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U.S.-Turkey Commodity Trade and J-Curve Phenomenon: Evidence from 23 Industries

ABD- Türkiye Emtia Ticareti ve J-Eğrisi Fenomeni: 23 Sektörden Kanıt

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ÖZ

Bu makale, reel döviz kurunun Türkiye'nin ticaret dengesi üzerindeki etkilerini toplam ve dağınık düzeyde incelemektedir. 1989-2017 yılları arasında 23 sektörden oluşan bir veri kümesi analiz edilmiştir. Doğrusal ARDL sonuçları, toplam düzeyde J eğrisi fenomeni belirtisi olmadığını doğrulamaktadır. Bununla birlikte, Ulaştırma, Tekstil ve Giyim ve Maden ve Metal endüstrilerinde dağınık düzeyde doğrusal ARDL sonuçları. J eğrisi fenomeni için destek sağlamaktadır. Ayrıca, Türk lirasındaki değer kaybı, uzun vadede çoğu sektör üzerinde olumlu etkiye sahiptir. Bu sonuçlar politika yapıcılara değer düşürme politikasının bazı ticaret ortaklarına karşı ihracatı artırabileceğini ve yurtiçi çıktıları teşvik edebileceğini vurgulamaktadır. Öte yandan, Türk lirasındaki değer kaybının ticari çıkarlar karşısındaki olumsuz sonuçları dikkatle değerlendirilmelidir.

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This paper empirically explores the effects of real exchange rate on Turkey's balance of trade at aggregate and dis-aggregate level. A dataset of 23 industries is analyzed over 1989-2017. Linear ARDL results confirm that there is no sign of J-curve phenomenon at aggregate level. However, linear ARDL results at dis-aggregate level support for J-curve phenomenon in Transportation, Textiles & Clothing and Ores & Metals industries. Furthermore, Turkish lira depreciation has favorable effect on most of the industries in the long-run. These results highlight to policymakers that depreciation policy could increase the exports against some trade partners and promote the domestic outputs. Whilst, one should carefully assess the adverse consequences of Turkish lira depreciation against trade benefits.

1. Introduction

The continuous deficit in trade balance is a source of external vulnerability for a country. A country eliminates the trade deficit through currency depreciation or devaluation thereby attracts academicians and policymakers. Currency depreciation has not been homogenous across the countries; thus, researchers have attempted to improve methods that are harmonized with the most recent literature. In early studies, elasticities of imports and exports have been used to estimate the effects of currency depreciation on balance of trade. While, a trade balance model had formulated in most recent studies, in which trade balance is directly associated with exchange rate and other related variables. Thus, recent approach allowed the researchers to examine effects of currency depreciation on balance of trade. The theory of economics suggests that currency depreciation initially worsens the trade balance but with the passage of time, it

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starts to improve thereby forming the shape of J-letter. The cointegration and error correction methods (ECM) help to catch the dynamics of currency depreciation on balance of trade. The mixed findings were reported about the effects of real exchange rate on balance of trade in the literature of Bahmani-Oskooee and Ratha (2004) and Bahmani-Oskooee and Hegerty (2010).

It reveals in the literature that there is an aggregation bias at different level while using the trade balance data. One group conducted the empirical investigations between Turkey and rest of world. In this group, Bahmani-Oskooee and Alse (1994) who found that devaluation had positive effect on Turkey's trade balance, Kale (2001) who found that balance of trade improved under long-run due to the Turkish lira depreciation and Akbostanci (2004) who found no support of J-curve phenomenon. This group opposed by Rose and Yellen (1989) due to the aggregation bias thereby criticized the studies who used the trade data at aggregate level and proposed to apply the bilateral trade data between two countries. Second group includes those investigations who examined the trade balance at bilateral level between Turkey and her trading partners. This group includes Halicioglu (2008b), who investigated the bilateral J-curve between Turkey and her 13 trading partners (Austria, Germany, Denmark, Holland, Canada, Italy, Belgium, Sweden, Switzerland, France, Japan, UK and USA) and unable to observe the J-curve. Similarly, Bahmani-Oskooee and Kutan (2009), who also unable to discover the J-curve with respect to Turkey.

Bahmani-Oskooee et al. (2016) argued that trade data at bilateral level also suffered from another aggregation bias because different industries between Turkey and her trading partners such as US could respond differently to real exchange rate thereby criticized the second group. Therefore, a dis-aggregate trade data of 23 industries between Turkey and US has considered for the current investigation. Bahmani-Oskooee et al. (2016) explored the trade data at industries level between Pakistan and US to observe J-curve by employing bounds testing approach over the period 1972-2013. They observed no support of J-curve phenomenon under aggregate trade data but dis-aggregate trade data supported the J-curve pattern in 17 cases. Bahmani - Oskooee and Harvey (2018) conducted an empirical study to observe the effect of J-curve in the industries trade between Singapore and Malaysia over the period 1974-2011. The results confirmed that J-curve exhibited in 22 industries. Bahmani-Oskooee et al. (2015) conducted an empirical study to test the J-curve effect at industry level between US and Korea. They employed the ARDL model on the annual data over the period 1971 to 2010 and found the support of J-curve in 24 industries. Bahmani-Oskooee and Xu (2013) attempted to analyze the J-curve at industry level between Japan and China by using annual data from 1978 to 2008. It was confirmed in study's results that J-curve exist in 24 cases out of 73 by specifying the dis-aggregate trade data.

