TAMAMLAYICILIK İNDEKSİ ÇALIŞMASI: TÜRKİYE ÖRNEĞİ

Aydın ÇELEN[1], Ayşe DEMİREL[2]

Öz

Bu çalışma, Türkiye'nin ticari yapısını bilimsel bir şekilde ele alarak anlamayı amaçlamaktadır. Buradaki kantitatif soru, Türkiye'nin ticaretinin partnerleriyle ne derece uyumlu olduğudur. Bunun için, literatür taraması sonucunda erişilen ve bir ülke pazarının diğer ülke pazarlarıyla ne kadar örtüştüğünü ölçmek amacıyla oluşturulmuş endeksler üzerinde çalışılmaktadır. Hepsi tek tek ele alınıp birbirleri ile karşılaştırması yapılmaktadır. Her birinin kendine has avantaj ve dezavantajları olan endekslerin yalnız bir tanesini uygulamaktan kaçınarak, hepsinin bir kombinasyonu olan yeni bir endeks üretilmektedir. Elde edilen ilgili verilerin bahsi geçen indeks üzerinde uygulamaya konulması sonucu Türkiye'nin 2011-2015 yıllarında; Kuveyt, Suudi Arabistan, Özbekistan, Katar ve Avusturya ile en üst düzeyde tamamlayıcı ticaret yapısına sahip iken; Singapur, Malta, Yunanistan, Hindistan ve Japonya ile en düşük düzeyde tamamlayıcı ticaret yapısına sahip olduğu ortaya çıkmaktadır. Bu çalışmayı önemli kılan faktör ise, Türkiye'nin ticaret tamamlayıcılığı üzerine yapılan ilk çalışma olmasıdır.

Anahtar Kelimeler: Ticaret, Ticaret Tamamlayıcılık Endeksi, Türkiye
JEL Sınıflandırması: F14, F10, F17

A COMPLEMENTARITY INDEX STUDY: THE CASE OF TURKEY

Abstract

This paper aims to understand the trade structure of Turkey in a scientific base. The empirical question is how much compatible Turkey's trade is with its partners. After a literature review, we work through the indices created to gauge a market's complementarity with another and evaluate the appropriateness of these indices by examining each and making a comparison between them. Rather than relying upon one of them -of each has its own pros and cons-, we create a new index which is a combination of other indices found in the literature. In the end, by applying the related trade data to the concept, calculations show that, for the period throughout 2011 and 2015 in general, Turkey has the highest complementary trade structure with Kuwait, Saudi Arabia, Uzbekistan, Qatar and Austria while Singapore, Malta, Greece, India and Japan emerge as the partner countries with the lowest complementarity with Turkey. The most important feature of this study, after all, is its being the first searching about the trade complementarity of Turkey.

Keywords: Trade, Trade Complementarity Index, Turkey
JEL Classification: F14, F10, F17

[1] . *Assoc. Prof. Dr., İstanbul Commerce University, Faculty of Business, Department of Economics, acelen@ticaret.edu.tr. Director, Center for Foreign Trade Research (TEDAM) ORCID: 0000-0001-6415-0129,*
[2] . *Researcher, Center for Foreign Trade Research (TEDAM), ademirel@ticaret.edu.tr, ORCID: 0000-0002-2309-1705,*

DOI; 10.18092/ulikidince.328464
Makalenin Geliş Tarihi (Recieved Date): 14/07/2017
Yayına Kabul Tarihi (Acceptance Date): 10/10/2017

1. Introduction

There are reasons of trade partner selection among all countries. These reasons can be listed as: geographical proximity, special institutional and historical ties, lesser trade costs and preferences etc. But the most accentuated reason in the international trade literature is the diverse product bundles of two countries. It is hypothesised that a country is inclined to export the product groups in which it is rich and inclined to import the product groups which it is deprived of -at least in comparative terms-. Therefore; the more different the product bundles of two countries are, the more likely they trade between each other. This reasoning is especially effective in complementarity trade type rather than competitive trade type which we do not discuss here.

In this respect, some economists work on this subject and find some indices to be able to measure the compatibleness of countries to trade. These indices aim to find how much a product type a country exports is imported by another country. By combining rates of every product types, these indices appear as a number showing complementarity ratio of two countries' product bundles. This way, they give a measurement of similarity between one country's export and the other's import structure. Therefore, in a complementary trade model they can be seen as a probability of trade.

