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THE EFFICIENCY OF MANUFACTURING TRADE BETWEEN TURKEY AND THE EUROPEAN UNION

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ABSTRACT

In this study, the manufacturing trade efficiency of Turkey with the European Union-25 (EU-25) is examined by applying stochastic frontier gravity model over the period of 2006–2016. In addition, this study is analyzed whether there is a convergence in efficiency of manufacturing trade between Turkey and the EU-25. Findings show that Turkey's average trade efficiency score is 56,3% and it ranged from 0,01% to 92,5% for all countries. Manufacturing trade flow of Turkey is significantly affected by income, market size of the trading partner and the distance between them. The findings also suggest that trade flows are affected by the global financial crisis.

Keywords: *Efficiency, Stochastic Frontier Analysis, Gravity Model, Foreign Trade, Turkey, the European Union*

JEL Codes: *F10, F14*

TÜRKİYE-AVRUPA BİRLİĞİ ARASINDAKİ İMALAT SANAYİ TİCARETİ ETKİNLİĞİ

ÖZ

Bu çalışmada, Türkiye'nin Avrupa Birliği-25 (AB-25) ile imalat sanayi ticaret etkinliği, 2006-2016 döneminde stokastik sınır çekim modeli uygulanarak araştırılmıştır. Ayrıca, Türkiye ile AB-25 arasındaki imalat sanayi ticaretinin etkinliğinde bir yakınsama olup olmadığı incelenmektedir. Bulgulara göre, Türkiye'nin ortalama ticaret etkinliği % 56,3 ve tüm ülkeler için % 0,01 ile % 92,5 arasında değişmektedir. Türkiye'nin imalat sanayi ticaretini; ticaret ortaklarının geliri, pazar büyüklüğü ve aralarındaki uzaklık önemli ölçüde etkilemektedir. Tahmin sonuçları, ticaret akımlarının küresel finansal krizden etkilendiğini de göstermektedir.

Anahtar Kelimeler: *Etkinlik, Stokastik Sınır Analizi, Çekim Modeli, Dış Ticaret, Türkiye, Avrupa Birliği*

JEL Kodu: *F10, F14*

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1. INTRODUCTION

Efficiency is basically described as the rate of the actual output to the potential output. Since the potential output is an unobservable magnitude, it should be estimated by quantitive techniques (Zhang et al., 2013: 654-655). In this context, the potential trade, and the factors through which this potential can be increased are addressed within the framework of trade efficiency.

Deterministic and stochastic approaches are widely used in the estimation of efficiency. Factors such as bad weather, any measurement or recording error are regarded as inefficiency in the deterministic approach, whereas in the stochastic approach, these random factors which are independent of the economic units, are decomposed from inefficiency (Kalirajan and Shand, 1999). In this context, the distinguishing feature of this study is the use of a stochasticfrontier analysis for the measurement of potential trade. In addition, it is also questioned whether Turkey is able to converge to the potential level of foreign trade.

Turkey's total trade volume with the EU-25 countries was about 79 billion euros in 2006, 144 billion euros in 2016. These volumes are %43 and %47 of Turkey's total trade volumes respectively. Thus, Turkey's manufacturing trade with the EU-25 almost consist of total trade with them.. In this study, Turkey's bilateral manufacturing trade with the EU-25 countries is analyzed for the period of 2006-2016. Country-specific trade efficiency scores and trade potentials are estimated. Finally, the reasons for under-efficiency discussed and policy recommendations have introduced.

The basic aim of this study is to estimate the efficiency of trade. For this purpose, Turkey's bilateral manufacturing trade with the EU-25 has been analyzed by using two main methods in the literature. These are, firstly, the stochastic frontier analysis (SFA) technique that estimates efficiency and secondly the gravity model that analyzes bilateral trade by using factors such as distance, Gross Domestic Product (GDP), common border, common economic integration etc. The remainder of this paper is organized as follows. The next section clarifies theoretical and conceptual framework that contains the gravity model, efficiency concept and the linkage between them. The third section reviews the literature. The fourth section focuses on the model and the data set. Fift section handles and reports empirical findings. Finally, last section reveals concluding remarks and policy implications.

2. THE STOCHASTIC FRONTIER GRAVITY MODEL: THEORETICAL FRAMEWORK

The pioneer economists that have implemented the gravity model to study international trade flows were Tinbergen (1962) and Pöyhönen (1963). In recent years, the gravity model has become popular in quantitive trade analysis. The model has been applied to flows of various types like migration, foreign direct investments and especially to international trade flows. Using gravity models, exports between countries are explained by their economic sizes (Gross National Products (GNP) or Gross Domestic Products (GDP)), populations, distances, and variety of dummies associating many form of institutional options common to specific flows (Zarzoso, 2003: 176).