Theoretical literature on trade balance reveals short-run and long-run effects of real exchange rate on trade balance. For instance, Magee (1973) stated that devaluation effects on US trade balance occur through currency contracts, quantity adjustment and pass-through with favorable effect on trade balance under long-run. Himarios (1985) also stated that devaluation improves trade balance. Demirden and Pastine (1995) documented that depreciation shock of exchange rate negatively effect on balance of trade in five-quarter followed by long-lasting favorable improvement. Lal and Lowinger (2002) reported significant effects of real exchange on country's trade balance. Akbostanci (2004) presented the long-run association of real exchange rate with balance of trade. Bahmani-Oskooee and Harvey (2009) found short-run and long-run effects of currency depreciation on balance of trade. Nusair (2016) and Ari et al. (2019) reported that exports could be increased through exchange rate policy of as well as to promote economic growth in long-run.

This paper contributes towards J-curve literature on the impacts of real exchange rate effects Turkey-US balance of trade over the period from 1989 to 2017. The current investigation will be the first study that examines the Turkey-US trade balance at aggregate and dis-aggregate level collectively to bring further evidence. Previous studies that criticized the aggregation bias without analyzing the aggregate trade data, thus current investigation has analyzed both aggregate and dis-aggregate trade data. The Turkish economy has facing the problems of trade deficit from a long time, reaching the peak level in 2011 when trade deficit was USD89.16billion and current account deficit was 8.9% of GDP. Since, short-term capital inflows are mainly used to finance these deficits (Yurdakul and Cevher, 2015) and becoming the root of outer vulnerability, ending with high volatility in exchange rate. The trade deficits are still high (current account deficit 5.1% of GDP on average between 2011 and 2017) despite continuous depreciation of Turkish lira from 2011 to onwards. Moreover, US is an important trade partner that accounts 5.51% in total exports and 5.11% in total imports during 2017. Hence, the current investigation serves as a compelling case study for J-curve literature.

There are few empirical investigations which examined the effects of real exchange rate on Turkey's trade balance at dis-aggregate level but reported mixed findings. Empirical investigations that used aggregate trade data include Brada et al. (1997), Kale (2001), Akbostanci (2004), Halicioglu (2008a), Yazici and Klasra (2010), Celik and Kaya (2010) and Cergibozan and Ari (2018). While, some empirical investigations have used dis-aggregate trade data to examine the connection of real exchange rate with balance of trade. For instance, Bahmani-Oskooee and Durmaz (2016) investigated volatility of Turkish lira on 61 industries by employing the trade data of Turkey with rest of the world and reported impacts of exchange rate volatility in many industries under short-run horizon, which continued in 12 exporting industries and 24 importing industries under long-run horizon. Durmaz (2015) collected the trade data of 58 industries to observe J-curve effect using ARDL cointegration approach. The results indicated that Turkish lira depreciation has substantial influence in 13 industries and observed J-curve sign in 13 industries. Yazici (2006) examined the real exchange rate influence on balance of trade utilizing the agricultural sector and found that results of the study do not follow the J-curve pattern. Yazici also noted that devaluation has unfavorable influence on agriculture's balance of trade under long run. Ari et al. (2019) applied ARDL model developed by Pesaran et al. (2001) employing balance of trade between Turkey and 18 European union member countries. The study's results do not endorse for J-curve phenomenon.

The current investigation adopts the linear ARDL method as in Bahmani-Oskooee et. al, (2017). It uses annual data from 1989 to 2017 and comprises of 23 industries. The empirical investigation explores the influence of real exchange rate on Turkish trade balance with respect to US, because US is noteworthy partner of trade with respect to import expenditures and export revenues. Results of current investigation confirmed that aggregate trade data do not validate the J-curve form that is in line with the outcomes of Halicioglu (2008b) and Bahmani-Oskooee and Kutan (2009). Dis-aggregate balance of trade at industry level confirmed the J-curve in Textiles & Clothing, Ores & Metals and Transportation industries and received the support of J-curve definition as specified by Bahmani‐Oskooee and Harvey (2018). The remaining part is organized in 4 sections; data and methodology are explained in 2nd section, outcomes are presented in 3rd section and concluding remarks in the last section.

2. Data and Methodology

Rose and Yellen (1989) linked the bilateral merchandise balance of trade with real exchange rate, real income of America and trading partners during estimation of US bilateral merchandise balance of trade with her six trading partners (Japan, Italy, Germany, France, U.K. and Canada). Similarly, Bahmani-Oskooee et al. (2019) related the bilateral balance of trade with three main determinants which include real bilateral exchange rate, real income of US and trading partner. Therefore, dis-aggregate balance of trade at industry level between Turkey and US, economic activity in Turkey, economic activity in US and real bilateral exchange rate (RBER) have employed in current investigations. Trade data composed of 23 industries shown in Table 1. Moreover, I restrict myself to annual data over 1989 to 2017 period due to data limitation and its availability at industry level. (Table 1) The main purpose to dis-aggregate balance of trade at industry level is to evade bias of trade aggregation as criticised by Bahmani-Oskooee et al. (2016) because each industry may react differently towards real exchange rate. Thus, trade data will be analyzed at aggregate and dis-aggregate level. Trade data at industry level has collected from World Integrated Trade Solution (WITS). Data of economic activity and consumer price index of Turkey and US has gathered from International Financial Statistics. While, nominal exchange data come from Central Bank of the Republic of Turkey.

