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J-Curve and Impact of Exchange Rate on Bilateral Trade between Turkey and its Two Trading Partners; Germany and the United States

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Abstract

In This paper, we try to investigate Marshall-Lerner condition and J-curve effect on bilateral trade between Turkey and itstwo major partners by employing Nonlinear Autoregressive Distributed Lag (NARDL) and Johansen-Juselius cointegration approaches. The study is mainly focused on estimating J-curve effect of devaluation by employing an aggregate trade data on bilateral trade between Turkey-Germany and Turkey-USA over the period from 2005Q04-2020Q01 (before outbreak of covid-19 pandemic). The methods are selected depend on stationary degree of series in each model. In case of Turkey-Germany the series aremixed integrated series (i.e. I(1) and I(0)) that allow us to use NARDL models and estimate asymmetric effects of real exchange rate on trade balance. In case of Turkey-USA, all the series are integrated at I(1) that lead us to apply for Johansen - Juselius cointegration approaches. Findings support J-curve phenomenon in both Turkey-Germany and Turkey-USA. These results indicate that a depreciations/decrease on Turkish Lira has long run and positive effect on trade balance of Turkey. Thus, devaluation in Turkish Lira canimprove the trade balance (i.e. eliminate persistent balance of payments deficits) of bilateral trade between Turkey-Germany and Turkey -USA.

Keywords: J-Curve, Marshall–Lerner, International Trade, Trade Balance.

1. Introduction

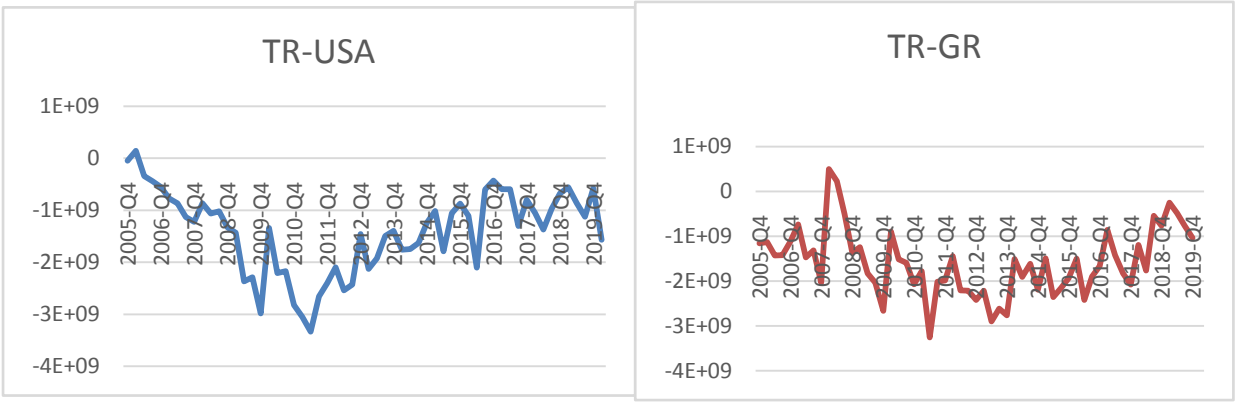
The J-curve phenomenon summarizes the response of the trade balance to devaluation or currency depreciation. If exports and imports adjust gradually to real exchange rate change, the current account may follow a J-Curve pattern after a real currency depreciation, first worsening and the improving. If such a J-Curve exists, currency depreciation may have an initial contractionary effect on output, and exchange rate overshooting will be amplified. Limited exchange rate pass-through, along with domestic price increases, may reduce the effect of a nominal exchange rate change on the real exchange rate. R. Krugman, Obstfeld, and Melitz (2012). To summaries, The long run relationship between the exchange rate and the trade balance is theoretically such that devaluation/decrease of domestic money can have a positive effect on the trade balance.

2.TradebetweenTurkey-GermanyandTurkey-USA:

Figure 1 shows the value of trade balance of Turkey with USA and Germany.The values of deficit of

Turkish Trade Balance with Germany and US in 2020 is -57521 and -13412 million in US Dollar, respectively. Some researchers believe that - in case of Marshall–Lerner holds - a possible way to improve trade balance in the long run would be a decrease/depreciation of the real exchange rate. While in the short-term the trade balance deficit could worsen if the trade balance has the J-curve pattern.