Anderson (1979) was the first to develop a strong theoretical basis of the gravity model. In his model, products are diversified by their place of origin, also called the Armington assumption. Armington (1969) allocates goods not only by their type (e.g. chemicals, electronics, textile product etc.) but also by their place of production (Starck,2012: 7).

Anderson's gravity equation can be represented as:

$$M_{ijk} = \propto_k Y_i^{\beta k} Y_J^{\gamma k} N_i^{\varepsilon k} N_j^{e k} d_{ij}^{\mu k} U_{ijk} \qquad (1)$$

where M_{ijk} is the flow of goods or factors k from region or country i to region or country j, Y_j and Y_i are incomes in j and i; N_j and N_i are populations in j and i, and d_{ij} is the distances between regions (countries) i and j. The U_{ijk} is a lognormally distributed error term (Anderson, 1979: 106).

The fundamental natural logarithmic linear gravity model used in analysis of trade is revealed in equation 2:

$$\ln F_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta 3 \ln (Dist_{ij}) + \mu_{ij} \qquad (2)$$

where, F_{ij} indicates the trade flows between countries, β_0 is the country-pair fixed effects including all unobservable factors that affect trade, GDP_j and GDP_i are respectively gross domestic products of impoter and exporter, $Dist_{ij}$ is the distance between economic centers or capitals, and μ_{ij} is the error term. β_0, β_1, β_2 and β_3 are coefficients to be estimated (Greene, 2013:8).On the other hand, researchers generally use augmented-gravity model to consider different factors effects on trade.Depending on the research area, researchers add variables such as; physical land area, population density, rates of exchanges, market access, tariffs and

non-tariffs barriers, trade openness, common culture, common language, contiguity, common economic integration etc. to their analyses.

Based on the methodology of Kalirajan (2008), stochastic frontier technique for the prediction of the gravity models has been used. Additionally, the study questions whether there is a convergence to the potential trade with Turkey's partners. The main hypothesis of the study is ; "there is a gap between Turkey's actual and potential trade volumes and this gap is decreasing per annum". Based on this, by estimating the efficiency of Turkey's manufacturing trade, making a comparison between the EU- 25 countries, the paper aims to contribute to policy formation for the improvement of the trade efficiency.

According to Kalirajan (2008); following a stochastic frontier technique, the gravity equation can be inscribed as (Demir et. al, 2017: 3):

$$X_{ij} = f(Z_i; \beta) + \varepsilon_{it} \quad (3)$$

$$\varepsilon_{it} = v_{it} - u_{it}$$

$$u_{it} = G(t)u_i$$

$$v_{it} \sim N(0, \sigma_v^2)$$

$$u_{it} \sim N^+(\mu, \sigma_u^2)$$

where; X_{ij} refers to the export of the country i to country j and Z_i's refers to the factors of potential trade. The error term is dissociated into two pieces ($v_{it} - u_{it}$) .The v_{it} piece is the random error term, which makes the frontier stochastic; where the u_{it} piece refers to inefficiency.

"Maximum likelihood" method is generally the predictor of stochastic frontier gravity models. When expressed with logarithmic terms, the rate of the real trade volume to potential trade volume gives the efficiency level (exp ($-u_i$));

$$\exp(-u_i) = \frac{X_{ij}}{f(Z_i;\beta)+\exp(v_i)} \quad (4)$$

(exp ($-u_i$)) is a value between 1 and 0. If the value is equal to 0, there is no inefficiency, so this means that the observed trade volume is equal to potential trade volume. If this value is greater than 0 but is less than or equal to 1, this indicates the presence of inefficiency ($0 < (\exp(-u_i)) \leq 1$) (Demir et. al , 2017: 3).

