



HAL
open science

The J-Curve Dynamics of Turkey: An Application of ARDL Model

Ferda Halicioglu

► **To cite this version:**

Ferda Halicioglu. The J-Curve Dynamics of Turkey: An Application of ARDL Model. *Applied Economics*, 2008, 40 (18), pp.2423-2429. <10.1080/00036840600949496>. <hal-00582102>

HAL Id: hal-00582102

<https://hal.science/hal-00582102v1>

Submitted on 1 Apr 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization



The J-Curve Dynamics of Turkey: An Application of ARDL Model

Journal:	<i>Applied Economics</i>
Manuscript ID:	APE-06-0194.R1
Journal Selection:	Applied Economics
JEL Code:	C22 - Time-Series Models < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods, F31 - Foreign Exchange < F3 - International Finance < F - International Economics, F14 - Country and Industry Studies of Trade < F1 - Trade < F - International Economics
Keywords:	J-curve, trade balance, cointegration, causality, sstability

powered by ScholarOne
Manuscript Central™

I. INTRODUCTION

A deficit in the trade balance of a country may be eliminated by a real devaluation in the domestic currency. Success of devaluation, however, depends on whether or not the sum of import and export elasticities exceeds unity, which is also known as the Marshall- Lerner (ML) condition. Bahmani-Oskooee (1985) argued that there has been cases under which the ML condition was satisfied yet the trade balance continued to deteriorate. Therefore, he concludes that the focus of a trade policy should be on the short-run dynamics that trace the post devaluation time path of the trade balance implying the J-curve phenomenon. The J-curve effect suggests that the trade balance of a nation initially worsens after a real depreciation of the home currency, and then it gets better. Krueger (1983) has argued that at the time an exchange occurs, goods, which are already in transit and under contract, have been purchased, and the completion of those transactions dominates the short-term change in the trade balance. Arndt and Dorrance (1987) indicates that this so called J-curve effect occurs if the domestic currency prices of exports are sticky. There has been growing interest in the J-curve phenomenon in the last three decades. Bahmani-Oskooee and Ratha (2004a) provides a very comprehensive survey on the J-curve literature for the period of 1973-2003 from thirty-seven articles. The recent examples of the J-curve studies include Bahmani-Oskooee and Ratha (2004b), Bahmani-Oskooee *et al.* (2005), Hacker and Hatemi (2004), Narayan (2004), and Narayan and Narayan (2004). The empirical literature on the evidence of the J-curve, however, is fairly ambiguous.

In regards to the empirical evidence for the Turkish J-curve, one can identify readily a few previous studies with inconclusive results. Rose (1990) finds that the real exchange rates have no impact on the trade balance. The work of Bahmani-Oskooee

1
2
3 and Malixi (1992), which is based on Almon lag structure on real exchange rate, has
4 found no support for it either. On employing the Engle-Granger cointegration approach,
5 Bahmani-Oskooee and Alse (1994) asserts that the long-run impact of devaluation on
6 the trade balance model is positive. Brada *et al.* (1997) who divided the data set into
7 two sub-samples reports no long-run relationship between the variables of the trade
8 balance function in the 1970s but they have revealed reverse results for the 1980s. Kale
9 (2001) points out that a real depreciation of the domestic currency helps to improve the
10 trade balance with a lag of about one-year and the impacts of devaluations on the trade
11 balance are positive in the long-run. In a recent study, Akbostanci (2004) also presents
12 empirical evidence of the J-curve phenomenon in the long-run. As a passing note, one
13 should point out that the last two studies are based on that of Johansen-Juselius (1990)
14 multivariate cointegration procedure with short data spans derived from the 1980s and
15 1990s.

16
17 Turkey has adopted a policy of trade liberalization since 1980 and has pursued a
18 successful export-led growth policy. The ratio of total exports to gross domestic
19 product (GDP) increased from 4.1 to 13.3 percent during the period 1980-1988 and the
20 real GDP grew by 5.8 percent in the same period. In 1989, there was a policy reversal,
21 which slowed the depreciation of the Turkish lira (TL), in part to control inflation, but
22 mainly to be able to easily borrow from the domestic markets, which led to five
23 recessions in 1989, 1991, 1994, 1999, and 2001. The recessions of 1991, 1994 and
24 2001 were preceded by substantial increases in the real exchange rates. The impacts of
25 devaluations on the trade balance, however, seem to be short lived as the early
26 improvements in the trade balance are reversed steadily after a while. To combat the
27 spiralling twin deficits in 2001, the IMF-led stabilization policy was put into effect
28 once more. As a result, the internal imbalance has improved considerably but at the

1
2
3 same time the external balance has got worse. Despite having the free-floating
4 exchange regime, the TL has been steadily appreciating against the major world
5 currencies in real terms since 2002. This situation is being attributed to excess real
6 domestic interest rates that are intentionally set at high levels to prevent inflation rising
7 again. As a direct consequence of the overvalued TL, the current account deficit, which
8 stems largely from the trade account deficit, has currently exceeded 6% of that Turkish
9 GDP. Ertugrul and Selcuk (2001) provides a detailed account of the causes and
10 consequences of the Turkish twin deficits in the 1980s and 1990s. A similar account of
11 the Turkish economy beyond 2000 is given in Akyurek (2006).

12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
The motivation of this study is three fold: persistent balance deficits of Turkey since the
1980s provide a good rationale to revisit the J-curve phenomenon; data quality and its
span is now far superior than the previous studies relating to Turkey; finally, the
cointegration procedure in this paper has been used for many countries in testing the J-
curve phenomenon, except for Turkey.

The objectives of this study are as follows: i) to investigate the existence of the J-curve
phenomenon both in the short-run and long-run using recent advances in time-series
econometrics; ii) to establish the direction of causal relationships between trade balance,
real effective exchange rates, foreign and domestic incomes variables; and iii) to
implement parameter stability tests of Brown *et al.* (1975) to ascertain stability or
instability in the trade balance model.

The remainder of this paper is organized as follows. Section II describes the study's
model and methodology. Section III discusses the empirical results, and finally Section
IV concludes.

II. THE MODEL AND METHODOLOGY

1
2
3
4
5
6 The trade balance model employed in this study adopted the form of Rose and Yellen
7
8 (1989) and it takes the following long-run (cointegrating) form:
9

$$10 \ln TB_t = a_0 + a_1 \ln REER_t + a_2 \ln YW_t + a_3 \ln YT_t + \varepsilon_t \quad (1)$$

11
12
13
14
15
16
17
18 where the measure of the trade balance, TB is the ratio of imports to exports; REER is
19
20 the real effective exchange rate; YW is the industrial production index of industrial
21
22 countries; YT is the industrial production index of Turkey. Ln is the natural logarithm
23
24 transformation and ε_t is the random error term. According to the J-curve phenomenon,
25
26 it is expected that $a_1 < 0$ since an increase in real effective exchange rate initially
27
28 reduces the demand for the home country's export but increases its demand for imports.
29
30 As a result, the balance of trade worsens initially but it will improve after a while as
31
32 export and import volumes adjust to price changes. While there are no *priori*
33
34 expectations about the signs of a_2 and a_3 , however, one asserts tentatively that a_2 is
35
36 negative and a_3 is positive.
37
38
39
40
41
42

43 On investigating the cointegrating trade balance model with a view of testing the J-
44
45 curve phenomenon, several econometric methods were implemented in the last two
46
47 decades. In regards to univariate cointegration approaches, there are several examples
48
49 including Engle-Granger (1987) and the fully modified OLS procedures of Phillips and
50
51 Hansen's (1990). In terms of multivariate cointegration, Johansen (1988), Johansen and
52
53 Juselius (1990), and Johansen's (1996) full information maximum likelihood
54
55 procedures are widely employed. See Bahmani-Oskooee and Ratha (2004a) for a full
56
57 account of the econometric procedures applied in the J-curve studies. A recent single
58
59 cointegration approach, known as autoregressive-distributed lag (ARDL) of Pesaran
60

and Shin (1999) and Pesaran *et al.* (2001), has become popular amongst the researchers. Pesaran *et al.*, cointegration approach, also named as bounds testing, has certain econometric advantages in comparison to other single cointegration procedures. Firstly, endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger method are avoided. Secondly, the long and short-run parameters of the model in question are estimated simultaneously. Thirdly, all variables are assumed to be endogenous. Fourthly, the econometric methodology is relieved of the burden of establishing the order of integration amongst the variables and of pre-testing for unit roots. The ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely $I(0)$, purely $I(1)$, or fractionally integrated. Finally, according to Narayan (2004), the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration.