With the help of these indices, we can compare the trade intensity of two countries according to their trade compatibility. If the relation between them is found to be loose, it means that further studies need to be done to examine the excuses so that action can be taken to clear the way. Moreover, when the complementarity is high, it is also expected that a successful trade arrangement may occur between them. In this respect, this can also be suggestive for politicians. (Shinyekwa and Othieno, 2013).

Little empirical work to capture Turkey's trade structure has been done until far. Particularly about complementarity/similarity between Turkey's export and its partners' imports; to be able to meet the deficit, after a literature review, we measure the indices for Turkey with it partner trading countries. This way, we can also make reasonable comments about the external trade of Turkey.

2. Complementarity Indices

Following a literature review, we detect six trade complementary indices proposed and applied in several studies. Now, we explain each of them one by one.[3]

2.1. COS Index

COS index originates from the mathematical cosine formula which is used to find the angle between the two vectors. The intuition behind cosine formula can be applied in order to calculate the proximity of export and import vectors of two countries in k-dimensional commodity space. (Linnemann and Beers, 1988)

$$COS_{ij} = \frac{\sum_{k=1}^{K}\left[X_{ik} \times M_{jk}\right]}{\sqrt{\left[\sum_{k=1}^{K} X_{ik}^{2} \times \sum_{k=1}^{K} M_{jk}^{2}\right]}} \quad (1)$$

In this specification, i refers to the target country, j refers to trade partners and k is the commodity group. Then X_{ik} stands for the total export of country i in k commodity group, M_{jk} stands for the total import of country j in k commodity group while k=0,1,2,…k. It is obvious that COS value ranges from 0 to 1. When the index is 0, the export composition of home country and the import composition of trade partner country are so different that they do not overlap at all and the vectors X_{ik} and M_{jk} are orthogonal. When the index is 1, they match fully (Linnemann and Beers, 1988).

[3] *Different names and abbreviations may be used for the same complementary indices in different studies. For this reason, we try to adopt the most common usage of an index, if possible. If not, we rename them.*

That is to say, when COS is 0, either X_{ik} or M_{jk} is 0 and it is probable that two countries have similar export shares and a competitive trade structure against each other. When it gets bigger, the complementary trade structure increases and when finally it becomes 1, country i's export and country j's import shares identical and the trade structure between them is perfectly complementary. Therefore, COS is the degree of trade complementarities. One step further, we can also say that COS index shows the factor endowment differences between countries, because traded commodities can reflect the factor endowments (Huot and Kakinaka, 2007).

2.2. EIS Index

Another measure for trade complementarity of two countries is EIS index which is a derived version of Finger and Kreinin's (1979) export similarity index and Grubel-Lloyd's S index (1975). While the S index of Finger and Kreinin is made up to measure export similarities of two countries (exports of i with exports of j), EIS is used for export-import similarity of two countries. Moreover, while the S index covers trade with a particular importer only, EIS refers to all foreign trade. EIS is also related to the Grubel-Lloyd intra-industry trade index (exports of i with imports of i). Furthermore, Aquino's amended version of it is pretty much like EIS index (Linnemann and Beers, 1988).

$$EIS_{ij}=\sum_{k=1}^{K}\min\left(\frac{X_{ik}}{\sum_{k=1}^{K}X_{ik}},\frac{X_{ik}}{\sum_{k=1}^{K}X_{ik}}\right) \quad (2)$$

In this formula, X_{ik} is the export vector of country i and M_{ik} is the import vector of country j. But here, for each k commodity, export vector is divided by total export vector of all commodities for country i and the import vector is divided by total import vector of all commodities for country j. And then between them, the smaller one is selected for commodity k so as to sum up over commodity k. Here, the selection of the smaller one represents overlap and complementarity. EIS is also between 0 and 1 (Linnemann and Beers, 1988)

2.3. TCI Index

Another index measuring overlap of export profile of relevant country and import profile of its partners is TCI of Drysdale (1982). The original equation is multiplied by 100 so that the result ensues in percental. Nevertheless we prefer not to. In this way, similar to other indices, TCI takes values between 0 and 1. This indicator provides the information of how much export set of industries from the source country matches with the import set of industries from the destination country. The more the index is high, the more the countries' export-import profiles match better (Castro, 2012).