3. LITERATURE, EMPIRICAL MODEL AND THE DATA

Here in this part, the papers searching the trade efficiency within the framework of gravity model have been introduced by using stochastic frontier technique in a chronological order. This study is distinct from others in the literature on the ground that it is the first one using the stochastic frontier gravity model on the Turkish manufacturing industry trade. Empirical literature review of the stochastic frontier gravity model is presented at the Appendix 1. This section presents some literature on bilateral trade between Turkey andEU under panel data concept. Adam and Moutos (2008) find some asymmetric effect on the trade between EU-15 and Turkey. Bayar et.al. (2015) indicate that Turkish industrial productivity affecting Turkey's industrial export. Kalaycı and Artan (2010) research the effect of custom union on trade. Results shows that export of Turkey increase more than its import. Antonucci and Manzocchi (2006) suggested that economic size of economies effect trade between EU and Turkey. Akyuz et. al. (2010) shows that Turkey has more potential trade volume with EU countries regarding the field of forest product industry. Ulengin et.al. (2015) indicate that trade barriers have a significantly negative effect on Turkish exports via road transportation. Nowak-Lehmann et. al. (2007) express that a rise in Turkish real effective exchange rate led to a significant increase of Turkish exports in all sectors. Magee (2016) investigates trade creation or diversion effects of tariffs and custom unions. It concludes that the custom union has generated more than twice as much trade creation as trade diversion. Togan (2004) finds that accessing the EU will increase trade potential. Akbostancı et al. (2016) reveal that custom unions do not affect Turkey's exports. Aysan and Hacıhasanoglu (2007) indicate that the main factor behind the Turkish export growth after 2000 is productivity. Frede and Yetkiner (2017) find that custom union has a positive effect on Turkish imports but negative on exports. Akan and Balin (2016) finds that custom union agreements do not change trade patterns. Akkoyunlu (2006) et. al. investigates the impact of custom union agreement is only recognizable in the intra-industry trade. Arvas and Iç (2008) find the effect of real exchange rate in EU-Turkey trade significant and positive.

Bilici et. al. (2008) and Lejour and Mooij (2005) are the other studies that investigate the effect of custom union agreement on EU- Turkey trade with panel gravity regression techniques. All these studies indicate that market size, productivity and trade diversion effects of tariffs are factors that influence EU- Turkey trade. In our study we also find the same viewpoint; gross

domestic product as a productivity, population as a market size and trade freedom index as tariffs are all statistically significant.

Folowing Greene (2013), stochastic frontier gravity equation can be estimated as::

$$\text{Ln } EXP_{ij}^{t} = \alpha_0 + \alpha_1 \text{ Ln } GDP_i^t + \alpha_2 \text{ Ln } GDP_j^t + \alpha_3 \text{ Ln } POP_i^t + \alpha_4 \text{ Ln } POP_j^t + \alpha_5 \text{ Ln } TFI_i^t + \alpha_6 \text{ LnTFIjt} + \alpha_7 \text{ Ln DISTANCE}_{ij} + \alpha_8 \text{ CONTIGUITY} + \alpha_9 \text{ YEAR} + \exp(v_{ij}^t) + \exp(-u_{ij}^t)$$

Table 1. The Descriptive Statistics of The Variables

Variables	Observation	Mean	S.D.	Minimum	Maximum
Ln EXP_{ij}^t	550	20.27	1.97	10.85	23.82
Ln GDP_i^t	550	26.77	1.30	22.63	28.98
Ln GDP_j^t	550	26.77	1.30	22.63	28.98
Ln POP_i^t	550	16.99	1.52	12.91	18.22
Ln POP_j^t	550	16.99	1.52	12.91	18.22
Ln TFI_i^t	550	4.44	0.025	4.39	4.47
LnTFIjt	550	4.44	0.025	4.39	4.47
Ln $DISTANCE_{ij}$	550	7.43	0.40	6.32	8.08
CONTIGUITY	550	0.04	0.196	0	1
YEAR	550	2011	3.16	2006	2016

A panel data set is designed in the framework of bilateral manufacturing goods trade with Turkey and the EU-25 countries for the years 2006-2016. Ln EXPijt is manufacturing export between country i to j for t year and ensured from Worldbank (World Integrated Trade Solutions) and United Nation web pages. Ln GDP_i^t and Ln GDP_j^t are gross domestic products of trade partners for t year. GDPs are obtained from Worldbank web page. Ln $DISTANCE_{ij}$ are the distances between trade partners and ensured from CEPII (Centre de recherche français dans le domaine de l'économie internationale). Ln POP_i^t and Ln POP_j^t are populations of trade partners for t year. POPs are obtained from Worldbank web page. Ln TFI_i^t and Ln TFI_j^t are trade freedom indices of trade partners for t year. Trade freedom indices are obtained from Heritage Foundation. Trade Freedom Index_i = (((Tariff_{max} – Tariff_i)/(Tariff_{max} – Tariff_{min}))*100) – NTB_i where Tariff_{min} and Tariff_{max} show the lower and upper limits for tariff rates (%); and Tariff_i shows the country i's weighted average tariff rate (%). The minimum tariff is naturally zero percent, and the upper limit was set as 50 percent. An NTB (Non-Tariff

Barriers) penalty is then subtracted from the base score. CONTIGUITY is the dummy variable shows that the two countries have border. YEAR is year fixed effects in the regression to use year dummy control time specific effects separately and prevent misleading results. The descriptive statistics of the variables presented in this paper are given in Table 1.