An ARDL representation of equation (1) is formulated as follows:

$$\Delta \ln TB_t = a_0 + \sum_{i=1}^m a_{1i} \Delta \ln TB_{t-i} + \sum_{i=0}^m a_{2i} \Delta \ln REER_{t-i} + \sum_{i=0}^m a_{3i} \Delta \ln YW_{t-i} + \sum_{i=0}^m a_{4i} \Delta \ln YT_{t-i} \quad (2)$$

$$+ a_5 \ln TB_{t-1} + a_6 \ln REER_{t-1} + a_7 \ln YW_{t-1} + a_8 \ln YT_{t-1} + v_t$$

Pesaran *et al.* cointegration procedure is briefly outlined as follows. The bounds testing procedure is based on the F or Wald-statistics and is the first stage of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration, ($H_0: a_5 = a_6 = a_7 = a_8 = 0$), should be performed for equation (2). The F test used for this procedure has a non-standard distribution. Thus, Pesaran *et al.* compute two sets of critical values for a given significance level. One set assumes that

all variables are $I(0)$ and the other set assumes they are all $I(1)$. If the computed F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

Once a long-run relationship has been established, equation (2) is estimated using an appropriate lag selection criterion. At the second stage of the ARDL cointegration procedure, it is also possible to perform a parameter stability test for the selected ARDL representation of the error correction model.

A general error correction model (ECM) of equation (2) is formulated as follows:

$$\begin{aligned} \Delta \ln TB_t = & b_0 + \sum_{i=1}^k b_{1i} \Delta \ln TB_{t-i} + \sum_{i=0}^k b_{2i} \Delta \ln REER_{t-i} + \sum_{i=0}^k b_{3i} \Delta \ln YW_{t-i} \\ & + \sum_{i=0}^k b_{4i} \Delta \ln YT_{t-i} + \lambda EC_{t-1} + u_t \end{aligned} \quad (3)$$

where λ is the speed of adjustment parameter and EC is the residuals that are obtained from the estimated cointegration model of equation (1).

The Granger representation theorem suggests that there will be Granger causality in at least one direction if there exists a cointegration relationship among the variables in equation (1), providing that they are integrated order of one. Engle-Granger (1987) indicates the Granger causality test which is conducted via a first difference vector autoregressive (VAR) will be misleading in the presence of cointegration. Therefore, an inclusion of additional variable to the VAR system such as the error correction term would help us to capture the long-run relationship. To this end, an augmented form of Granger causality test involving the error correction term is formulated in a multivariate p th order vector error correction model.

$$\begin{bmatrix} \Delta \ln TB_t \\ \Delta \ln REER_t \\ \Delta \ln YW_t \\ \Delta \ln TY_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \sum_{i=1}^p \begin{bmatrix} d_{11i} & d_{12i} & d_{13i} & d_{14i} \\ d_{21i} & d_{22i} & d_{23i} & d_{24i} \\ d_{31i} & d_{32i} & d_{33i} & d_{34i} \\ d_{41i} & d_{42i} & d_{43i} & d_{44i} \end{bmatrix} \begin{bmatrix} \Delta \ln TB_{t-i} \\ \Delta \ln REER_{t-i} \\ \Delta \ln YW_{t-i} \\ \Delta \ln TY_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \end{bmatrix} \begin{bmatrix} EC_{TB,t-1} \\ EC_{REER,t-1} \\ EC_{YW,t-1} \\ EC_{TY,t-1} \end{bmatrix} + \begin{bmatrix} \omega_{1t} \\ \omega_{2t} \\ \omega_{3t} \\ \omega_{4t} \end{bmatrix} \quad (4)$$

EC_{t-1} is the error correction term, which is derived from the long-run relationship, and it is not included in equation (4) if one finds no cointegration amongst the variables in question.

The existence of a cointegration derived from equation (2) does not necessarily imply that the estimated coefficients are stable as argued in Bahmani-Oskooee and Brooks (1999). Therefore, stability tests of Brown *et al.* (1975), which are also known as cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests based on the recursive regression residuals, may be employed to that end. These tests also incorporate the short-run dynamics to the long-run through residuals. The CUSUM and CUSUMSQ statistics are updated recursively and plotted against the break points of the model. Providing that the plot of these statistics fall inside the critical bounds of 5% significance, one assumes that the coefficients of a given regression are stable. These tests are usually implemented by means of graphical representation.

III. THE EMPIRICAL RESULTS

Quarterly data over 1980I-2005IV period were used to estimate equation (2). Data definition and sources of data are cited in the appendix. Equation (2) was estimated in two stages. In the first stage of the ARDL procedure, the order of lags on the first-differenced variables for equation (2) was obtained from unrestricted VAR by means of

1
2
3 Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), which
4 indicated the optimal lag level as four and six quarters respectively for this study. The
5 results of this stage are not reported here for brevity. Then an F deletion test was
6 applied to equation (2) in order to test the existence of a long-run relationship by using
7 lags from four to six on following Bahmani-Oskooee and Goswami (2003). As they
8 have shown that the results of this stage are sensitive to the order of VAR. Equation (2)
9 was also estimated three more times in the same way but the dependent variable each
10 time was replaced by one of the explanatory variables in search of other possible long-
11 run relationship in any other form than it had already been described in equation (1).
12 The summary results of bounds tests are presented in Table 1. Table 1 indicates only
13 one plausible a long-run relationship in which lnTB is dependent variable.
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

[INSERT TABLE 1 ABOUT HERE]

33
34
35
36 In the second stage of ARDL cointegration procedure, equations (2) and (3) were
37 estimated respectively on the basis of AIC and SBC criteria with six lags in search of
38 selecting best-fitted model. The results of the model selection stages are reported in
39 Table 2 and 3 respectively.
40
41
42
43
44
45
46
47

[INSERT TABLE 2 ABOUT HERE]

48
49
50
51
52
53 Considering the long-run coefficients in the panel A of Table 2, one concludes that the
54 SBC based trade balance model seems to be a slightly better fit than the AIC model
55 since all the coefficients in the former model are statistically significant at the 5% level.
56
57
58
59
60 Apart from that difference, both model selection criteria reveal almost identical results.

1
2
3
4
5
6 [INSERT TABLE 3 ABOUT HERE]
7
8
9

10
11 As far as the ECMs are concerned, it can be seen from Table 3 that the results of
12 equation (3) are also very close in both model selection criteria. The long-run and short
13 run results of the SBC version of the trade balance model, however, provide again
14 relatively better results in terms of the expected signs and econometric diagnostics. The
15 speed of adjustment coefficient, -0.35 is considerably low indicating a slow
16 convergence to equilibrium in the case of a shock to the cointegrating relationship and
17 that long-run equilibrium is attained only after three quarters. Based on the AIC and
18 SBC results, however, one can suggest that there are no J-curve effects both in the long
19 and short-runs since the coefficient of the real effective exchange rates does not alter
20 from positive to negative in either case. Considering that the focus of this paper is
21 essentially on the dynamics of devaluation, the impact of the lags of the real exchange
22 rates on the trade balance from error correction version of the SBC model was
23 estimated. The results are reported in Table 4. The evidence of the J-curve is now
24 apparent in the REER variable as the positive coefficients are followed by the negative
25 coefficients. This pattern of the coefficients shows an initial deterioration followed by
26 an improvement in the trade balance.
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