$$TCI_{ij}=1-\left(\sum_{k=1}^{K}\left|\frac{X_{ik}}{\sum_{k=1}^{K}X_{ik}}-\frac{M_{jk}}{\sum_{k=1}^{K}M_{jk}}\right|\right)\div 2 \quad (3)$$

In this specification, i is the exporting country, j is the partner country and k is the categories of goods. Firstly, the sum of the absolute value of the difference between the sectoral export shares of source country and the sectoral import shares of the destination country is taken and divided by 2 so that the result ends up to be a number between 0 and 1.Then subtracting this number from 1 reverses the sign. Index equals 1 when export supply of exporter country (i here) perfectly matches the import needs of importer country (j here).Conversely it gets 0 when there is no overlap between sectoral composition of country i's exports and sectoral composition of country j's imports. (Shinyekwa and Othieno, 2013).

2.4. S Index

An alternative similarity index measured in terms of Euclidean distance "S" is normally used in Geostatistics and in Biostatistics and measured as; (Somerfield, 2008)

$$S=1-\frac{\sum_{k=1}^{K}|x_{ik}-m_{ik}|}{\sum_{k=1}^{K}(x_{ik}+m_{ik})} \quad (4)$$

In this specification, $X_{ik}=X_{ik}/\sum_{k=1}^{K}X_{ik}$ is export share of country i in sector k and $m_{jk}=M_{jk}/\sum_{k=1}^{K}M_{jk}$ is import share of country j in sector k. Although the paper written by Benedicts and Tajoli (2007) uses this index to measure the similarity between two countries' export shares; it is possible to convert it as an index measuring the similarity between export shares of one country and import shares of another. Here, the second term (the ratio between two sums) represents the distance (dissimilarity) between the two variables (export share of country i in sector k and import share of country j in sector k) so that all equation gives the similarity between them, and takes values between 0 and 1. (Benedictis and Tajoli, 2007)

In addition to these indices, there are other complementary indices derived in the literature. These are the traditional measure of Pearson's correlation coefficient "COR" and the complementarity index taking account of the closeness of countries' commodity trade structures relative to world trade structure "C".

2.5. COR Index

The traditional measure of the degree of association between two variables is Pearson's coefficient of correlation. With the term which is generated by the help of means and standard deviations of the two variables, we get the strength of the linear association between them. In our study, at any given point in time between years 2011 and 2015, the two variables are vectors of sectoral export and import shares respectively $x_i \equiv [x_{i1}, \dots x_{ik}, \dots x_{iK}]$ and $m_j \equiv [m_{j1}, \dots m_{jk}, \dots m_{jK}]$ with $0 \leq x_k \leq 1$ and, $0 \leq m_k \leq 1$ where $X_{ik}=X_{ik}/\sum_{k=1}^{K}X_{ik}$ is export share of country i in sector k and $m_{jk}=M_{jk}/\sum_{k=1}^{K}M_{jk}$ is import share of country j in sector k. Under this specification, the coefficient of correlation is defined as follows (Benedictis and Tajoli, 2007):

$$COR=\frac{\sigma_{xm}}{\sigma_x\sigma_m}=\frac{\sum_{k=1}^{K}\left(x_{ik}-\frac{\sum_{k=1}^{K}x_{ik}}{K}\right)\left(m_{jk}-\frac{\sum_{k=1}^{K}m_{jk}}{K}\right)}{\sqrt{\sum_{k=1}^{K}\left(x_{ik}-\frac{\sum_{k=1}^{K}x_{ik}}{K}\right)^2}\sqrt{\sum_{k=1}^{K}\left(m_{jk}-\frac{\sum_{k=1}^{K}m_{jk}}{K}\right)^2}} \quad (5)$$