4. EMPIRICAL FINDINGS

This stage of the study consists of two parts. Firstly, maximum likelihood based regression estimates of stochastic frontier are introduced. Secondly, country specific trade efficiency scores are acquired by using Jondrow- Lowell et. al. (1982) formula.

4.1. Estimation Results of the Stochastic Frontier Gravity Model

The maximum likelihood estimation results of the stochastic frontier gravity model and standart panel gravity model for 2006-2016 period are shown in Table 2.

The Hausman Test is used to decide wheter fixed effects and random effects predictors are to be used in panel data models. For this reason, the Hausman Test has been applied to determine which of the fixed effects and random effects predictors should be used in the model (Tekin and Hancıoğlu, 2017:29).

Table 2. Results of the Stochastic Frontier Gravity Model

Variables	Stochastic Frontier Gravity Regression	Panel Gravity Random Effect Regression
Constant	16.6 (0.97)	29.89 (1.49)
Ln GDP_i^t	0.85 (12.40)**	1.22(6.53)**
Ln GDP_j^t	0.48 (6.56)**	1.06(5.67)**
Ln POP_i^t	0.21 (3.22)**	-0.06(-0.36)
Ln POP_j^t	0.29 (3.98)**	-0.14(-0.74)
Ln TFI_i^t	4.00 (3.06)**	-0.85(-0.51)
LnTFIjt	-3.92 (-3.08)**	-6.6(-3.95)**
Ln $DISTANCE_{ij}$	-0.72 (-6.93)**	-0.2(-0.67)
CONTIGUITY	-1.25 (-7.21)**	-0.4(-0.69)
YEAR	-0.01 (-1.69)*	-0.01(-1.36)
σ^2 (u)	5.72 (2.26)*	R^2= 0.71
σ^2 (v)	0.36 (0.027)**	Prob > F = 0.000
γ	15.59 (2.53)**	F/Wald Statistic = 268.63
LOGLIKELIHOOD	-622.27	

Notes: 1- $\gamma=\sigma^2$ (u)/ σ^2 (v) 2- σ^2 (u)the variance of the efficiency 3 - σ^2 (v) The variance of the random error term 4- () values in parentheses are z scores. 5-* significance at 10%, ** significance at 1%

One important feature of the panel data is that it allows to control unobservable variables and to take into account the heterogeneity. The data used in the study study, includes variables that do not change over time, such as distance, neighborhood, or common colonial. These variables are unique to specific entities within the panel and must be associated with other properties. The error terms are likely to correlate with these time-invariant variables, and therefore it is reasonable not to select fixed effects (Kumar and Ahmed, 2015:237).

The theoretical logic for the idea that bilateral trade depends on the GDPs comes from the works of Helpman and Krugman (1985). The countries with the largest GDP's trade more. This is because exporting countries' higher levels of GDP imply more space for promoting exports based on their comparative advantages. In addition, for the importers higher income reflects more economic power for importing goods and services. GDP is anindicator for the size of the economy. The coefficients for the GDPs in the regression are therefore expected to have a positive effect in both exporting and importing countries (i.e. $\alpha_1 \geq 0$ and $\alpha_2 \geq 0$ to confirm that the bigger the economy, the higher the trade becomes) (Sumani,2015: 52). Accordingly, we estimate a significant and positive coefficient for the GDP of Turkey and its partners.

The distance variable is significant and negative in accordance with the theory. The greater the distance between the two countries, the more transport costs tend to rise, and consequently reducing the volume of trade; hence, it is expected that $\alpha_7 < 0$ or the expected sign for the distance coefficient for trade is negative (Sumani, 2015: 53).

The impact of population on trade can be either positive or negative in the literature. In our model we estimate a positive and significant coefficient for population. Yang and Martinez-Zarzoso (2013) states that a greater population in an importing country facilitate imported goods to compete better with domestic goods and balances exporters for the cost of sales activities abroad. This indicates economies of scale and supports the country to trade more with foreign partners in a larger set of goods (Sumani, 2015: 52).