2.1. Model specifications

I conform the novel literature, particularly of Bahmani-Oskooee et al. (2017) and assume that industry trade balance for k industry for t time period takes the following arrangement on the basis of their formulations and modifications.

$$\mathrm{lnTB}_{\mathrm{k,t}} = \alpha + \beta \mathrm{ln}Y_t^{TR} + \gamma \mathrm{ln}Y_t^{US} + \delta \mathrm{lnRBER}_t + \varepsilon_\mathrm{t} \quad (1)$$

Where, $\mathrm{TB_k}$ is $\left(\frac{X_k}{M_k}\right)$ that is proportion of Turkey's industry k exports to US against the imports of industry k from US to Turkey and measures industry k's trade balance.[3] Y^{TR} and Y^{US} represent the economic activity in Turkey and US. Real bilateral exchange rate (RBER) is indicated by $\left(\frac{P_{US}\times \mathrm{BER}}{P_{TR}}\right)_t$ where P_{US} and P_{TR} are consumer price index in US and Turkey respectively and BER is bilateral nominal exchange rate.[4] ε_t indicates error term in Eq. (1). RBER is formulated in such a way that an increase in RBER demonstrates real Turkish lira depreciation, if such depreciation is going to enhance industry k's trade balance thereby parameter of δ is assumed to be positive. Industrial production index is used as proxy to measure the Turkey and US economic activities. Turkey imports more from US because of rise in economic activity or from another perspective, US exports more to Turkey. Therefore, estimates of β and γ are assumed as negative and positive respectively.[5] Estimation of Eq. (1) will only give the long-run parameters and will not give the parameters of short run. Therefore, I follow the specifications of Pesaran et al. (2001) to inspect the J-curve pattern. Thus, Eq. (1) takes the following form:

$$\begin{aligned}\Delta \mathrm{LnTB}_{\mathrm{k,t}} = \alpha &+ \sum_{n=1}^{m} \beta_\mathrm{n} \Delta \mathrm{LnTB}_{\mathrm{k,t-n}} + \sum_{n=0}^{m} \gamma_\mathrm{n} \Delta \mathrm{Ln}Y_{t-n}^{TR} \\ &+ \sum_{n=0}^{m} \delta_\mathrm{n} \Delta \mathrm{Ln}Y_{t-n}^{US} + \sum_{n=0}^{m} \theta_\mathrm{n} \Delta \mathrm{LnREER}_{\mathrm{t-n}} \\ &+ \rho_1 \mathrm{LnTB}_{\mathrm{k,t-1}} + \rho_2 \mathrm{Ln}Y_{t-1}^{TR} + \rho_3 \mathrm{Ln}Y_{t-1}^{US} \\ &+ \rho_4 \mathrm{LnRBER}_{\mathrm{t-1}} + \mu_\mathrm{t}\end{aligned} \quad (2)$$

β, γ, δ and θ represents the short-run estimates, while ρ_1-ρ_4 represents the long-run estimates and μ_t indicates error term in equation (2). Kremers et al. (1992) stated that ECM helps to establish the cointegration. The equation of ECM is given as below:

$$\begin{aligned}\Delta \mathrm{LnTB}_{\mathrm{k,t}} = \alpha &+ \sum_{n=1}^{m} \beta_\mathrm{n} \Delta \mathrm{LnTB}_{\mathrm{k,t-n}} + \sum_{n=0}^{m} \gamma_\mathrm{n} \Delta \mathrm{Ln}Y_{t-n}^{TR} \\ &+ \sum_{n=0}^{m} \delta_\mathrm{n} \Delta \mathrm{Ln}Y_{t-n}^{US} + \sum_{n=0}^{m} \theta_\mathrm{n} \Delta \mathrm{LnREER}_{\mathrm{t-n}} \\ &+ \lambda EC_{t-1} + \mu_\mathrm{t}\end{aligned} \quad (3)$$

EC, λ and μ_t represent the residuals, speed of adjustment towards equilibrium and error term. Bahmani-Oskooee and Brooks (1999) described that co-efficient of Eq. (3) could be unstable. Therefore, it is necessary to check the model's stability. Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) are the two famous methods proposed by Brown et al., (1975) to check the model stability. Coefficients are stable, if plot remain inside the critical bound of 0.05 significance level.

2.2. Unit root test

First of all, stationary position of each variable has tested because ARDL model is sensitive to stationary level and restrict to use the time series variable integrated at I(0) or I(1) or I(0)/I(1). There is a possibility of biased results due to the inclusion of I(2) variable thereby making the parameters of long-run unreliable. To that end, Phillips Perron Test (PP) and Augmented Dickey-Fuller Test (ADF) have used to check the unit root of each variable.