50 [INSERT TABLE 4 ABOUT HERE]
51
52
53
54

55 Granger causality test requires that all variables are in equation (1) should be in
56 integrated of order one. To this end, the traditional unit root tests such as the augmented
57 Dickey and Fuller (1979, 1981) and the Phillips and Peron (1988) were employed. The
58
59
60

1
2
3 unit root test results suggest that all variables in their first level differences are $I(1)$. For
4 brevity of presentation, they are not reported here either. Given the results of the
5 bounds test in Table 1, Granger causality test was conducted to equation (4) as such
6 that only the trade balance vector was estimated with an error correction term. Similarly
7 the Granger causality tests were applied to other models without the error correction
8 terms since one could not ascertain any long-run relationship for the other vectors.
9 Table 5 summarises the results of long-run and short-run Granger causality.
10
11
12
13
14
15
16
17
18
19

20
21
22 [INSERT TABLE 5 HERE]
23
24
25
26

27 On considering the long-run Granger causality, one suggests that the lagged error
28 correction term is statistically significant which also confirms the results of the bounds
29 test. The speed of the adjustment, however, is less than the ARLD estimations
30 suggesting that the long-term convergence to equilibrium will take longer. Granger
31 causality runs interactively via both exchange rates and world income to trade balance
32 ratio. In regards to the short-run Granger causality, one sees that there exists a bi-
33 directional Granger causality between exchange rates and trade balance ratio, implying
34 that as the trade balance improves it causes a real appreciation of the TL. Likewise, a
35 real depreciation will have a positive impact on the trade balance. There are, however,
36 uni-directional Granger causalities, which run from world income to the trade balance,
37 from world income to domestic income, and from exchange rates to domestic income.
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

54
55 [INSERT FIGURE 1 AND 2 ABOUT HERE]
56
57
58
59
60

1
2
3 The parameter stability tests were implemented via equation (3), which captures the
4 short-run dynamics of equation (2) and the long-run impact of equation (1). Equation
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

The parameter stability tests were implemented via equation (3), which captures the short-run dynamics of equation (2) and the long-run impact of equation (1). Equation (3) was estimated by ordinary least squares with a lag length of four based on the SBC criterion. Figure 1 and 2 provides the plots of CUSUM and CUSUMSQ tests respectively. Figure 1 and 2 present conflicting results in regards to the parameter stability tests. Whilst the former test indicates instability the later suggests stability in the parameters of the trade balance equation.

IV. CONCLUSION

This study has attempted to estimate the J-curve phenomenon through a reduced form trade balance model in search of providing fresh empirical evidence in the case of Turkish data. A recent single cointegration technique proposed by Pesaran *et al.* (2001) was employed to investigate the short-run and long-run responses of the trade balance to currency depreciation. The results from bounds tests have indicated only one possible long-run relationship in which the trade balance is the dependent variable. In contrast to the results of the previous results relating to Turkey, one finds no long-run impact of a real devaluation on the trade balance but there exists the J-curve phenomenon in the short-run. Whilst, in the long-run, real effective exchange rates and world income Granger cause to the trade balance, in the short-run there is a feedback relationship between the real effective exchange rates and trade balance. The parameter stability tests on the long-run trade balance equation appear to be inconclusive.

APPENDIX

1
2
3 *Data definition and sources*
4
5
6
7

8 The data set used in this study cover the period 1980I to 2005IV. All data are collected
9 from International Financial Statistics, IMF and Central Bank of Turkey (CBT).
10
11

12
13
14
15 TB is Turkey's trade balance. It is defined as the ratio of real imports to real exports.

16
17 The raw data of exports and imports were deflated by the USA consumer price index.

18
19 Source: IMF.
20

21
22 REER is the real effective exchange rates index. Source: CBT.
23

24
25 WY is industrial production index of industrial countries. Source: IMF.
26

27
28 YT is industrial production index of Turkey. Source: IMF
29
30

31
32 REFERENCES
33
34

35
36 Akbostanci, E. (2004) Dynamics of the trade balance: the Turkish J-curve, *Emerging*
37
38 *Markets Finance and Trade*, **40**, 57-73.
39

40
41 Akyurek, C. (2006) The Turkish crisis of 2001: a classic?, *Emerging Markets Finance*
42
43 *and Trade*, **42**, 5-32.
44

45
46 Arndt, H. W. and Dorrance, G. (1987) The J-curve, *The Australian Economic Review*,
47
48 **11**, 9-19.
49

50
51 Bahmani-Oskooee, M. (1985) Devaluation and the J-curve: some evidence from LDCs,
52
53 *The Review of Economics and Statistics*, **17**, 500-504.
54

55
56 Bahmani-Oskooee, M. and Alse, J. (1994) Short-run versus long-run effects of
57
58 devaluation: error correction modelling and cointegration, *Eastern Economic Journal*,
59
60 **20**, 453-464.

1
2
3 Bahmani-Oskooee, M. and Brooks, T. J. (1989) Bilateral J-curve between US and her
4 trading partners, *Weltwirtschaftliches Archiv*, **135**, 156-165.

5
6
7
8 Bahmani-Oskooee, M. and Malixi, M. (1992) More evidence on the J-curve from LDCs,
9
10 *Journal of Policy Modeling*, **14**, 641-653.

11
12
13 Bahmani-Oskooee, M. and Goswami, G. G. (2003) A disaggregated approach to test
14 the J-curve phenomenon: Japan versus her major trading partners, *International Journal*
15 *of Economics and Finance*, **27**, 102-113.

16
17
18 Bahmani-Oskooee, M. and Ratha, A. (2004a) The J-curve: a literature review, *Applied*
19 *Economics*, **36**, 1377-1398.

20
21
22 Bahmani-Oskooee, M. and Ratha, A. (2004b) The J-curve dynamics of U.S. bilateral
23 trade, *Journal of Economics and Finance*, **28**, 32-38.

24
25
26 Bahmani-Oskooee, M., Goswami, G.G., and Talukdar, B. K. (2005) The Bilateral J-
27 curve: Australia versus her 23 trading partners, *Australian Economic Papers*, **44**, 110-
28 120.

29
30
31 Dickey, D.A., and Fuller, W.A., (1979) Distributions of the estimators for
32 autoregressive time series with a unit root, *Journal of the American Statistical*
33 *Association*, **74**, 427-431.

34
35
36 Dickey, D.A., and Fuller, W.A. (1981) Likelihood ratio statistics for autoregressive
37 time series with a unit root, *Econometrica*, **49**, 1057-1072

38
39
40 Brada, J.C., Kutan, A.H., and Zhou, S. (1997) The exchange rate and the balance of
41 trade: the Turkish experience, *Journal of Development Studies*, **33**, 675-692.

42
43
44 Brown, R.L., Durbin, J. and Evans, J.M. (1975) Techniques for testing the constancy of
45 regression relations over time, *Journal of the Royal Statistical Society*, **37**, 149-163.

46
47
48 Ertugrul, A. and Selcuk, F. (2001) A brief account of the Turkish economy, 1980-2000,
49
50
51
52
53
54
55
56
57
58
59
60 *Emerging Markets Finance and Trade*, **37**, 6-30.