The classical goal of economic integration is to clear obstacles such as tariffs to trade. This means openness to the flow of goods and services across geographical border with simplify (Sumani, 2015: 53). In this study trade freedom indices have a significant and positive effect for exporters, while negative for importers. Random effects models indicates that trade freedom coefficient of importer countries is also negative and significant. Therefore it can be stated that tariffs may damage the import flow of goods.The common border coefficient was negative and statistically significant. Considering that only Turkey and Greece have a common

border in the data set, it may be expected that the sign of this coefficient will be negative.The year dummy is significant and negative. Depending on the time span of data set, we think that global financial crisis that have an impact on Euro area affect the trade flow negatively.

4.2. Trade Efficiency Scores

Trade efficiency scores were acquired using the results of our Stochastic Frontier Gravity model. Estimated efficiency scores on Turkey's export and import for the years 2006-2016 are presented in Appendix 2. Jondrow- Lowell et. al. (1982) formula is used in the estimation of Country-specific efficiency scores. Jondrow- Lowell et. al. (1982) have proposed the following formula;

$$E(u|\varepsilon) = \sigma_v \left[\frac{f(A)}{1-F(A)} - A\right],\ A = {}^{\varepsilon}/_{\sigma_v} + \sigma_v/\sigma_u \qquad (5)$$

Country specific technical efficiency scores (TE_i)are calculated as follows;

$$(TE_i)=\exp[E(u_i I \varepsilon_i)] \qquad (6)$$

Efficiency is estimated to be 56.3 percent on average, minimum 0.01 percent, and maximum 92.5 percent. Country-specific efficiency scores are presented in Appendix 2.

Efficiency scores show some remarkable points. 20 of countries in the data for export and 15 countries for import efficiency scores decrease from 2008 to 2009. It is pointed that global financial crisis has effects on trade.

Countries that have over the average level of efficiency in all years' export scores are Belgium, Germany, France, Britain, Greece, Netherlands, Spain and Malta. They are countries that have larger Turkish heritage population other than Malta and Spain.

Turkey's export to transition economies like Lithuania, Latvia, Estonia, Hungary, Slovakia, Slovenia, Czech Republics, Poland are increasing at the end of the period. For example Turkey's export to Latvia in 2006 has efficiency score % 28.1 but in 2016 it is 59.6 %. Market integration process and interrelations with Turkey have a power on this trade growth.

Between 2006 and 2016 , the efficiency of Turkey's export to Belgium, Germany, Spain, Britain, Slovenia have estimated above %80. This situation reveals the status of relations with former members of Turkey.

5. CONCLUSION

Using a combination of efficiency and gravity concepts, this paper analyzes Turkey's manufacturing trade with the EU-25 countries. Following the introduction, the gravity model and the stochastic frontier analysis has been discussed. Estimation results are then presented and finally bilateral trade efficiency scores for each country are estimated for the 2006-2016 period. Overall efficiency is calculated to be 56.3 percent on average, maximum 92.5 percent and minimum 0.01 percent. The estimation of individual and mean trade potential suggest that Turkey and the EU-25 countries can substantially expand both imports and exports among themselves if they can minimize various behind and beyond the border constraints.

Manufacturing trade flow of Turkey is significantly affected by income, population, tariffs, common border and the distance. The estimation results also suggest that trade flows are affected by the global financial crisis. Given the result, several insights are suggested:

-A positive and significant coefficient on the GDP variable means that the countries with the largest GDP's trade more. Therefore, growth-oriented policies can help expand trade potential in the long term. These growth-oriented policies are able to achieve a new frontier with high-tech technologies. Depends on endogenous growth model countries will increase their research and development expenditures.

-Population variables which show the economies of scale are positive and significant. This finding apparently reflects the necessity of policies towards the improvement of human capital to increase trade flows.

-Negative and significant year variable for the global financial crisis implies that Turkey's trade is affected negatively by the crisis. Therefore, monetary and fiscal policies to reduce internal fragility could help minimize the effects of negative externalities posed by the globalization related factors. As a result, macroeconomic stability is necessary for countries.

Finally, in today's world trade wars, trade diversion effects of tariffs and non-tariff barriers are inevitable. In order to reduce the trade deflector effect of these obstacles, it is necessary not to go beyond the rules set forth by the World Trade Organization.

The study have some limitations like data availability.. For further studies researchers may expand the analysis on the sub-sectors of manufacturing, by using sociological variables such as Turkish heritage population in these countries.