2.3. Conintegration test

After the unit root test, F-test has used to find the cointegration. Bahmani-Oskooee and Goswami (2003) argued that F-test is sensitive to lag order. Because, incorrect selection of the lag may lead to bias results. To select optimal lag and avoid bias results, Optimal lags are decided through VAR lag length criteria and adopt the Akaike information criterion (AIC) and Schwarz information criterion (SC). If there is a disagreement between these two criteria then I follow the criteria which has minimum optimal lag.[6] Pesaran et al., (2001) demonstrated that joint significance of lagged variables has been tested through cointegration approach test, which is termed as lagged error-correction term. The null hypothesis for this cointegration is $H_0\colon \rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$ and alternative hypothesis is $H_1\colon \rho_1 \neq \rho_2 \neq \rho_3 \neq \rho_4 \neq 0$. The bound testing approach depends on F-test against the critical values as defined newly by Pesaran et al., (2001).[7] It has two classes where one class presumes that variables are purely integrated at I(0) while another class presumes that variables are purely integrated at I(1). If F-value passes from upper bound, H_0 will be rejected, if it is below from lower bound then cointegration doesn't exist, if it lies in between these two bounds then inconclusive. Instead of Pesaran et al. (2001), critical values produced by Narayan (2005) produced have been used to test the cointegration. Because, Pesaran et al. (2001) produced the critical values which are more suitable for large sample size (T = 500 to 4000). Narayan and Narayan (2005) argued that cointegration decision could be biased if critical values of Pesaran et al. (2001) are used. Therefore, it is appropriate to use critical values produced by Narayan (2005) for small sample size (T = 30 to 80).

2.4. Linear ARDL

Since all variables are integrated at I(1), this study will use the linear ARDL model. ARDL model developed by Pesaran et al. (2001) offer advantages over other methods. Firstly, it gives the coefficients of short-run and long-run simultaneously. Secondly, model is applicable irrespective of underlying variables are integrated at any form excluding I(2). Thirdly, incorporating the short-run adjustment process makes the endogeneity and multicollinearity less problematic. Moreover, Halicioglu (2008a) and Bahmani-Oskooee et. al (2017) also used this method for J-curve.

3. Results and Discussions

It can be seen that variables are stationary at I(1) as reported in table 1. Outcomes of F test in table 3 show that cointegration exist in all commodities except 1-Animal, 2-Vegetable, 3-Minerals, 5-Chemicals, 7-Hides and Skins, 8-Wood, 10-Footwear, 12-Metals and 20-Intermediate goods. After establishing the cointegration, equation 2 has been estimated using aggregate and dis-aggregate trade data.

For brevity purpose and to observe J-curve, I report only short-run estimates. Estimates of short-run and long-run coefficients are mentioned in Table 2, while values of diagnostic results are mentioned in table 3. Estimates of short-run coefficients illustrate that RBER carries significant coefficient in 18 out of 23 industries. The positive coefficients which improve the trade balance significantly for the industries includes 1-Animal, 2-Vegetable, 4-Fuels, 6-Plastic or Rubber, 8-Wood, 11-Stone and Glass, 13-Mach and Elec, 15-Agricultural Raw Materials, 16-Food, 17-Manufactures, 19-Consumer goods, 20-Intermediate goods, 21-Capital goods and 23-Miscellaneous, while following coefficients deteriorate the industry trade balance such as 5-Chemicals, 9-Textiles and Clothing, 14-Transportation, 22-Ores and Metals due to the Turkish lira depreciation. Moreover, overall trade balance with US improves in short-run as indicated by ΔlnRBER. Parameters of long-run attach with LnBRER variable are statistically significant in 16 industries, indicating that industries's trade balance will further improve due to Turkish lira depreciation. Similarly, overall trade balance under long-run improves with US as indicated by LnBRER. Therefore, Turkish lira depreciation has positive influence on most of industries's trade balance under short-run and long-run. Because, Turkish goods become more cheaper and price competitive due to the Turkish Lira depreciation thereby Turkey will export more to US, thereby it turns to improve the trade balance.

Table 1. Unit Root Result (Based on AIC, maxlag = 4)