1
2
3 Engle, R. and Granger, C. (1987) Cointegration and error correction representation:
4 estimation and testing, *Econometrica*, **55**, 251-276.
5
6

7
8 Hacker, R.S. and Hatemi, A.J. (2004) The effect of exchange rate changes on trade
9 balances in the short and long run, *Economics of Transition*, **12**, 777-799.
10
11

12
13 Johansen, S. (1988) Statistical analysis of cointegrating vectors, *Journal of Economic*
14 *Dynamics and Control*, **12**, 231-254.
15
16

17
18 Johansen, S. (1996) *Likelihood-Based Inference in Cointegrated Vector Auto-*
19 *Regressive Models*, 2nd ed., Oxford University Press, Oxford.
20
21

22
23 Johansen, S. and Juselius, K. (1990) Maximum likelihood estimation and inference on
24 cointegration—with application to the demand for money, *Oxford Bulletin of Economics*
25 *and Statistics*, **52**, 169-210.
26
27

28
29 Kale, P. (2001) Turkey's trade balance in the short and the long run: an error correction
30 modelling and cointegration, *The International Trade Journal*, **15**, 27-56.
31
32

33
34 Krueger, A.D. (1983) *Exchange Rate Determination* Cambridge University Press,
35 Cambridge.
36
37

38
39 Narayan, P.K. (2004) New Zealand's trade balance: evidence from the J-curve and
40 granger causality, *Applied Economics Letters*, **11**, 351-354.
41
42

43
44 Narayan, P.K. and Narayan, S. (2004) The J-curve: evidence from Fiji, *International*
45 *Journal of Applied Economics*, **18**, 369-380.
46
47

48
49 Peseran, M. H. and Shin, Y. (1999) An autoregressive distributed lag modelling
50 approach to cointegration analysis, In Strom, S. (Ed.): *Econometrics and Economic*
51 *Theory in 20th Century: The Ragnar Frisch Centennial Symposium*, Chapter 11,
52 Cambridge University Press, Cambridge.
53
54
55

56
57 Pesaran, M.H., Shin, Y., and Smith, R.J. (2001) Bounds testing approaches to the
58 analysis of level relationships, *Journal of Applied Econometrics*, **16**, 289-326.
59
60

1
2
3 Phillips, P.C. B. and Perron, P. (1988) Testing for a unit root in time series regression,
4
5 *Biometrika*, **75**, 335-359.
6

7
8 Phillips, P. and Hansen, B. (1990) Statistical inference in instrumental variables
9
10 regression with $I(1)$ process, *Review of Economic Studies*, **57**, 99-125.
11

12
13 Rose, A. K. (1990) Exchange rates and the trade balance: some evidence from
14
15 developing countries, *Economics Letters*, **34**, 271-275.
16

17
18 Rose, A. K. and Yellen, J. L. (1989) Is there a J-curve?, *Journal of Monetary*
19
20 *Economics*, **24**, 53-58.
21

Table 1. F-statistics for cointegration relationship

	Critical value bounds of the F-statistic			
	90% level		95% level	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$
	2.721	3.773	3.232	4.351
Calculated F-statistics				
$F(\ln TB \ln REER, \ln YW, \ln YT) = 5.175^*$				
$F(\ln REER \ln TB, \ln YW, \ln YT) = 1.412$				
$F(\ln WY \ln REER, \ln TB, \ln YT) = 3.283$				
$F(\ln YT \ln REER, \ln YW, \ln TB) = 3.104$				
The relevant critical values are obtained from Table C1.iii (with an unrestricted intercept and no trend with three regressors) in Pesaran <i>et al.</i> (2001). * indicates the statistical significance at the 5 % level. The optimal lag length is four.				

Table 2. Long-run coefficients of the trade balance of Turkey

Panel A: the long-run results

Dependent variable $\ln TB$

Regressors	Model Selection Criterion			
	AIC	ARDL (1,2,3,0)	SBC	ARDL (1,1,3,0)
$\ln REER$	0.468	(1.449)	0.656*	(2.068)
$\ln YW$	-3.123*	(2.326)	-3.440*	(2.477)
$\ln YT$	1.328*	(2.371)	1.491*	(2.572)
Constant	7.387	(2.081)	7.186	(1.989)

Panel B: the short-run diagnostic test statistics

$\chi^2_{SC}(4)=2.324$, $\chi^2_{FC}(1)=5.731$	$\chi^2_{SC}(4)=2.144$, $\chi^2_{FC}(1)=4.948$
$\chi^2_N(2)=8.176$, $\chi^2_H(1)=0.206$	$\chi^2_N(2)=7.192$, $\chi^2_H(1)=0.325$

Notes: The absolute value of t-ratios is in parentheses. χ^2_{SC} , χ^2_{FC} , χ^2_N , and χ^2_H are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. * indicates statistical significance at the 5% level.

Table 3. Short-run coefficients of the trade balance of Turkey-
estimates from ECM

Dependent variable $\Delta \ln TB_t$

Regressors	Model Selection Criterion			
	AIC	ARDL (1,2,3,0)	SBC	ARDL (1,1,3,0)
$\Delta \ln REER_t$	0.907*	(3.759)	0.952*	(3.890)
$\Delta \ln REER_{t-1}$	0.494*	(2.044)	-	-
$\Delta \ln YW_t$	-2.323*	(4.011)	-2.225*	(3.787)
$\Delta \ln YW_{t-1}$	0.831	(1.276)	1.116	(1.723)
$\Delta \ln YW_{t-2}$	2.845*	(5.138)	2.939*	(5.233)
$\Delta \ln YT_t$	0.467*	(2.525)	0.522*	(2.804)
Constant	2.600	(2.251)	2.517	(2.143)
EC_{t-1}	-0.351*	(4.938)	-0.350*	(4.830)
\bar{R}^2	0.481		0.507	
F-statistics	14.168		15.287	
DW-statistics	2.034		2.041	
RSS	2.071		2.131	

Notes: The absolute values of t-ratios are in parentheses. RSS stands for residual sum of squares.
* indicates statistical significance at the 5% level.

Table 4. Coefficient estimates of $\Delta \ln REER_{t-i}$ and error correction termDependent variable $\Delta \ln TB_t$

Regressors	Coefficients	t-statistics
$\Delta \ln REER_t$	0.890*	3.144
$\Delta \ln REER_{t-1}$	0.370	1.308
$\Delta \ln REER_{t-2}$	0.323	1.115
$\Delta \ln REER_{t-3}$	0.327	1.141
$\Delta \ln REER_{t-4}$	-0.094	0.319
$\Delta \ln REER_{t-5}$	-0.240	0.838
$\Delta \ln REER_{t-6}$	0.403	1.407
Constant	-0.018	0.961
EC_{t-1}	-0.327*	4.102
\bar{R}^2	0.421	

Diagnostic test statistics
 $\chi^2_{SC}(4)=5.129$, $\chi^2_{FC}(1)=2.623$, $\chi^2_N(2)=4.143$, $\chi^2_H(1)=0.003$

Notes: t-ratios are in absolute values. χ^2_{SC} , χ^2_{FC} , χ^2_N , and χ^2_H are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. * indicates statistical significance at the 5% level.

Table 5. Results of Granger Causality

Dependent Variable	$\Delta \ln TB_t$	$\Delta \ln REER_t$	$\Delta \ln YW_t$	$\Delta \ln YT_t$	EC_{t-1} (t-statistics)
$\Delta \ln TB_t$	-	2.94* (0.01)	4.82* (0.01)	1.54 (0.18)	-0.26* (3.24)
$\Delta \ln REER_t$	3.32* (0.01)	-	1.42 (0.22)	1.46 (0.20)	-
$\Delta \ln YW_t$	0.79 (0.55)	0.65 (0.66)	-	2.18 (0.06)	-
$\Delta \ln YT_t$	1.64 (0.15)	3.40* (0.00)	2.97* (0.01)	-	-

Causality inference: REER \leftrightarrow TB, YW \Rightarrow TB, WY \Rightarrow YT, REER \Rightarrow YT
Notes: * indicates statistical significance at the 5% level. The optimal length is 4 and is based on SBC.