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Appendix 1. Summary of the Studies on Stochastic Frontier Gravity Model of Trade

Author/Date	Data Set	Findings
Kang and Frattianni (2006)	177 country Years: 1975,1980, 1985,1990,1995,1999	Significant increases in global trade flows can be achieved by relative low-efficiency countries converging to the performance of high-efficiency countries.
Kalirajan and Singh (2008)	China and India's 74 partners Years: 2000-2013	By including the convergence theory to the analysis, they put forward the necessary policies to India to reach China's efficiency scores level.
Armstrong, Drysdale and Kalirajan (2008)	East and South Asian countries Years: Averages of 1993-1995, 1996-1998, 1999-2001, 2002-2004	East Asia's trade efficiency lower than North America and Europe. South Asia's trade shifted to East Asia and China. Reduction of trade restrictions by some countries had a positive impact on their trade performance.
Armstrong and Drysdale (2009)	65 countries Years: 1980-2006	Trade efficiency scores are ranged between %50 and %80.
Salim, Kabir and Mawali (2011)	GCC(Gulf Cooperation Council) countries and their main trading partners, Years: 1980-2008	Council's trade enhancing effect is significant but potential trade is still high among the members.
Khan and Kalirajan (2011)	Pakistan's trade partners. Years: 1999 and 2004 (separately).	Looking for trade costs impact on export. Results show that reduction of export because of trade costs.
Danquah, Barimah and Ohemeng (2013)	ECOWAS (Economic Community of West African States) Countries Years: 1970-2010	Regional associations increase efficiency scores.
Koh (2013)	Brunei Darussalem's 40 trading partners. Years: 2000-2011	Export and import efficiency scores are %25 and %56 respectively. Because of cross-border effects efficiency levels are low.
Geda, Mosisa and Asefa (2013)	China-52 African Countries. Years; 2001-2008	In particular, They found that commodity demand surge from China may lock African countries in the traditional commodities export sector and result in diminished manufacturing export opportunities.
Sanyal, Brady and Vurgin (2013)	China's REE (rare earth elements) trade with world. Years: 2001-2009	Cross-border constraints and implicit cross-border trade constraints affected China's REE trade both in positive and negative ways
Roberto and Edgardo (2014)	Philippines's 69 trading partners. Years: 2009-2012	Efficiency scores ranged between %38 and 42% and is lover against larger markets (USA, China and Japan) which means there is much greater potential trade with the aforementioned countries.
Ravishankar and Stack (2014)	14 EU and 3 EFTA (European Free Trade Area) member countries trade with the10 former Eastern bloc countries which are members of the EU Years: 1994-2007 (Transition period)	Increasing efficiency of trade between Western Europe and the Eastern Bloc are emphasized. They also noted increasing effect of free trade agreements on efficiency.

Bhattacharya and Das (2014)	SAARC (South Asian Association for Regional Cooperation Organization) member countries, Years: 1995-2008	Low trade efficiency scores between members. Most significant factor for these low scores is cross-border constraints.
Miankhel, Kalirajan and Thangavelu (2014)	Australia's 65 trading partners. Years: 2006-2008 (4 sectoral level)	Even in the case of Australia, which is a developed country, 'behind the border' factors are important in explaining the reasons for its failure to export to its full potential.
Ahsan and Chu (2014)	Bangladesh's environmental goods export with 41 partner countries.Years: 2001-2007	Reducing 'explicit beyond the border' constraints by partner countries aided Bangladesh in attaining positive export growth
Drysdale and Armstrong (2014)	177 countries. Years: 2000-2011	Relationship between Japan and China has a great role on trade efficiencies.
Effendi (2014)	Indonesia's 25 main partners. Years: 2002-2011	Indonesian government should promote more exports with ASEAN (Association of Southeast Asian Nations) countries to accomplish the objectives of the Asian Free Trade agreement declaration two decades ago.
Sayavong (2015)	Laos's 32 trade partners Years: 2001-2011	Half of the countries in the study efficiency scores in trade are high; in another half they don't reach the desired levels the reasons are behind the border restrictions and real exchange rates.
Viorica(2015)	27 EU and 8 non-Eu countries Years: 2001-2008	North European industrialized countries have higher efficiency scores, crisis has not significantly changed trade patterns and hierarchies between EU countries, only lowered trade performances.
Waheed and Abbas (2015)	Bahrain's 31 trading partners. Years: 1994-2013	Real exchange rates, GCC and free trade agreement with United States are factors to promote Bahrain's exports.
Miankhel (2015)	Pakistan's total and sectoral trade with partners from all over the world. Years: 2006-2008 and 2009-2011	Pakistan needs to develop its institutional capacity to promote competitive exports given the explicit and implicit beyond the border trade barriers it faces and work to remove political obstacles to regional trade
Armstrong (2015)	65 countries, Years: 1990-2006	East Asian countries performance better than South Asian countries.
Atif, Haiyun and Mahmood (2016)	Pakistan's agricultural exports with 63 countries, Years: 1995-2014	Technical efficiency estimates reveal that Pakistan has great export potential with neighboring, Middle Eastern and European countries.
Nguyen and Kalirajan (2016)	India's environmental goods export with 11 partner countries, Years: 1996-2010	Environmental goods export was negatively affected by 'behind the border' constraints such as weak infrastructure and institutions