		ADF Tests		PP Tests		
Variables	Exogenous	Level	1st Difference	Level	1st Difference	Decision
LnRBER	Intercept	-1.78	-5.78**	-1.88	-5.78**	I(1)
	Intercept and Trend	-1.45	-5.71**	-1.70	-5.71**	
LnY^{TR}	Intercept	0.29	-4.29**	0.85	-4.28**	I(1)
	Intercept and Trend	-2.27	-4.35**	-1.92	-4.33**	
LnY^{US}	Intercept	-1.79	-3.77**	-1.74	-3.78**	I(1)
	Intercept and Trend	-1.07	-4.00**	-1.24	-3.95*	
1- Animal	Intercept	-2.07	-6.05**	-2.15	-6.04**	I(1)
	Intercept and Trend	-2.21	-6.33**	-2.18	-6.33**	
2- Vegetable	Intercept	-2.87	-6.40**	-2.78	-7.29**	I(1)
	Intercept and Trend	-2.86	-5.79**	-2.85	-8.13**	
3-Minerals	Intercept	-2.24	-5.10**	-2.32	-5.16**	I(1)
	Intercept and Trend	-2.37	-5.14**	-2.18	-5.21**	
4- Fuels	Intercept	-1.46	-4.82**	-1.66	-4.85**	I(1)
	Intercept and Trend	-1.61	-4.68**	-1.70	-4.72**	
5-Chemicals	Intercept	-2.40	-8.16**	-3.05*	-8.23**	I(1)
	Intercept and Trend	-2.48	-8.04**	-3.07	-8.04**	
6-Plastic or Rubber	Intercept	-3.07*	-6.21**	-3.15*	-7.30**	I(1)
	Intercept and Trend	-3.57	-4.95**	-3.60*	-7.75**	
7- Hides and Skins	Intercept	-2.98*	-4.75**	-3.04*	-4.74**	I(1)
	Intercept and Trend	-2.94	-4.90**	-3.50	-4.91**	
8- Wood	Intercept	-2.25	-5.86**	-2.26	-5.82**	I(1)
	Intercept and Trend	-2.19	-5.73**	-2.29	-5.70**	
9- Textiles and Clothing	Intercept	-1.02	-6.96**	-1.44	-6.94**	I(1)
	Intercept and Trend	-2.55	-6.83**	-2.50	-6.82**	
10- Footwear	Intercept	-1.12	-6.41**	-1.09	-6.73**	I(1)
	Intercept and Trend	-3.21	-6.23**	-3.33	-6.44**	
11- Stone and Glass	Intercept	-2.57	-7.79**	-2.49	-8.06**	I(1)
	Intercept and Trend	-1.46	-7.87**	-2.16	-8.90**	
12- Metals	Intercept	-2.99*	-2.61	-1.95	-6.00**	I(1)
	Intercept and Trend	-3.19	-2.61	-1.78	-5.97**	
13- Mach and Elec	Intercept	-2.45	-6.08**	-1.02	-6.06**	I(1)
	Intercept and Trend	-1.69	-5.10**	-2.16	-5.99**	
14- Transportation	Intercept	-1.23	-12.75**	-2.25	-11.86**	I(1)
	Intercept and Trend	-1.04	-12.59**	-3.18	-12.20**	
15- Agricultural Raw Materials	Intercept	-2.17	-1.44	-2.09	-7.15**	I(1)
	Intercept and Trend	-2.69	-2.03	-2.68	-9.98**	
16- Food	Intercept	-3.32*	-7.33**	-3.29*	-9.02**	I(1)
	Intercept and Trend	-3.20	-7.33**	-3.24	-12.28**	
17-Manufactures	Intercept	-1.56	-2.86	-1.69	-5.42**	I(1)
	Intercept and Trend	-1.65	-2.82	-1.80	-5.32**	
18-Machinery and Transport Equipment	Intercept	-0.91	-8.94**	-1.19	-8.70**	I(1)
	Intercept and Trend	-1.28	-8.76**	-2.29	-8.55**	
19- Consumer goods	Intercept	-1.68	-5.51**	-1.69	-5.51**	I(1)
	Intercept and Trend	-1.72	-5.52**	-1.70	-5.52**	
20- Intermediate goods	Intercept	-2.42	-7.42**	-2.38	-7.42**	I(1)
	Intercept and Trend	-2.81	-7.27**	-2.81	-7.27**	
21-Capital goods	Intercept	-0.92	-8.05**	-1.29	-7.63**	I(1)
	Intercept and Trend	-1.31	-7.87**	-2.18	-7.49**	
22- Ores and Metals	Intercept	-1.51	-3.88**	-1.37	-3.85**	I(1)
	Intercept and Trend	-1.85	-3.80*	-1.59	-3.77*	
23-Miscellaneous	Intercept	-0.71	-5.75**	-0.63	-9.66**	I(1)
	Intercept and Trend	-3.08	-5.59**	-3.11	-9.42**	
$24\text{-}TB^{US}$	Intercept	-2.80	-1.96	-1.79	-5.35**	I(1)
	Intercept and Trend	-2.75	-1.93	-1.78	-5.25**	

**,* indicates significance level at 1 and 5 per cent respectively.

Parameters of long-run coefficients are validated through establishing the cointegration. Long-run cointegration has been validated through F-test. I also tried t-test as an alternative approach to validate estimates of long-run coefficients as recommended by Pesaran et al. (2001). The alternative approach is ECM, a significant and negative value attached to ECM is another way to support cointegration. The effort yield for further support of cointegration in 1-Animal, 2-Vegetable, 3-Minerals, 5-Chemicals, 7-Hides and Skins, 8-Wood, 10-Footwear, 12-Metals and 20-Intermediate goods thereby didn't futile. The real economic activity for US carries significant coefficient in 14 industries under long-run. While the coefficient is significant positive in 12 industries which include 4-Fuels, 8-Wood, 11-Stone and Glass, 12-Metals, 13-Mach and Elec, 14-Transportation, 17-Manufactures, 18-Machinery and Transport Equipment, 19-Consumer goods, 20-Intermediate goods, 21-Capital goods and 23-Miscellaneous and significant negative in 2 industries which include 9-Textiles and Clothing and 15-Agricultural Raw Materials.