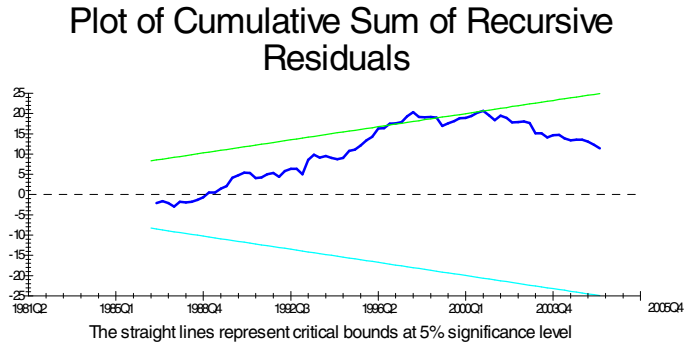


Figure 1. Plot of CUSUM

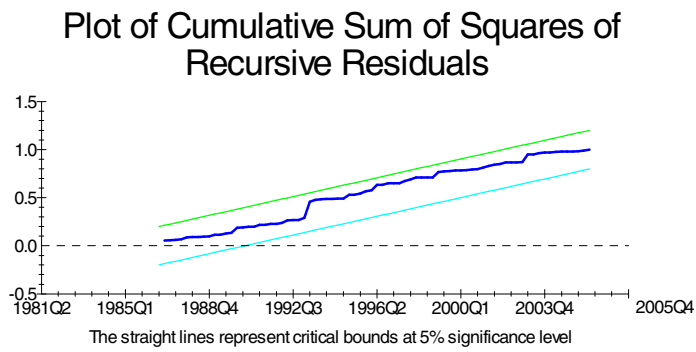


Figure 2. Plot of the CUSUMSQ

I. INTRODUCTION

A deficit in the trade balance of a country may be eliminated by a real devaluation in the domestic currency. Success of devaluation, however, depends on whether or not the sum of import and export elasticities exceeds unity, which is also known as the Marshall- Lerner (ML) condition. Bahmani-Oskooee (1985) argued that there have been cases under which the ML condition was satisfied yet the trade balance continued to deteriorate. Therefore, he concludes that the focus of a trade policy should be on the short-run dynamics that trace the post devaluation time path of the trade balance implying the J-curve phenomenon. The J-curve effect suggests that the trade balance of a nation initially worsens after a real depreciation of the home currency, and then it gets better. Krueger (1983) has argued that at the time an exchange occurs, goods, which are already in transit and under contract, have been purchased, and the completion of those transactions dominates the short-term change in the trade balance. Arndt and Dorrance (1987) indicates that this so called J-curve effect occurs if the domestic currency prices of exports are sticky. There has been growing interest in the J-curve phenomenon in the last three decades. Bahmani-Oskooee and Ratha (2004a) provides a very comprehensive survey on the J-curve literature for the period of 1973-2003 from thirty-seven articles. The recent examples of the J-curve studies include Bahmani-Oskooee *et al.* (2006), Bahmani-Oskooee *et al.* (2005), Bahmani-Oskooee and Ratha (2004b), Hacker and Hatemi (2004), Narayan (2004), and Narayan and Narayan (2004). The empirical literature on the evidence of the J-curve, however, is fairly ambiguous.

In regards to the empirical evidence for the Turkish J-curve, one can identify readily a few previous studies with inconclusive results. Rose (1990) finds that the real exchange rates have no impact on the trade balance. The work of Bahmani-Oskooee

1
2
3 and Malixi (1992), which is based on Almon lag structure on real exchange rate, has
4 found no support for it either. On employing the Engle-Granger cointegration approach,
5 Bahmani-Oskooee and Alse (1994) asserts that the long-run impact of devaluation on
6 the trade balance model is positive. Brada *et al.* (1997) who divided the data set into
7 two sub-samples reports no long-run relationship between the variables of the trade
8 balance function in the 1970s but they have revealed reverse results for the 1980s. Kale
9 (2001) points out that a real depreciation of the domestic currency helps to improve the
10 trade balance with a lag of about one-year and the impacts of devaluations on the trade
11 balance are positive in the long-run. In a recent study, Akbostanci (2004) also presents
12 empirical evidence of the J-curve phenomenon in the long-run. As a passing note, one
13 should point out that the last two studies are based on that of Johansen-Juselius (1990)
14 multivariate cointegration procedure with relatively short data spans derived from the
15 1980s and 1990s.

16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34 Turkey has adopted a policy of trade liberalization since 1980 and has pursued a
35 successful export-led growth policy. The ratio of total exports to gross domestic
36 product (GDP) increased from 4.1 to 13.3 percent during the period 1980-1988 and the
37 real GDP grew by 5.8 percent in the same period. In 1989, there was a policy reversal,
38 which slowed the depreciation of the Turkish lira (TL), in part to control inflation, but
39 mainly to be able to easily borrow from the domestic markets, which led to five
40 recessions in 1989, 1991, 1994, 1999, and 2001. The recessions of 1991, 1994 and
41 2001 were preceded by substantial increases in the real exchange rates. The impacts of
42 devaluations on the trade balance, however, seem to be short lived as the early
43 improvements in the trade balance are reversed steadily after a while. To combat the
44 spiralling twin deficits in 2001, the IMF-led stabilization policy was put into effect
45 once more. As a result, the internal imbalance has improved considerably but at the
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 same time the external balance has got worse. Despite having the free-floating
4 exchange regime, the TL has been steadily appreciating against the major world
5 currencies in real terms since 2002. This situation is being attributed to excess real
6 domestic interest rates that are intentionally set at high levels to prevent inflation rising
7 again. As a direct consequence of the overvalued TL, the current account deficit, which
8 stems largely from the trade account deficit, has currently exceeded 6% of that Turkish
9 GDP. Ertugrul and Selcuk (2001) provides a detailed account of the causes and
10 consequences of the Turkish twin deficits in the 1980s and 1990s. A similar account of
11 the Turkish economy beyond 2000 is given in Akyurek (2006).

12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
The motivation of this study is two fold: persistent trade balance deficits of Turkey
since the 1980s provide a good rationale to revisit the J-curve phenomenon and the
cointegration procedure in this paper has been used for many countries in testing the J-
curve phenomenon, except for Turkey.

The objectives of this study are as follows: i) to investigate the existence of the J-curve
phenomenon both in the short-run and long-run using recent advances in time-series
econometrics; ii) to establish the direction of causal relationships between trade balance,
real effective exchange rates, foreign and domestic incomes variables; and iii) to
implement parameter stability tests of Brown *et al.* (1975) to ascertain stability or
instability in the trade balance model.

The remainder of this paper is organized as follows. Section II describes the study's
model and methodology. Section III discusses the empirical results, and finally Section
IV concludes.

II. THE MODEL AND METHODOLOGY

The trade balance model employed in this study adopted the form of Rose and Yellen (1989) and it takes the following long-run (cointegrating) form:

$$\ln TB_t = a_0 + a_1 \ln REER_t + a_2 \ln YW_t + a_3 \ln YT_t + \varepsilon_t \quad (1)$$

where the measure of the trade balance, TB is the ratio of imports to exports; REER is the real effective exchange rate; YW is the industrial production index of industrial countries; YT is the industrial production index of Turkey. Ln is the natural logarithm transformation and ε_t is the random error term. According to the J-curve phenomenon, it is expected that $a_1 < 0$ since an increase in real effective exchange rate initially reduces the demand for the home country's export but increases its demand for imports. As a result, the balance of trade worsens initially but it will improve after a while as export and import volumes adjust to price changes. While there are no *priori* expectations about the signs of a_2 and a_3 , however, one asserts tentatively that a_2 is negative and a_3 is positive.

On investigating the cointegrating trade balance model with a view of testing the J-curve phenomenon, several econometric methods were implemented in the last two decades. In regards to univariate cointegration approaches, there are several examples including Engle-Granger (1987) and the fully modified OLS procedures of Phillips and Hansen's (1990). In terms of multivariate cointegration, Johansen (1988), Johansen and Juselius (1990), and Johansen's (1996) full information maximum likelihood procedures are widely employed. See Bahmani-Oskooee and Ratha (2004a) for a full account of the econometric procedures applied in the J-curve studies. A recent single

cointegration approach, known as autoregressive-distributed lag (ARDL) of Pesaran and Shin (1999) and Pesaran *et al.* (2001), has become popular amongst the researchers. Pesaran *et al.*, cointegration approach, also named as bounds testing, has certain econometric advantages in comparison to other single cointegration procedures. Firstly, endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger method are avoided. Secondly, the long and short-run parameters of the model in question are estimated simultaneously. Thirdly, all variables are assumed to be endogenous. Fourthly, the econometric methodology is relieved of the burden of establishing the order of integration amongst the variables and of pre-testing for unit roots. The ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely $I(0)$, purely $I(1)$, or fractionally integrated. Finally, according to Narayan (2004), the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration.