Figure 1: Turkey-Germany and Turkey-USA Trade Balance (Quarterly, US Dollar thousand):



In this study, we try to investigate that whether J-curve can be detected in data on Turkey's bilateral trade with the Germany and US.The meaning of the existing of J-curve is that, the devaluation/decrease in Turkish Lira will be one of the possible ways to decrease trade balance deficit.

3. Methodology and Data Set:

Quarterly data over the period 2005Q04-2020Q01 are used to carry out the empirical analysis. Variables, data and sources of data are given in the Table 1.

Table 1: Variables and Sources:

Series[3]	Data Sources
EUR/TL	Central Bank of the Republic of Turkey
DOLAR/TL	Central Bank of the Republic of Turkey
Export volume with the USA	Turkish Statistical Institute
Import volume with the USA	Turkish Statistical Institute
Export volume with the Germany	Turkish Statistical Institute
Import volume with the	Turkish Statistical Institute

[1] https://www.trademap.org/Bilateral_TS.aspx?nvpm=1%7c792%7c%7c276%7c%7cTOTAL%7c%7c%7c2%7c1%7c1%7c3%7c2%7c1%7c1%7c1%7c1%7c1

[2] https://www.trademap.org/Bilateral_TS.aspx?nvpm=1%7c792%7c%7c842%7c%7cTOTAL%7c%7c%7c2%7c1%7c1%7c3%7c2%7c1%7c1%7c1%7c1%7c1

[3] All data are seasonally adjusted using the MA method.

Germany	
CPI_{USA}	FRED
CPI_{GR}	FRED
CPI_{TR}	Turkish Statistical Institute
Real GDP_{USA}	FRED
Real GDP_{GR}	FRED
GDP_{TR} (Industrial Production Index)[4]	Central Bank of the Republic of Turkey

The following formula is used to obtain the real exchange rate between Turkey and its major partners is as follows:

$RER = \frac{NER \times P_F}{P}$; **RER**: Real Exchange Rate, **NER**: Nominal Exchange rate; $\boldsymbol{P_F}$**:** CPI of partners (CPI of US and Germany), **P** is CPI of Turkey.

3.1. The Trade Balance Model:

Our model and scaling purposes are similar to researches of **Bahmani-Oskooee and Durmaz (2020)** and **Bahmani-Oskooee and Brooks (1999)** that there are two scale variables (one for the Turkey and the other for the trading partner), and the real exchange rate. In linear form, the trade balance model takes the form of equation (1), $TB_{j,t}$: where is Turkey trade balance with trading partmer j, $Y_{Tr,t}$ is the index of Turkey real GDP, $Y_{j,t}$ is the index of cotmtry j's GDP, $RER_{j,t}$ is the bilateral real exchange rate between the TRY and j's currency. Following **Bahmani-Oskooee and Ratha (2004**) we have no a priori expectations about the signs of coefficient of $Y_{Tr,t}$ (b) and $Y_{j,t}$ (c), while we do expect about coefficient of real exchange (d) to be positive if real depreciation is to improve the trade balance in the long run.

$$TB_{j,t} = a + b.Y_{Tr,t} + c.Y_{j,t} + d.RER_{j,t} + \varepsilon_t \qquad (1)$$

In this study, we consider bilateral trade between Turkey-German, Turkey-USA. The equation (2), and (3) show liner form of J-Curve models between those countries:

$$TB_{Tr-GR,t} = a_1 + b_1.Y_{TR,t} + c_1.Y_{GR,t} + d_1.RER_{GR,t} + \varepsilon_t \qquad (2)$$

$$TB_{Tr-USA,t} = a_2 + b_2.Y_{TR,t} + c_2.Y_{USA,t} + d_2.RER_{USA,t} + \ell_t \qquad (3)$$

3.2. Unit Root Test:

For clarification of stationary of time series, Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) unit root test has applied. Table 2 shows all variable are stationary at the I (0), I (1) and none of them is stationary at I (2). In addition, all variables seasonally adjusted. The results of unit root test is given in the Table 2.

[4]GDP in Turkey is I(2). Therefore, industrial production index is used as Proxy for GDP.