Table 2. Coefficients Estimates of Short-run and Long-run under ARDL Model

Commodity (Criteria, Optimal lag)	Estimates of Short run				Estimates of Long run			
	ΔlnRBER_t	$\Delta \text{lnRBER}_{t-1}$	$\Delta \text{lnRBER}_{t-2}$	$\Delta \text{lnRBER}_{t-3}$	Constant	LnBRER	LnY^{TR}	LnY^{US}
1-Animal (SC, 1)	2.15(2.44)*				-26.63(-1.38)	6.44(1.61)	3.00(1.20)	1.66(0.36)
2-Vegetable (SC, 1)	1.10(2.79)**				-3.07(-1.08)	1.49(2.74)**	1.10(2.39)**	-0.89(-1.01)
3-Minerals(AIC, 4)	4.50(1.38)	-2.53(-0.80)	-1.74(-0.64)	2.22(0.88)	-5.90(-1.03)	7.70(4.90)**	0.14(0.05)	0.26(0.08)
4-Fuels (AIC, 4)	3.16(3.39)**				-50.06(-4.76)**	4.91(2.65)**	-5.09(-6.99)**	14.68(5.92)**
5-Chemicals (SC, 1)	-0.18(-0.30)	-1.82(-1.92)	0.03(0.05)	-2.00(-2.93)*	-11.75(-2.63)**	-0.25(-0.25)	1.39(0.63)	0.82(0.29)
6-Plastic or Rubber (AIC, 4)	3.97(4.36)**	-1.96(-1.611)			-5.24(-1.06)	1.50(2.31)*	0.021(0.04)	0.51(0.40)
7-Hides and Skins (SC, 1)	-0.05(-0.11)				-8.01(-0.73)	-0.16(-0.11)	1.05(0.88)	0.99(0.35)
8-Wood (SC, 1)	1.46(3.03)**				-24.70(-5.04)**	2.76(2.84)**	0.18(0.24)	4.00(2.56)**
9-Textiles and Clothing (AIC, 4)	-1.83(-2.40)	-4.41(-6.92)**	-2.42(-3.50)*	-2.66(-7.61)**	3.07(2.61)**	3.24(9.06)**	0.94(2.044)	-1.83(-3.53)**
10-Footwear (SC, 1)	2.01(1.79)				-32.16(-2.47)**	-2.79(-1.61)	-2.69(-1.07)	10.06(2.04)
11-Stone and Glass (AIC, 4)	1.67(2.30)*	1.17(1.32)			-25.43(-5.91)**	2.94(2.25)*	-2.89(-5.77)**	8.26(7.97)**
12-Metals (AIC, 4)	3.41(1.97)	-2.85(-1.35)	-3.25(-1.88)	1.87(1.20)	-24.25(-9.12)**	3.91(5.52)**	-1.74(-2.03)	6.29(5.52)**
13-Mach and Elec (AIC, 4)	0.17(0.64)	1.04(3.66)**	0.81(2.74)**	0.83(3.29)**	-21.36(-15.20)**	-0.67(-1.93)	-0.32(-0.99)	4.74(9.01)**
14-Transportation (AIC, 2)	1.22(1.08)	-2.54(-2.33)*			-48.64(-16.18)**	1.47(2.25)**	-1.02(-2.05)	11.17(12.12)**
15-Agricultural Raw Materials (SC, 1)	1.29(2.17)**				7.26(2.01)	1.72(2.54)*	0.70(1.18)	-3.38(-3.04)**
16-Food (SC, 1)	0.95(2.86)**				0.001(0.001)	1.19(2.67)*	1.01(2.81)**	-1.30(-1.88)
17-Manufactures (SC, 1)	0.87(3.96)**				-15.94(-5.27)**	1.91(2.74)*	-0.47(-1.11)	3.58(4.37)**
18-Machinery and Transport Equipment (SC, 1)	0.54(1.25)				-30.59(-12.32)**	0.57(1.08)	-0.11(-0.22)	6.40(7.78)**
19-Consumer goods (SC, 1)	1.47(4.95)**				-14.21(-7.20)**	1.82(4.32)**	-1.47(-4.74)**	4.42(7.29)**
20-Intermediate goods (SC, 1)	0.76(2.20)*				-11.60(-4.24)**	1.07(2.09)**	0.04(0.11)	2.19(2.70)**
21-Capital goods (SC, 1)	1.12(3.19)**				-29.50(-16.07)**	1.03(2.93)**	-0.31(-1.12)	6.22(11.46)**
22-Ores and Metals (AIC, 4)	-2.28(-1.84)	-7.36(-4.39)**	-3.12(-2.98)*	1.03(1.16)	-7.62(-1.77)	4.75(8.11)**	-0.59(-0.96)	1.11(0.82)
23-Miscellaneous (AIC, 4)	1.63(1.60)	4.48(2.68)*	3.01(2.54)*	2.04(2.54)*	-23.49(-12.20)**	-0.89(-1.67)	-1.25(-1.46)	5.96(5.39)**
24-TB^{US} (SC, 1)	1.01(5.03)**				-12.82(-5.07)**	2.19(3.50)**	-0.23(-0.58)	2.56(3.52)**

Values inside the parenthesis represent t-ratios.
**,* indicates significance level at 1 and 5 per cent respectively.