2.6. C Index

C complementarity index is proposed by Drysdale (1969) and it is different from all other indices in one way. This divergence is expressed by Drysdale (1969) as: "Complementarity is often used loosely to describe the extent to which countries have dissimilar resource endowments and structures of production and are therefore likely to trade intensively with each other. In this paper the concept is defined in a very precise way. It is employed in a relative sense and measures the extent to which one country's export pattern matches another country's import pattern more closely than it matches the pattern of world imports. An index of the degree of complementarity in bilateral trade can be derived to measure exactly the extent to which country i's exports to country j are relatively large because the commodity composition of i's exports matches that of j's imports more closely than it matches the commodity composition of world trade. It follows that for each pair of countries, in a multi-country, multi-commodity world, there are two measures of

the degree of complementarity in bilateral trade, one derived from the flow of i's exports to j and the other from the flow of j's exports to i."[4] (p.323)

$$C_{ij}=\sum_{k}\left(\frac{X_i^k}{X_i}\times\frac{M_w-M_i}{M_w^k-M_i^k}\times\frac{M_j^k}{M_j}\right) \quad (6)$$

C index is composed of the R_{ik} (an index of country i's specialization in the export of commodity k) and D_{jk} (an index of country j's specialization in imports of commodity k). (Drysdale, 1969)

$$R_i^k=\left(\frac{X_i^k}{X_i}\right)\Big/\left(\frac{M_w^k-M_i^k}{M_w-M_i}\right) \quad (7)$$

where X_i^k is i's exports of commodity k, X_i is i's total exports, M_w^k is world's imports of commodity k, M_i^k is i's imports of commodity k, M_w is world's total imports and M_i is i's total imports.

The index of export specialization provides a measure of the extent to which country i exports relatively more or less of commodity k than all other exporters on average (Drysdale, 1969).

$$D_j^k=\left(\frac{M_j^k}{M_j}\right)\Big/\left(\frac{M_w^k-M_i^k}{M_w-M_i}\right) \quad (8)$$

where M_j^k is j's imports of commodity k, M_j is j's total imports and all other terms are as defined above.

The index of import specialization provides a measure of the extent to which country j imports relatively more or less of commodity k than all other importers on average. (Drysdale, 1969)

$$C_{ij}=\sum_{k}\left(R_i^k\times D_j^k\times\frac{M_w-M_i}{M_w^k-M_i^k}\right) \quad (9)$$

The C index of the degree of complementarity in trade provides a measure of the extent to which country i's export trade with j is relatively large or small because of the character of i's export specialization and j's import specialization in trade (Drysdale, 1969). This is because the C complementarity index is the weighted sum of the products of each commodity's share in country i's exports and country j's imports with commodities weighted by the inverse of their shares in world trade. This index's difference from that of Linneman is its taking account of the closeness of countries' commodity trade structures relative to world trade structure. (Drysdale and Garnaut, 1982)

3. Data

The above-mentioned complementarity indices are computed for certain 73 countries for the time interval between 2011 and 2015. The reason behind the selection of these countries is that they have the largest share in Turkey's exports so that exports to these countries make up 93% of its total exports according to Turkish Statistical Institute.[5] Moreover, narrowing the cluster eases data collection. The trade data are taken from International Trade Statistics of International Trade Centre, UNCTAD/WTO at the Harmonized System two-digit level.

[4] *Country subscripts j and A are adjusted as i and j respectively, according to the formula in this paper from the original paper of Drsysdale (1969).*

[5] *Among 73 countries, only for Iraq in 2011, 2012 and 2013, and for United Arab Emirates in 2011, the complementary indices cannot be measured due to the unavailability of data.*

4. Comparison of the Trade Complementarity Indices Computed for Turkey

In order to see the consistency between the results of the alternative trade complementarity indices computed for Turkey and also to make a full comparison between them, we calculate correlations between findings of the alternative indices. Before presenting correlation and consistency results, two explanations are in order:

Firstly, one may easily realize that among the above-explained complementary indices, TCI index and S index given in equations (3) and (4) respectively are exactly the same formulas. Because, the nominators of these equations are the same while the denominator of the equation (4), namely, $\sum_{k01}^{K}(x_{ik} + m_{ik})$ is equal to 2, which is the denominator of equation (3). Since we also confirm the equality of these two indices with our dataset, we refer the S indices and TCI indices interchangeably.

Secondly, according to all of the complementarity indices explained above, the higher the index takes value, the larger complementarity exists between trade patterns of the countries. In other words, higher is better for the trade complementarity. However, all indices except C index may take values between 0 and 1 while C may take values larger than 1. To make a full comparison between alternative indices including C, we may normalize the C index in such a way that its largest value is equal to 1. However, this cannot provide a full comparison, given that other indices may take the value of 1 at most, but do not result in the value of 1 in reality. For this reason, instead of normalizing C index, we include its measured values directly to the comparisons.[6]

Table-1 presents the descriptive statistics of the alternative trade complementarity indices for Turkey throughout the 2011-2015 periods. The yearly descriptive statistics for the indices may be seen from Appendix-1.