Table 2: Unit Root Test Results:

Variables	ADF[5]		PP[6]	
	Intercept	intercept and trend	intercept	intercept and trend
RER_{USA}	4.11(9)	2.98(10)	4.05	1.05
ΔRER_{USA}	-1.71	-3.50**	-5.35***	-6.49***
RER_{GR}	2.78(9)	2.20(9)	4.78(1)	1.84(1)
$\Delta\ RER_{GR}$	-4.4(0)***	-5.83 (0)***	-4.58(4)***	-5.77(2)***
IPI_{TR}	-1.44(4)	-2.0(9)	-1.47(57)	-3.80(3)**
ΔIPI_{TR}	-6.8(2)***	-6.76(2)***	-11.7(17)***	-11.7(16)***
$\boldsymbol{GDP_{USA}}$	0.41(1)	-2.07(1)	0.6(4)	-1.51(3)
$\Delta\boldsymbol{GDP_{USA}}$	-4.6(0)***	-4.72(0)***	-4.76(3)***	-4.85(3)***
$\boldsymbol{GDP_{GR}}$	-3.0(2)**	-4.76(1)***	-2.95(4)**	-2.97(5)
$\Delta\boldsymbol{GDP_{GR}}$	-5.7(1)***	-5.80(1)***	-3.83(18)***	-3.9 (19)**
$\boldsymbol{TB_{Tr-USA}}$	-2.44(1)	-2.61(1)	-2.72(3)*	-2.78(4)
$\Delta\boldsymbol{TB_{Tr-USA}}$	-10.1(0)***	-6.22(2)***	-11.1(11)***	-12.3(19)***
$TB_{Tr\text{-}GR}$	-3.98(0)***	-1.42(3)	-4.05(4)***	-4.0(4)***

Note: The signs ***, ** and * represent 1%, 5% and 10% significance level, and parantes shows number of optimal lag.

According to the results of Table 2, the variables related to the models (2) and (3) show that different analysis methods should be considered in terms of level of stationary. TB_{Gr} is integrated at level, TB_{USA} and all GDPs and as well as RER are integrated at first differences. Thus, ARDL bound developed by (Pesaran, Shin, and Smith 2001) and Non-ARDL model developed by **Shin, Yu, and Greenwood-Nimmo (2014**) - that refer to combines a non-linear long run relationship with nonlinear and asymmetric error correction by use of constructed partial sum decompositions- and for model (3) Johansen cointegration test have been considered.

3.3. Trade between Turkey-Germany:

NLARDL long-run relationship:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t$$

Where xt is a k × 1 vector and $x_t = x_0 + x_t^+ + x_t^-$

[5]Based on AIC
[6]Based on Bartlett Kernel

Where x^{pos}_t and x^{neg}_t are partial sum processes of positive and negative changes in xt defined by

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0), x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0)$$

And x^{pos}_t,x^{neg}_t are the related asymmetric long-run elements. error-correction form of the system is as follows:

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta y_{t-j} + \sum_{j=0}^{q} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) + \varepsilon_t ,$$

where null hypothesis ρ = θ pos = θ neg = 0

long-run steady state of the system can be written as follows by the asymmetric cumulative dynamic multipliers:

$$m_h^+ = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \vartheta x_t^+$$
$$m_h^- = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \vartheta x_t^- \quad \text{h= 0, 1, 2, …}$$

where m_h^+ and m_h^- tend toward the respective asymmetric long-run coefficients $\beta^+ = \theta^+ / -\rho$ and $\beta^- = \theta^- / -\rho$, respectively, as $h \to \infty$.

In our case of asymmetric or Non-linear ARDL (NLARDL):

$$\begin{aligned} \Delta TB_{TR-GR} = {} & \alpha_0 \\ & + \sum_{q=1}^{p1} \alpha_{1q} \Delta TB_{TR-GR_{i,t-1}} + \sum_{q=0}^{p2} \alpha_{2q} \Delta RER_{TR-GR,t-q}^{\ pos} + \sum_{q=0}^{p3} \alpha_{3q} \Delta RER_{TR-GR,t-q}^{\ neg} \\ & + \sum_{q=0}^{p4} \alpha_{4q} \Delta GDP_{TR,t-q} + \sum_{q=0}^{p5} \alpha_{5q} \Delta GDP_{GR,t-q} + \\ & + \beta_1 TB_{TR-GR_{i,t-1}} + \beta_2 GDP_{TR,t-1} + \beta_3 GDP_{GR,t-1} + \beta_4 RER^{pos}{}_{TR-GR,,t-1} + \beta_5 RER^{neg}{}_{TR-GR,t-1} \\ & + \varepsilon_t \end{aligned}$$

Because of important rule of real exchange rate on J-curve a, real exchange rate is selected as asymmetric variable in Non-ARDL equation. The results of NARDL model is summarized in Table 3:

Table 3: NARDL (1,0,0,0,1) Long run Coefficients :

Variables	Long Run Coefficients
Y_{GR}	902.8 (0.47)
Y_{TR}	45333 (0.306)
$RER^{POS}{}_{TR-GR}$	1.19×10^{-8}***

	(4.00)
$RER^{NEG}{}_{TR-GR}$	1.44×10^{-9}*** (3.01)
Constant	-2.23×10^{-9} (-1.23)
F-Bounds	5.66*** (upper bound of 1%= 4.37)
ECT[7]$_{-1}$	-0.60*** (-5.38)
χ^2_{Serial}	0.32 (prob.:0.84)
$\chi^2_{RESET,ARCH}$	1.59 (prob.:0.207)
Stability Tests: CUSUM and CUSUMQ	stable

Note: The signs *** represent 1% significance level, and parantes shows t-statistics.

According to results of estimation of NARDL which summarized in Table 3; the error term is negative and less than 2 and at the same time F-Statistics of the bound test is 5.66 which is larger than bound critical value (4.37). The sign of coefficient of both $RER^{POS}{}_{TR-GR}$ and $RER^{NEG}{}_{TR-GR}$ are positive and statistically significant that has been providing the J-Curve effect between Turkey and Germany. The results indicate that devaluation against EURO in Turkey at the long run as/will in favor of Turkey.

3.4. Trade between Turkey-USA:

According to results of Unit Root Test of Table 2, the series related to trade of Turkey and UAS are nonstationary at level and integrated of order one that indicates the series are stationary at I(1). The nonstationary series are integrated of the same order (in our case I(1)) and the residual sequence is stationary; that is, the sequences are cointegrated. This necessitates the estimation of an error-correction model8.

Considering Johansen test if there are r variable or series which all have unit roots, there are at most (r – 1) cointegrating vectors. In our case we have four variable of I(1) series each with unit roots, there are at most three cointegrating vectors. Table 4 shows results of residual based Hansen cointegration tests Phillips and Ouliaris (1990)9 residual-based tests, Hansen's instability test (Hansen 1992)[10] results and Figure 2 shows residual of Hansen Cointegration test.

[7]EC = TB_{TR-GR} - (118968922.9$RER^{POS}{}_{TR-GR}$ + 39287305.5$RER^{NEG}{}_{TR-GR}$+ 902.8369Y_{GR} + 4533311.03Y_{TR} - 2232214994.8).

[8]Enders, W. Applied Econometric Time Series. New York, NY: John Wiley and Sons, 2004.

[9]https://econpapers.repec.org/article/ecmemetrp/v_3a58_3ay_3a1990_3ai_3a1_3ap_3a165-93.htm

[10]https://econpapers.repec.org/article/eeejpolmo/v_3a14_3ay_3a1992_3ai_3a4_3ap_3a517-533.htm

Table 4: Cointegration Test of Model 3 (Hansen Parameter Instability):

	Stochastic	Deterministic	Excluded
Lc_ist	Trends (m)	Trends (k)	Trends (p2)
0.572356	3	0	0

Figure 2 shows cointegration residual of model of trade between Turkey-USA and Table 5 shows optimum lag of the model.