The reason is that when US economy grows, it will improve the US ability to produce more close substitute goods thereby reducing the imports from Turkey. Similarly, real economic activity for Turkey is significant positive in two industries and significant negative for 4-Fuels, 11-Stone and Glass and 19-Consumer goods.[8] It is because, Turkey imports more from US and exports less due to lower production of close substitute goods. Results documented that J-curve does not exist in aggregate trade data thereby consistent with the results of Halicioglu (2008b). But, dis-aggregate trade data at industry level between Turkey and US confirmed he J-curve phenomenon in the following industries such as 9-Textiles and Clothing, 14-Transportation and 22-Ores and Metals thereby received the support of new J-curve definition. Empirical investigations conducted by Bahmani-Oskooee and Xu (2013), Bahmani-Oskooee et al. (2015), Bahmani-Oskooee et al. (2016), Bahmani-Oskooee and Harvey (2018) also confirmed the J-curve phenomenon in dis-aggregate trade data.

Table 3. Diagnostic statistics of ARDL Model

Commodity	Diagnostic statistics								
	F	ECM_{t-1}	χ^2_{LM}	χ^2_{RESET}	χ^2_H	Normality	CM	CMQ	ADJ.R^2
1-Animal	3.27	-0.33(-3.84)*	2.1	0.04	0.46	0.61(0.73)	S	S	0.36
2-Vegetable	4.02	-0.73(-4.86)*	1.14	0.07	0.18	0.82(0.66)	S	S	0.45
3-Minerals	3.7	-1.28(-5.39)**	1.65	5.59	2.87	0.33(0.84)	S	S	0.71
4-Fuels	5.69*	-0.64(-6.23)**	2.75	1.22	0.63	1.41(0.49)	S	S	0.76
5-Chemicals	3.18	-0.44(-4.79)**	0.03	7.47**	0.56	1.40(0.49)	S	S	0.86
6- Plastic or Rubber	4.72*	-1.48(-6.09)**	5.66	4.35	2.01	0.53(0.76)	S	S	0.79
7-Hides and Skins	3.33	-0.34(-4.43)**	0.15	0.19	0.22	0.09(0.95)	S	S	0.48
8-Wood	3.92	-0.52(-4.79)**	0.11	2.39	0.19	0.41(0.81)	S	S	0.42
9-Textiles and Clothing	17.92**	-1.28(-12.22)**	2.19	0.244	0.56	0.36(0.83)	S	S	0.96
10-Footwear	3.62	-0.35(-4.64)**	0.32	0.01	0.42	1.85(0.39)	S	UnS	0.49
11-Stone and Glass	5.44*	-0.98(-6.38)**	2.14	4.8	1.36	0.51(0.77)	S	S	0.90
12-Metals	3.17	-1.93(-5.34)**	1.32	0.06	0.29	2.42(0.29)	S	S	0.82
13-Mach and Elec	5.51*	-0.87(-6.13)**	0.25	1.66	1.22	0.82(0.66)	UnS	UnS	0.82
14-Transportation	13.16**	-1.42(-8.96)**	2.51	0.1	1	2.90(0.23)	S	UnS	0.79
15-Agricultural Raw Materials	5.10*	-0.74(-5.51)**	0.71	0.77	0.53	3.37(0.18)	S	S	0.55
16-Food	5.01*	-0.79(-5.42)**	1.02	0.07	0.45	1.78(0.41)	S	S	0.52
17-Manufactures	6.57*	-0.45(-6.21)**	1.13	2.11	1.15	0.001(0.99)	S	S	0.58
18-Machinery and Transport Equipment	7.10**	-1.03(-5.34)**	3.01	1.24	1.88	0.62(0.73)	S	S	0.55
19-Consumer goods	8.47**	-0.81(-7.05)**	0.84	1.62	0.51	1.40(0.49)	S	S	0.64
20-Intermediate goods	3.9	-0.70(-4.78)**	0.06	0.1	0.25	3.75(0.15)	S	S	0.45
21-Capital goods	9.39**	-1.07(-7.45)**	4.01	0.08	1.38	5.96(0.05)	S	S	0.68
22-Ores and Metals	9.21**	-1.45(-8.03)**	0.03	0.45	2.24	0.48(0.78)	S	S	0.79
23-Miscellaneous	6.95**	-1.54(-7.61)**	2.89	2.43	0.91	0.20(0.90)	S	UnS	0.76
24-TBUS	7.15**	-0.46(-6.48)**	0.3	0.15	0.84	0.26(0.87)	S	S	0.60

**,* indicates significance level at 1 and 5 per cent respectively.

CM and CMQ represent CUSUM and CUSUMSQ where S represents stable and UnS represents unstable.

F-test is used for cointegration purpose and critical values for upper bound are 6.760 and 4.663 at 1% and 5% significance level (k =1), 6.265 and4.428 at 1% and 5% significance level (k =2) and 5.840 and4.223 at 1% and5%significance level (k =4). These values taken from Narayan (2005) due to the small sample size.