Table 1: **Descriptive Statistics of the Alternative Complementarity Indices**

Variable	Obs	Mean	Std. Dev.	Min	Max
COS	361	.6829532	.1148138	.3893824	.8864275
EIS	361	.580991	.066818	.3888779	.6993921
TCI	361	.5809771	.0668151	.3888779	.6993921
COR	361	.6243691	.1263085	.3170303	.8623074
C	361	1.119247	.1901723	.6346936	1.655933

Source: Authors' calculations with the software package Stata.

Correlations between alternative trade complementarity indices for Turkey during the 2011-2015 periods are presented in Table-2. The yearly correlations may be seen at the Appendix-2.

The most striking finding in Table-2 is that although the formulas of EIS and TCI (equations (2) and (3)) seem to be rather different, they give the same complementarity values for all trade partners, which results in 1 as correlation coefficient between them. The yearly correlations presented in Appendix-2 also witness the same conclusion. Thus, given that we detect that S, TCI and EIS indices are in fact the same, we cannot state any preference among S, TCI and EIS indices.[7]

[6] In addition, Correlation between the results of the C indice and other indices' results is not affected from normalizing. Thus, normalizing does not result in any benefits for comparisons.

[7] The equality of S and EIS indices are also adressed by Benedictis and Tajoli (2007).

Table 2: **Correlations between the Results of the Alternative Complementarity Indices**

	COS	**EIS**	**TCI**	**COR**	**C**
COS	1.0000				
EIS	0.8732	1.0000			
TCI	0.8732	1.0000	1.0000		
COR	0.9932	0.8400	0.8401	1.0000	
C	0.5598	0.6642	0.6638	0.5244	1.0000

Source: Authors' calculations with the software package Stata.

Linnemann and Cees van Beers (1988) express that the larger the number of commodity classes distinguished, the closer COS approaches COR - except that it cannot take a negative value-. This is exactly what we saw from the Table-2: There exists a strong correlation (0.99) between COS and COR indices. For this reason, we are entirely indifferent between these two indices in measuring the complementarity between Turkey's exports and its trade partners' imports.

Both EIS and COS indices vary according to the level of disaggregation of the product classes; stronger disaggregation will result in lower values of both indices as a rule. On the other hand, EIS index is a linear construct, whereas COS index has non-linear properties. According to COS index, a strong correspondence in commodity class k scores relatively stronger, while a poor correspondence scores relatively poorer than EIS index. This causes the variance of COS will be larger than that of EIS, as can be seen from our results in Table-1. (Linnemann and Beers, 1988). Despite this fundamental difference between COS and EIS indices, comparing COS and COR with that of EIS (at the same time with those of S and TCI), we realize that COS and COR indices produce rather similar results with these indices, with correlation coefficients of 0.87 and 0.84, respectively.

One may claim some advantages of S index over COR index. The most important advantage is that S index is not increasing in k (total number of sectors). Secondly, S index lessens the effect of the largest differences, because the difference in high sectoral export shares contribute the same as the difference in small sectoral export shares as, and it is appropriate in presence of skewed distributions. Furthermore, S reflects the change of the export trends of countries better whereas COR hides the overshooting paths (Benedictis and Tajoli, 2007). Thirdly, it is not subject to a phenomenon called the double-zeros paradox (Legendre and Legendre, 1998). According to this paradox, two countries without any sectoral similarity between one's exports and other's imports may appear as being complementary, just because of a number of zero observations in the sample. In our study, since we do not have zero value of export shares, this advantage of S over COR cannot appear as a reason for preferring S instead of COR.

