugal), 0.002 (Ireland) and 0.004 (Finland).

⁴ To be able see fluctuations over time better in series, variables in this figure are displayed without taking their logarithms and trade balance here is measured as the difference between real exports and real imports.

⁵ The upper bound critical value for the F-statistic at 10% significance level is 3.77, taken from Peseran *et al.* (2001) (Table CI, Case III, p.300).

⁶ An algorithm developed by Dr. M. Qamarul Islam is used for this purpose.

⁷ The model picked up according to the method of previous literature is (k=0, l=0, m=1, n=4). However, in this case no serial correlation assumption fails.

⁸ In bounds testing approach, long-run coefficients are not separately obtained; rather they are derived from short-run estimation results of equation (2) by dividing the coefficient of each lagged independent variable by the coefficient of the lagged dependent variable and multiplying with a minus sign.

⁹ Graphs for these tests are generated using Eviews software version 7.1.