The values of ECM inside the parenthesis are t-ratios. The Banerjee et al. (1998) provided the critical values for small sample size which are -4.12 and -3.35 at 1% and 5% significance level (k =1), -4.53 and -3.64 at 1% and 5% significance level (k =2) and -5.27 and -4.18 at 1% and 5% significance level (k =4).

χ^2_{LM} and χ^2_{RESET} are attributed to LM and Reset tests with one degree of freedom and **, * represents 1 and 5 per cent significance level respectively.

I used the lagged level variable ECM_{t-1} to check the models equilibrium or dis-equilibrium position. A significant and negative value attach with ECM_{t-1}, will indicate the long-run adjustment toward equilibrium position and coefficient estimate will indicate speed of adjustment. All the models have negative value of ECM_{t-1}, indicate convergence towards equilibrium positions. The variables in industries like 12-Metals adjust faster and those as of 1-Animal adjust slowly.[9] Adjusted R^2 indicates which model is good fit. Some additional diagnostic tests are also reported to support the outputs. These include Lagrange Multiplier test (LM), Ramsey's RESET, Jarque–Bera, Breusch Pagan Godfrey, CUSUM and CUSUMSQ tests. Lagrange Multiplier test with one degree of freedom is attributed to χ^2_{LM}. LM test is insignificant in all cases which indicating residuals are free from auto-correlation. Ramsey's RESET test is attributed to χ^2_{RESET} with one degree of freedom. The values show that there is no issue with respect to model mis-specification except 5-Chemical industry. Breusch Pagan Godfrey test is used to see the heteroskedasticity which is attributed to χ^2_H, as can be seen in table 3 that all the models have insignificant value which reject the heteroskedasticity issue. Jarque–Bera test is implemented to see whether residuals are normally distributed or not, results in table 3 show that all the residuals are normally distributed. Model stability has been tested through CUSUM and CUSUMSQ tests. S indicates stable model while UnS indicates unstable. All the models are stable except 13-Mach and Elec industry as of CUSUM. However, CUSUMSQ indicated that all the models are stable except 10-Footwear, 13-Mach and Elec, 14-Transportation and 23-Miscellaneous.

4. Conclusion and Policy Implications

Previous studies that observed the Turkish's J-curve pattern are criticized because of aggregation bias, for the reason that each industry may react differently towards currency depreciation. Segregation of trade data at industry level could help to reduce such bias. In this empirical investigation, I have examined the effects of real exchange rate on bilateral trade balance between Turkey and US at industry level. Previous studies had criticized the aggregation bias without analyzing the aggregate trade data thereby current investigation analyzed both aggregate and dis-aggregate trade data. When I estimated linear ARDL model for aggregate trade data, there was no evidence for J-curve phenomenon. However, when I estimated linear ARDL model for dis-aggregate trade data at industry level, I found a significant support for J-curve phenomenon in Transportation, Textiles & Clothing and Ores & Metals industries. Moreover, there was no precise shape in other industries. The favorable effect lasted in Vegetable, Minerals, Fuels, Plastic or Rubber, Wood, Textiles and Clothing, Stone and Glass, Metals, Transportation, Agricultural Raw Materials, Food, Manufactures, Consumer goods, Intermediate goods, Capital goods & Ores and Metals under long-run. Overall, Turkish trade balance improves due to lira depreciation in short-run and long-run. Hence, it is recommended to policymakers that depreciation policy could be used for increasing the exports against some partners and promote the economic growth. However, adverse consequences of Turkish lira depreciation should be carefully assessed against trade benefits.

Notes

[1] Bahmani-Oskooee and Wang (2008) argued that aggregation bias reduced by employing disaggregate trade data at industries level.

[2] For J-curve theory and its literature, see Magee (1973), Bahmani-Oskooee and Ratha (2004) and Bahmani-Oskooee and Hegerty (2010).

[3] Bahmani-Oskooee (1991) argued that such ratio allows the researcher to formulate the model in log form due to the nature of unit-free measure.

[4] Bahmani-Oskooee et al. (2019) demonstrated as with the development of such exchange rate reflects the real depreciation of domestic currency due to increase in exchange rate.

[5] Bahmani-Oskooee and Wang (2008) explained that with the rise of real income leads towards more imports thereby causing negative trade balance.

[6] Due to limited data, minimum number of lags are imposed i.e.29. Davenport (1996) demonstrated that incorporating the more lags cause more degree of freedom to loss. Cointegration is a concept of long run thereby follows long spans instead of more observations (Hakkio and Rush, 1991). Therefore, 29 annual observations are as good enough as 116 quarters observations.

[7] Pesaran et al. (2001) provided the critical values for large sample. Banerjee et al. (1998) introduced the Error-correction mechanism and produced the critical values for small samples thereby used in this empirical investigation.

[8] For the estimates of long-run coefficient in real economic activity, Turkey carries significant coefficient in 5 commodities and for US in 15 commodities. The coefficients of real economic activity could be negative and positive (Bahmani-Oskooee et al., 2019).

[9] Commodities such as 9-Textiles and Clothing has a coefficient value of -1.28, in which almost 60 percent adjustment will take place within 6-months.

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