An ARDL representation of equation (1) is formulated as follows:

$$\Delta \ln TB_t = a_0 + \sum_{i=1}^m a_{1i} \Delta \ln TB_{t-i} + \sum_{i=0}^m a_{2i} \Delta \ln REER_{t-i} + \sum_{i=0}^m a_{3i} \Delta \ln YW_{t-i} + \sum_{i=0}^m a_{4i} \Delta \ln YT_{t-i} \quad (2)$$

$$+ a_5 \ln TB_{t-1} + a_6 \ln REER_{t-1} + a_7 \ln YW_{t-1} + a_8 \ln YT_{t-1} + v_t$$

Pesaran *et al.* cointegration procedure is briefly outlined as follows. The bounds testing procedure is based on the F or Wald-statistics and is the first stage of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration, ($H_0: a_5 = a_6 = a_7 = a_8 = 0$), should be performed for equation (2). The F test used for this procedure has a non-standard distribution. Thus, Pesaran *et al.*

compute two sets of critical values for a given significance level. One set assumes that all variables are $I(0)$ and the other set assumes they are all $I(1)$. If the computed F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

Once a long-run relationship has been established, equation (2) is estimated using an appropriate lag selection criterion. At the second stage of the ARDL cointegration procedure, it is also possible to perform a parameter stability test for the selected ARDL representation of the error correction model.

A general error correction model (ECM) of equation (2) is formulated as follows:

$$\begin{aligned} \Delta \ln TB_t = & b_0 + \sum_{i=1}^k b_{1i} \Delta \ln TB_{t-i} + \sum_{i=0}^k b_{2i} \Delta \ln REER_{t-i} + \sum_{i=0}^k b_{3i} \Delta \ln YW_{t-i} \\ & + \sum_{i=0}^k b_{4i} \Delta \ln YT_{t-i} + \lambda EC_{t-1} + u_t \end{aligned} \quad (3)$$

where λ is the speed of adjustment parameter and EC is the residuals that are obtained from the estimated cointegration model of equation (1).

The Granger representation theorem suggests that there will be Granger causality in at least one direction if there exists a cointegration relationship among the variables in equation (1), providing that they are integrated order of one. Engle-Granger (1987) caution that the Granger causality test, which is conducted in first difference via a vector autoregression (VAR) will be misleading in the presence of cointegration. Therefore, an inclusion of additional variable to the VAR system such as the error correction term would help us to capture the long-run relationship. To this end, an

augmented form of Granger causality test involving the error correction term is formulated in a multivariate p th order vector error correction model.

$$\begin{bmatrix} \Delta \ln TB_t \\ \Delta \ln REER_t \\ \Delta \ln YW_t \\ \Delta \ln YT_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \sum_{i=1}^p \begin{bmatrix} d_{11i} & d_{12i} & d_{13i} & d_{14i} \\ d_{21i} & d_{22i} & d_{23i} & d_{24i} \\ d_{31i} & d_{32i} & d_{33i} & d_{34i} \\ d_{41i} & d_{42i} & d_{43i} & d_{44i} \end{bmatrix} \begin{bmatrix} \Delta \ln TB_{t-i} \\ \Delta \ln REER_{t-i} \\ \Delta \ln YW_{t-i} \\ \Delta \ln YT_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \end{bmatrix} [EC_{t-1}] + \begin{bmatrix} \omega_{1t} \\ \omega_{2t} \\ \omega_{3t} \\ \omega_{4t} \end{bmatrix} \quad (4)$$

EC_{t-1} is the error correction term, which is derived from the long-run relationship, and it is not included in equation (4) if one finds no cointegration amongst the variables in question. The Granger causality test may be applied to equation (4) as follows: i) by checking statistical significance of the lagged differences of the variables for each vector; this is a measure of short-run causality and ii) by examining statistical significance of the error correction term for the vector that there exists a long-run relationship.

The existence of a cointegration derived from equation (2) does not necessarily imply that the estimated coefficients are stable as argued in Bahmani-Oskooee and Brooks (1999). Hence, stability tests of Brown *et al.* (1975), which are also known as cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests based on the recursive regression residuals, may be employed to that end. These tests also incorporate the short-run dynamics to the long-run through residuals. The CUSUM and CUSUMSQ statistics are updated recursively and plotted against the break points of the model. Providing that the plot of these statistics fall inside the critical bounds of 5% significance, one assumes that the coefficients of a given regression are stable. These tests are usually implemented by means of graphical representation.

III. THE EMPIRICAL RESULTS

Quarterly data over 1980I-2005IV period were used to estimate equation (2). Data definition and sources of data are cited in the appendix. Equation (2) was estimated in two stages. In the first stage of the ARDL procedure, the order of lags on the first-differenced variables for equation (2) was obtained from unrestricted VAR by means of Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), which indicated the optimal lag level as four and six quarters respectively for this study. The results of this stage are not reported here for brevity. Then an F deletion test was applied to equation (2) in order to test the existence of a long-run relationship by using lags from four to six on following Bahmani-Oskooee and Goswami (2003). As they have shown that the results of this stage are sensitive to the order of VAR. Equation (2) was also estimated three more times in the same way but the dependent variable each time was replaced by one of the explanatory variables in search of other possible long-run relationship in any other form than it had already been described in equation (1). The summary results of bounds tests are presented in Table 1. Table 1 indicates only one plausible a long-run relationship in which lnTB is dependent variable.

[INSERT TABLE 1 ABOUT HERE]

In the second stage of ARDL cointegration procedure, equations (2) and (3) were estimated respectively on the basis of AIC and SBC criteria with six lags in search of selecting best-fitted model. The results of the model selection stages are reported in Table 2 and 3 respectively.

1
2
3 [INSERT TABLE 2 ABOUT HERE]
4
5
6
7

8 Considering the long-run coefficients in the panel A of Table 2, one concludes that the
9 SBC based trade balance model seems to be a slightly better fit than the AIC model
10 since all the coefficients in the former model are statistically significant at the 5% level.
11
12 Apart from that difference, both model selection criteria reveal almost identical results.
13
14
15
16
17

18
19
20
21 [INSERT TABLE 3 ABOUT HERE]
22
23
24

25
26 As far as the ECMs are concerned, it can be seen from Table 3 that the results of
27 equation (3) are also very close in both model selection criteria. The long-run and short
28 run results of the SBC version of the trade balance model, however, provide again
29 relatively better results in terms of the expected signs and econometric diagnostics. The
30 speed of adjustment coefficient, -0.35 is considerably low indicating a slow
31 convergence to equilibrium in the case of a shock to the cointegrating relationship and
32 that long-run equilibrium is attained only after three quarters. Based on the AIC and
33 SBC results, however, one can suggest that there are no J-curve effects both in the long
34 and short-runs since the coefficient of the real effective exchange rates does not alter
35 from positive to negative in either case. Considering that the focus of this paper is
36 essentially on the dynamics of devaluation, the impact of the lags of the real exchange
37 rates on the trade balance from error correction version of the SBC model was
38 estimated. The results are reported in Table 4. The evidence of the J-curve is now
39 apparent in the REER variable as the positive coefficients are followed by the negative
40 coefficients. This pattern of the coefficients shows an initial deterioration followed by
41 an improvement in the trade balance.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

[INSERT TABLE 4 ABOUT HERE]

Granger causality test requires that all variables in equation (1) should be in integrated of order one. To this end, the traditional unit root tests such as the augmented Dickey and Fuller (1979, 1981) and the Phillips and Peron (1988) were employed. The unit root test results suggest that all variables in their first level differences are $I(1)$. For brevity of presentation, they are not reported here. Having a cointegrating relationship among $[TB_t, REER_t, YW_t, YT_t]$ on the basis of the results of the bounds test in Table 1, Granger causality test was conducted to equation (4) as such that only the trade balance vector was estimated with an error correction term. Similarly the Granger causality tests were applied to other models without the error correction terms since one could not ascertain any long-run relationship for the other vectors. Table 5 summarises the results of long-run and short-run Granger causality.