Nasir and Kalirajan (2016)	Group of Asian countries at the selected sectors level. Years: 2002-2008	High efficiency scores for East Asian countries.
Tamini, Chebbi and Abbasi (2016)	North African countries national and 9 products level data.Years: 2001-2012	In agricultural and textile products efficiency scores are very low. The countries in the analysis have to improve their trade logistics at the national level to enhance trade efficiency and to implement trade facilitation reform programs.
Kalirajan and Liu (2016)	RCEP(Renewable Energy Trade within Regional Comprehensive Economic Partnership) Countries Renewable Energy Trade datas. Years: 2006-2014	*First study in literature using meta-frontier gravity model. Non-tariff barriers, institutional and technological differences play a major role in trade.

Appendix 2. Turkey- EU-25 Countries Bilateral Manufacturing Trade: 2006-2016 Period Annually Efficiency Scores

CODE1	CODE2	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TUR	AUT	36	40.5	31.3	30.1	28.7	35.5	32.6	31.8	37.1	37.3	39.9
AUT	TUR	54.2	45.6	58	52.9	53.8	53.4	54.1	56.2	53.2	54.2	50.9
TUR	BEL	69	76.3	69.7	71.3	69.8	76.4	74.5	75.7	80	81.1	81.1
BEL	TUR	82.8	77.1	81.4	77.8	80	82	81.9	82.1	79.7	79.2	77.5
TUR	CYP	85.6	82.4	71.7	67.8	75.2	71.7	70.2	70.2	0.03	0.04	0.01
CYP	TUR	3.7	3.2	3.1	1.9	2.3	2.8	4	2	0.1	0.1	0.1
TUR	CZE	32.1	47.1	35.5	30.9	40.6	47.7	40	37.1	45.4	48.2	50.2
CZE	TUR	67.6	70.7	75.6	74.8	77.1	79.8	83.4	86.6	85	85.8	86.9
TUR	DEU	81.3	84.2	77.6	75.1	77.7	81	79.4	78.2	82.1	82.4	83.5
DEU	TUR	75.5	68.4	75.8	72.9	74.3	77.3	76.8	78.2	73.9	77.4	76.8
TUR	DNK	69.6	74.8	56.7	49.9	52.1	56.9	59.9	56.6	64.7	64.3	67
DNK	TUR	40.7	35.4	45.8	42.5	40.4	37	38.5	40.5	47.4	49.5	54.9
TUR	ESP	78.4	82.1	66.9	62.2	69	71.1	69	69.5	76	80.1	82
ESP	TUR	66.3	54.9	62.4	61.7	66.1	70.2	68.8	72.6	67.8	72.4	72.3
TUR	EST	46.2	46.7	72.1	50.1	39	53.1	62	64.5	63.2	52.7	68.3
EST	TUR	16.1	7.2	9.8	14.2	22	78.2	66.7	71.9	68.1	85.6	78.4
TUR	FIN	39.4	39.6	24.1	15.2	21	23.2	21	21	26.1	23	27.3
FIN	TUR	82.1	74.1	76.7	72.1	76.7	76.7	74.4	74.3	69.3	71.6	68.8
TUR	FRA	69.6	70.6	58.1	64.2	60.4	63.3	58.5	56.2	61	62.8	65.3
FRA	TUR	64	60.3	69.4	68.6	68.7	66.7	66.3	62.7	60.4	64.8	63.3
TUR	GBR	81.2	84	75.7	73.5	76.7	78.1	77.6	77.9	81.5	82.7	82
GBR	TUR	42.5	29.7	38.3	35.2	36.7	37.2	35.6	39.8	33.1	31.7	36
TUR	GRC	84	84.3	78.4	73.7	66.1	67.2	60.7	61.2	71.4	71.6	75.6