Figure 2: Co-integration residual

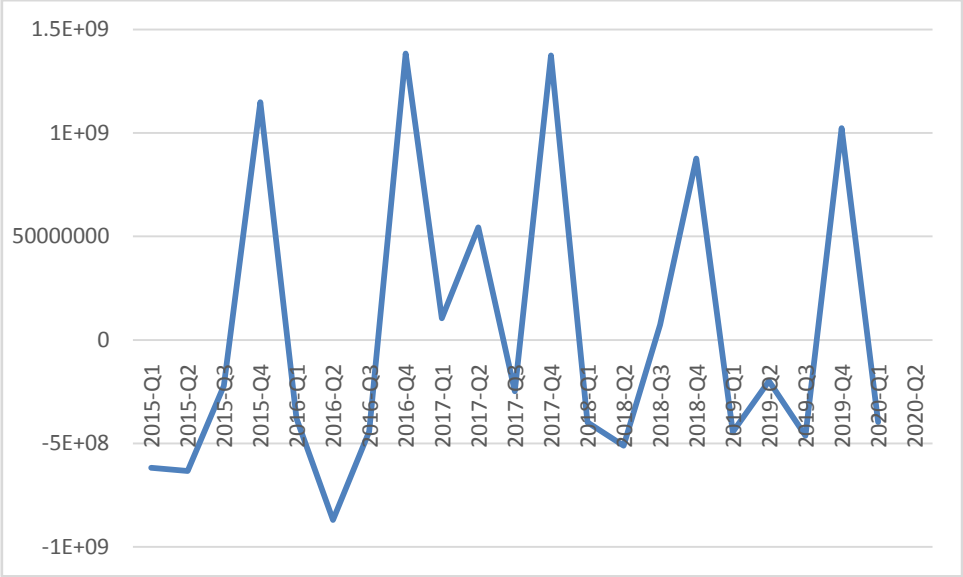


Table 5: Optimum lag of the model.

Lags	Akaike	Schwar	Hannan-Quinn
0	69.557	69.70660	69.61509
1	61.870	62.61367*	62.15608*
2	62.070	63.40904	62.58538
3	62.131	64.06502	62.87529
4	61.926	64.45419	62.89838
5	61.063*	64.18656	62.26468

Note: * represents the sign showing the most optimum lags.

According to Schwar and Hannan-Quinn information criteria the optimum lags of the model is one and by considering Akaike information optimum lags is five. Bye considering size of observations and Table 6, one lag is choose as optimum lags. The result of Johansen cointegrated analysis is summarized in Table 6.

Tablo 6: Results of Johansen veJuselius Cointegration Test[11].

Null hypothesis	Eigenvalue	Trace		Maximum Eigenvalue	
		J_{trace}	Critical Value	J_{max}	Critical Value
H0: r = 0	0.375	48.69	44.49**	26.36	25.12*
H0: r≤ 1	0.208	22.33	27.06	13.11	18.89
H0: r≤ 2	0.151	9.21	13.42	9.20	12.29
H0: r≤ 3	0.0001	0.006	2.70	0.006	2.7

Note:**, *; show the significance level at the 95% and 90% levels, respectively.

According to Table 6; Considering the trace and eigenvalue statistics, one cointegration vector has been determined, and the long-term cointegration equation is given below:

$$TB_{ABD,t} = 80 * 10^9 + 29 * 10^7 Y_{Tür,t} + -64 * 10^5 Y_{ABD,t} + 11 * 10^8 . RER_{ABD,t} + \ell_t \qquad (4)$$

According to equation (4), the coefficient of real exchange rate between the USA and Turkey is positive. The error correction method (VECM) should be applied to determine statistical significance and long-term relationship. The VEC equation is[12]:

$$\Delta \mathrm{TB}_{ABD} = \underset{(-1.90)}{-0.14}\mathrm{EC}_{t-1} \underset{(-1.84)}{-0.25}.\Delta \mathrm{TB}_{ABD-1} + \underset{(0.85)}{620186}.\Delta Y_{ABD-1} +$$

$$\underset{(2.32)}{32*10^6}.\Delta Y_{Tür-1} + 12*10^7 \underset{(0.617)}{.\Delta \mathrm{RER}_{ABD-1}} - \underset{(-1.51)}{13*10^7}$$

As seen in the equation, the error term coefficient (ECT) is negative and less than one, and it is also statistically significant at the 95% significance level. Checking the Breusch-Godfrey Serial Correlation (LM Test) shows, χ^2_{Serial}=1.15 and R2=2.56, indicate that there is no autocorrelation problem in our models. In other words, there are J-Curve effect for foreign trade between the USA and Turkey in the long run. In other words, decrease/devaluation of Turkish Lira will improve Turkey trade balance.

4. Conclusion

This study aimed to investigate J-curve effect of devaluation/decrease of Turkish Lira on bilateral trade between Turkey-Germany and Turkey-USA over the period from 2005Q04-2020Q01. We consider a dataset before outbreak of covid-19 pandemic.Based on integrated degree of series, weemploying Nonlinear Autoregressive Distributed Lag (NARDL) and Johansen-Juselius cointegration approaches. Findings support J-curve phenomenon in both Turkey-Germany and Turkey-USA. Findings are generally similar to the results of previous studies. That means; the devaluation of the Turkish Lira is in favor of Turkey and it has long-run effect on the trade balance between Turkey-USA and Turkey-Germany.

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[11] χ^2_{Serial}=1.19 and LRE*=18.8 shows that no autocorrelation problems were found in this model.
[12] Parentheses show the t-statistic

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