[INSERT TABLE 5 ABOUT HERE]

On considering the long-run Granger causality, one suggests that the lagged error correction term with the expected sign is statistically significant which also confirms the results of the bounds test. The speed of the adjustment, however, is less than the ARLD estimations suggesting that the long-term convergence to equilibrium will take longer. Granger causality runs interactively via both exchange rates and world income to trade balance ratio. In regards to the short-run Granger causality tests based on the F statistics, one sees that there exists a bi-directional Granger causality between exchange rates and trade balance ratio, implying that as the trade balance improves it causes a

1
2
3 real appreciation of the TL. Likewise, a real depreciation will have a positive impact on
4 the trade balance. There are, however, uni-directional Granger causalities, which run
5 from world income to the trade balance, from world income to domestic income, and
6 from exchange rates to domestic income.
7
8
9
10
11

12
13
14
15 [INSERT FIGURE 1 AND FIGURE 2 ABOUT HERE]
16
17
18
19

20 The parameter stability tests were implemented via equation (3), which captures the
21 short-run dynamics of equation (2) and the long-run impact of equation (1). Equation
22 (3) was estimated by ordinary least squares with a lag length of four based on the SBC
23 criterion. Figure 1 and 2 provides the plots of CUSUM and CUSUMSQ tests,
24 respectively. Figure 1 and 2 display conflicting results in regards to the parameter
25 stability tests. Whilst the former test indicates instability the later suggests stability in
26 the parameters of the trade balance equation.
27
28
29
30
31
32
33
34
35
36
37
38

39 IV. CONCLUSION 40 41 42

43 This study has attempted to estimate the J-curve phenomenon through a reduced form
44 trade balance model in search of providing fresh empirical evidence in the case of
45 Turkish data. A recent single cointegration technique proposed by Pesaran *et al.* (2001)
46 was employed to investigate the short-run and long-run responses of the trade balance
47 to currency depreciation. The results from bounds tests have indicated only one
48 possible long-run relationship in which the trade balance is the dependent variable. In
49 contrast to the results of the previous results relating to Turkey, one finds no long-run
50 impact of a real devaluation on the trade balance but there exists the J-curve
51
52
53
54
55
56
57
58
59
60

1
2
3 phenomenon in the short-run. The existence of J-curve in the short-run confirms that
4 the Turkish foreign trade balance deficit improves rather rapidly on following currency
5 depreciations as it has happened in the TL depreciations of 1994, 1999 and 2004. Whilst,
6 in the long-run, real effective exchange rates and world income Granger cause to the
7 trade balance, in the short-run there is a feedback relationship between the real effective
8 exchange rates and trade balance. The parameter stability tests on the long-run trade
9 balance equation appear to be inconclusive.
10
11
12
13
14
15
16
17
18
19
20
21

22 APPENDIX

23 *Data definition and sources*

24
25
26
27
28
29
30
31
32 The data set used in this study cover the period 1980I to 2005IV. All data are collected
33 from International Financial Statistics, (IMF) and Central Bank of Turkey (CBT).
34
35
36
37

38 TB is Turkey's trade balance. It is defined as the ratio of real imports to real exports.

39 The raw data of exports and imports were deflated by the USA consumer price index.

40
41
42
43 Source: IMF.

44
45 REER is the real effective exchange rates index. Source: CBT.

46
47 YW is industrial production index of industrial countries. Source: IMF.

48
49
50
51 YT is industrial production index of Turkey. Source: IMF
52
53
54
55
56
57
58
59
60

REFERENCES

1
2
3
4
5
6
7
8 Akbostanci, E. (2004) Dynamics of the trade balance: the Turkish J-curve, *Emerging
9 Markets Finance and Trade*, **40**, 57-73.

10
11
12 Akyurek, C. (2006) The Turkish crisis of 2001: a classic?, *Emerging Markets Finance
13 and Trade*, **42**, 5-32.

14
15
16
17 Arndt, H. W. and Dorrance, G. (1987) The J-curve, *The Australian Economic Review*,
18
19 **11**, 9-19.

20
21
22 Bahmani-Oskooee, M. (1985) Devaluation and the J-curve: some evidence from LDCs,
23
24 *The Review of Economics and Statistics*, **17**, 500-504.

25
26
27 Bahmani-Oskooee, M. and Alse, J. (1994) Short-run versus long-run effects of
28
29 devaluation: error correction modelling and cointegration, *Eastern Economic Journal*,
30
31 **20**, 453-464.

32
33
34 Bahmani-Oskooee, M. and Brooks, T. J. (1999) Bilateral J-curve between US and her
35
36 trading partners, *Weltwirtschaftliches Archiv*, **135**, 156-165.

37
38
39 Bahmani-Oskooee, M. and Malixi, M. (1992) More evidence on the J-curve from LDCs,
40
41 *Journal of Policy Modeling*, **14**, 641-653.

42
43
44 Bahmani-Oskooee, M. and Goswami, G. G. (2003) A disaggregated approach to test
45
46 the J-curve phenomenon: Japan versus her major trading partners, *International Journal
47 of Economics and Finance*, **27**, 102-113.

48
49
50 Bahmani-Oskooee, M. and Ratha, A. (2004a) The J-curve: a literature review, *Applied
51 Economics*, **36**, 1377-1398.

52
53
54 Bahmani-Oskooee, M. and Ratha, A. (2004b) The J-curve dynamics of U.S. bilateral
55
56 trade, *Journal of Economics and Finance*, **28**, 32-38.
57
58
59
60

1
2
3 Bahmani-Oskooee, M., Goswami, G.G., and Talukdar, B. K. (2005) The Bilateral J-
4 curve: Australia versus her 23 trading partners, *Australian Economic Papers*, **44**, 110-
5
6
7
8
9 120.

10 Bahmani-Oskooee, M. C. Econmidou, G.G. Goswami (2006) Bilateral J-curve between
11 the UK vis-à-vis her major trading partners, *Applied Economics*, **38**, 879-888.

12
13 Brada, J.C., Kutan, A.H., and Zhou, S. (1997) The exchange rate and the balance of
14 trade: the Turkish experience, *Journal of Development Studies*, **33**, 675-692.

15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Brown, R.L., Durbin, J. and Evans, J.M. (1975) Techniques for testing the constancy of regression relations over time, *Journal of the Royal Statistical Society*, **37**, 149-163.

Dickey, D.A., and Fuller, W.A., (1979) Distributions of the estimators for autoregressive time series with a unit root, *Journal of the American Statistical Association*, **74**, 427-431.

Dickey, D.A., and Fuller, W.A. (1981) Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica*, **49**, 1057-1072

Ertugrul, A. and Selcuk, F. (2001) A brief account of the Turkish economy, 1980-2000, *Emerging Markets Finance and Trade*, **37**, 6-30.

Engle, R. and Granger, C. (1987) Cointegration and error correction representation: estimation and testing, *Econometrica*, **55**, 251-276.

Hacker, R.S. and Hatemi, A.J. (2004) The effect of exchange rate changes on trade balances in the short and long run, *Economics of Transition*, **12**, 777-799.

Johansen, S. (1988) Statistical analysis of cointegrating vectors, *Journal of Economic Dynamics and Control*, **12**, 231-254.

Johansen, S. (1996) *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, 2nd ed., Oxford University Press, Oxford.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Johansen, S. and Juselius, K. (1990) Maximum likelihood estimation and inference on cointegration—with application to the demand for money, *Oxford Bulletin of Economics and Statistics*, **52**, 169-210.

Kale, P. (2001) Turkey's trade balance in the short and the long run: an error correction modelling and cointegration, *The International Trade Journal*, **15**, 27-56.

Krueger, A.D. (1983) *Exchange Rate Determination* Cambridge University Press, Cambridge.

Narayan, P.K. (2004) New Zealand's trade balance: evidence from the J-curve and granger causality, *Applied Economics Letters*, **11**, 351-354.

Narayan, P.K. and Narayan, S. (2004) The J-curve: evidence from Fiji, *International Journal of Applied Economics*, **18**, 369-380.