GRC	TUR	40.3	38	53.9	49.2	56	63.9	60.5	63	67.2	65.7	58.5
TUR	HUN	39.1	57.4	34.2	28.2	26.4	29	29.9	35.1	40.3	47.3	54.4
HUN	TUR	83.4	75.6	75.1	76.8	78.6	76.3	71.6	73	71.4	77.4	76.9
TUR	IRL	72.1	74.7	62.3	36.8	40.5	39.6	38.9	39.7	51.9	52.3	55.3
IRL	TUR	78	69.7	80.8	81.6	80.3	76.5	78	75.4	74.5	70.7	68.6
TUR	ITA	68.1	65.1	48.1	47.3	60.2	65.8	56.3	55	60.5	65.5	71.2
ITA	TUR	62.3	61.8	70	65.2	59.5	63.1	63.3	63.1	58.9	62.2	62.9
TUR	LTU	45.7	56.8	35.1	28.7	40.8	49.8	47	60.1	58.2	58.9	51.6
LTU	TUR	53.9	19.7	8.3	9.8	17.5	9.6	46.4	21.4	16.6	20.2	30.2
TUR	LUX	12.2	38.5	18.8	7.7	9.6	18.2	17	14.3	17.3	12.8	22.4
LUX	TUR	66.6	68.3	65.2	54.5	61.4	67.9	64.7	56.8	55.6	77.7	60.3
TUR	LVA	28.1	34.2	19.6	16.5	17.3	30.5	31.4	35.3	51.3	53.3	59.6
LVA	TUR	4.3	1.8	3.6	4.5	8.6	10.5	25.7	18.4	18	21.1	26.6
TUR	MLT	86.7	91.8	92.5	92.1	88.4	90.1	61.3	85.1	75.3	71.5	62.4
MLT	TUR	47.7	68.7	60.2	67.5	81.5	44.3	61.6	74.2	40.3	34.7	24.8
TUR	NLD	76.8	80	69.3	60.4	63.6	71.8	70.3	68.9	73.4	75.3	78.8
NLD	TUR	59.5	47.1	56.5	52.7	54.5	62	58	57.6	55	58.1	52.2
TUR	POL	40.1	49.2	34.6	36.6	36.2	40.9	41.5	43.3	53.6	57.1	64.8
POL	TUR	54.1	40.4	51.1	56.9	61.7	65.6	64.1	63.4	58.9	64.6	68.9
TUR	PRT	67.4	64.5	45.4	40.2	45.4	42.8	43.1	53.2	52.7	58.4	65.9
PRT	TUR	52.8	39.7	51.1	47.3	51.9	58.3	62.3	66	60.7	66.1	65.8
TUR	SVK	21.4	36.4	24.3	21.3	43.5	36.5	33.5	35.6	40.9	53.6	38.4
SVK	TUR	74.2	72.8	82.8	84.1	83.8	80.7	80.3	84.1	79.4	81.1	82.2
TUR	SVN	71.4	78.8	74.4	77.4	55.1	77.3	73.8	77.4	81.5	84.9	86.8
SVN	TUR	72.3	62	69.6	73.1	73.5	75.4	75.3	74.7	72.5	80.3	76.3
TUR	SWE	54.9	45.9	39.4	42.5	46.7	53.5	51.7	47.7	57.2	57.3	60.3
SWE	TUR	69.2	69.1	71	75.7	67.9	65.7	65.3	61.3	57.1	56.4	52.9

Notes: Code1: Exporter Countries ISO Codes, Code 2: Importer Countries ISO Codes, Year: Years, AUT: Austria, BEL: Belgium, CYP: Cyprus, CZE: Czech Republic, DEU: Germany, DNK: Denmark, ESP: Spain, EST: Estonia, FIN: Finland, FRA: France, GBR: United Kingdom, GRC: Greece, HUN: Hungary, IRL: İreland, ITA: Italy, LTU: Lithuania, LUX: Luxembourg, LVA: Latvia, MLT: Malta, NLD: Netherlands, POL: Poland, PRT: Portugal, SVK: Slovakia, SVN: Slovenia, SWE: Sweden. The logic of reading trade efficiency scores: for example; Turkey's Export to Austria in 2006 has an efficiency score of 36 %. Observed export is 560.312.963 dollars. Potential Export is (100*(Observed Export))/36. So it is 1.556.424.897 dollars.