Peseran, M. H. and Shin, Y. (1999) An autoregressive distributed lag modelling approach to cointegration analysis, In Strom, S. (Ed.): *Econometrics and Economic Theory in 20th Century: The Ragnar Frisch Centennial Symposium*, Chapter 11, Cambridge University Press, Cambridge.

Pesaran, M.H., Shin, Y., and Smith, R.J. (2001) Bounds testing approaches to the analysis of level relationships, *Journal of Applied Econometrics*, **16**, 289-326.

Phillips, P.C. B. and Perron, P. (1988) Testing for a unit root in time series regression, *Biometrika*, **75**, 335-359.

Phillips, P. and Hansen, B. (1990) Statistical inference in instrumental variables regression with $I(1)$ process, *Review of Economic Studies*, **57**, 99-125.

Rose, A. K. (1990) Exchange rates and the trade balance: some evidence from developing countries, *Economics Letters*, **34**, 271-275.

Rose, A. K. and Yellen, J. L. (1989) Is there a J-curve?, *Journal of Monetary Economics*, **24**, 53-58.

Table 1. F-statistics for cointegration relationship

Critical value bounds of the F-statistic					
		90% level		95% level	
		$I(0)$	$I(1)$	$I(0)$	$I(1)$
		2.721	3.773	3.232	4.351
Calculated F-statistics					
$F(\ln TB \ln REER, \ln YW, \ln YT) = 5.175^*$					
$F(\ln REER \ln TB, \ln YW, \ln YT) = 1.412$					
$F(\ln YW \ln REER, \ln TB, \ln YT) = 3.283$					
$F(\ln YT \ln REER, \ln YW, \ln TB) = 3.104$					
The relevant critical values are obtained from Table C1.iii (with an unrestricted intercept and no trend with three regressors) in Pesaran <i>et al.</i> (2001). * indicates the statistical significance at the 5 % level. The optimal lag length is four.					

Table 2. Long-run coefficients of the trade balance of Turkey

Panel A: the long-run results					
Dependent variable $\ln TB$					
Model Selection Criterion					
Regressors	AIC	ARDL (1,2,3,0)	SBC	ARDL (1,1,3,0)	
$\ln REER$	0.468	(1.449)	0.656*	(2.068)	
$\ln YW$	-3.123*	(2.326)	-3.440*	(2.477)	
$\ln YT$	1.328*	(2.371)	1.491*	(2.572)	
Constant	7.387	(2.081)	7.186	(1.989)	
Panel B: the short-run diagnostic test statistics					
$\chi_{SC}^2(4) = 2.324, \chi_{FC}^2(1) = 5.731$			$\chi_{SC}^2(4) = 2.144, \chi_{FC}^2(1) = 4.948$		
$\chi_N^2(2) = 8.176, \chi_H^2(1) = 0.206$			$\chi_N^2(2) = 7.192, \chi_H^2(1) = 0.325$		
Notes: The absolute value of t-ratios is in parentheses. $\chi_{SC}^2, \chi_{FC}^2, \chi_N^2$, and χ_H^2 are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. * indicates statistical significance at the 5% level.					

Table 3. Short-run coefficients of the trade balance of Turkey-estimates from ECM
Dependent variable $\Delta \ln TB_t$

Regressors	Model Selection Criterion			
	AIC	ARDL (1,2,3,0)	SBC	ARDL (1,1,3,0)
$\Delta \ln REER_t$	0.907*	(3.759)	0.952*	(3.890)
$\Delta \ln REER_{t-1}$	0.494*	(2.044)	-	-
$\Delta \ln YW_t$	-2.323*	(4.011)	-2.225*	(3.787)
$\Delta \ln YW_{t-1}$	0.831	(1.276)	1.116	(1.723)
$\Delta \ln YW_{t-2}$	2.845*	(5.138)	2.939*	(5.233)
$\Delta \ln YT_t$	0.467*	(2.525)	0.522*	(2.804)
Constant	2.600	(2.251)	2.517	(2.143)
EC_{t-1}	-0.351*	(4.938)	-0.350*	(4.830)
\bar{R}^2	0.481		0.507	
F-statistics	14.168		15.287	
DW-statistics	2.034		2.041	
RSS	2.071		2.131	

Notes: The absolute values of t-ratios are in parentheses. RSS stands for residual sum of squares.
* indicates statistical significance at the 5% level.

Table 4. Coefficient estimates of $\Delta \ln REER_{t-i}$ and error correction term
Dependent variable $\Delta \ln TB_t$

Regressors	Coefficients	t-statistics
$\Delta \ln REER_t$	0.890*	3.144
$\Delta \ln REER_{t-1}$	0.370	1.308
$\Delta \ln REER_{t-2}$	0.323	1.115
$\Delta \ln REER_{t-3}$	0.327	1.141
$\Delta \ln REER_{t-4}$	-0.094	0.319
$\Delta \ln REER_{t-5}$	-0.240	0.838
$\Delta \ln REER_{t-6}$	0.403	1.407
Constant	-0.018	0.961
EC_{t-1}	-0.327*	4.102
\bar{R}^2	0.421	

Diagnostic test statistics
 $\chi^2_{SC}(4)=5.129$, $\chi^2_{FC}(1)=2.623$, $\chi^2_N(2)=4.143$, $\chi^2_H(1)=0.003$

Notes: t-ratios are in absolute values. χ^2_{SC} , χ^2_{FC} , χ^2_N , and χ^2_H are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. * indicates statistical significance at the 5% level.

Table 5. Results of Granger Causality

Dependent Variable	F statistics (probability)				
	$\Delta \ln TB_t$	$\Delta \ln REER_t$	$\Delta \ln YW_t$	$\Delta \ln YT_t$	EC_{t-1} (t-statistics)
$\Delta \ln TB_t$	-	2.94* (0.01)	4.82* (0.01)	1.54 (0.18)	-0.26* (3.24)
$\Delta \ln REER_t$	3.32* (0.01)	-	1.42 (0.22)	1.46 (0.20)	-
$\Delta \ln YW_t$	0.79 (0.55)	0.65 (0.66)	-	2.18 (0.06)	-
$\Delta \ln YT_t$	1.64 (0.15)	3.40* (0.00)	2.97* (0.01)	-	-

Causality inference: REER \leftrightarrow TB, YW \Rightarrow TB, YW \Rightarrow YT, REER \Rightarrow YT
 Notes: * indicates statistical significance at the 5% level. The optimal length is 4 and is based on SBC.

Figure 1. Plot of CUSUM

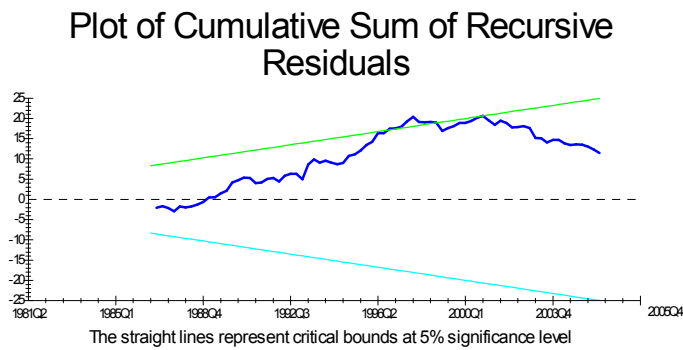
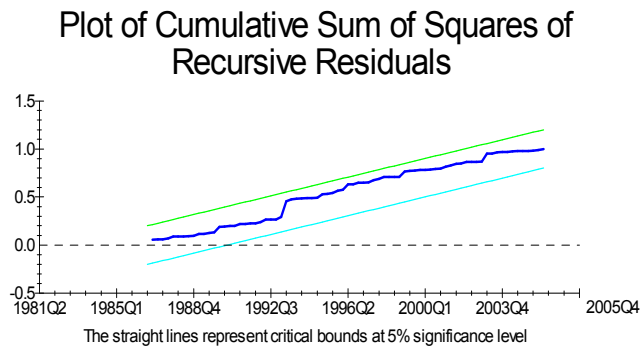


Figure 2. Plot of CUSUMSQ



For Peer Review