Table-2 suggests that all alternative indices provide rather similar complementarity index values for Turkey's trade with its partners. The Graph-1 also witnesses the pairwise consistency between the alternative indices. In addition, as explained above, each of the complementarity indices has their pros and cons in nature. For all these reasons, it does not seem to be reasonable to make a preference among alternative indices. Instead, using all alternative methods, we can create a composite complementarity index. In doing this, we may simply calculate the linear combination, for example by summing up all indices or taking their averages.[8] Taking the average has the advantage of having the same scale with each of the individual indices. However, all indices except C have the same scale while C may larger values in comparison to others, as can be seen from Table-1. Thus, using all indices directly in creation of new composite index means that we would attach more weight on C index. In other words, the index with larger standard deviations (C index in our case) would be weighted more in the composite. To prevent this and weight all the indices equally, we follow a two-step approach: (1) we firstly convert the raw index values to

[8] *The technical name of this new variable is factor-based score*.

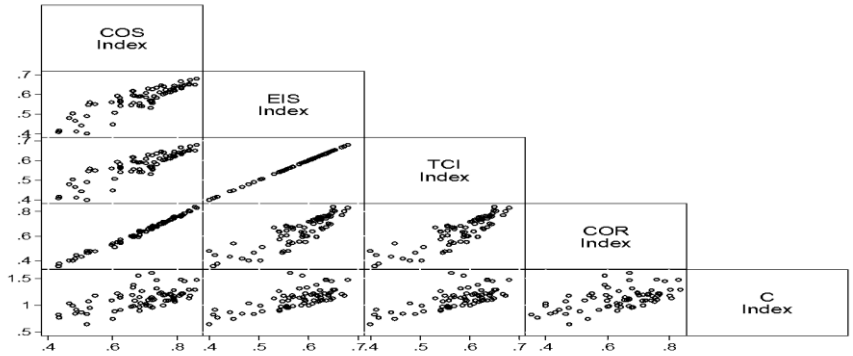
standardized variables (z-scores). In other words, we rescale indices to have a mean of zero and a standard deviation of one. (2) Then, we create the composite index (abbreviated as zCOMP) by adding up the newly created z-scores.[9] In this way, we preserve the feature of having a mean of zero, but the standard deviation of the composite index would be different from 1, as can be seen from the Table-3. Table-3 also includes descriptive statistics for the composite index (COMP) created by summing up themselves of the indices without any standardization.

Table 3: **Descriptive Statistics of the Standardized Complementarity Indices and the Composite Indices**

Variable	Obs	Mean	Std. Dev.	Min	Max
zCOS	361	$-1.95e^{-09}$	1	-2.556929	1.772211
zEIS	361	$-1.44\ e^{-09}$	1	-2.875169	1.771994
zTCI	361	$-6.69\ e^{-10}$	1	-2.875087	1.772278
zCOR	361	$2.77\ e^{-09}$	1	-2.433238	1.883787
zC	361	$2.84\ e^{-09}$	1	-2.547969	2.822102
zCOMP	361	$-5.12\ e^{-09}$	3.592871	-8.703395	7.252594
COMP	361	3.007546	.4389218	1.971715	3.914309

Source: Authors' calculations with the software package Stata.

Graph 1: **Pairwise Scatter Diagrams of Alternative Complementarity**



Source: Authors' calculations and visualisation with the software package Stata.

Table 4 presents correlations between our newly created composite indices (zCOMP and COMP) with the individual indices. Since these composite indices are unweighted averages of the standardized/unstandardized indices and all indices except C are close to each other, they are less correlated with C than with others. However, when we make a comparison between correlations of the composite indices with other indices, we observe that correlation between COMP and C higher than between zCOMP and C. And the reverse is valid for correlations between other indices. This result is not surprising given that COMP attach more weight to the C index just due to the fact that this composite index is created just summing up the unstandardized indices. Finally, as can be seen from Table-4, there exist a close correlation (0.99) between COMP and zCOMP; still, we will use the theoretically true composite index, namely zCOMP, in the following assessments.

[9] *Since TCI, EIS and S indices give the same values mathematically, we accept these three indices as one in summing up the indice values. In other words, in the second step, we sum up the standardized values of COS, TCI (namely EIS or S), COR and C.*

Table 4: **Correlations between the Results of the Alternative Complementarity Indices and the Composite Indices**

	COS	EIS	TCI	COR	C	zCOMP	COMP
COS	1.0000						
EIS	0.8732	1.0000					
TCI	0.8732	1.0000	1.0000				
COR	0.9932	0.8400	0.8401	1.0000			
C	0.5598	0.6642	0.6638	0.5244	1.0000		
zCOMP	0.9536	0.9400	0.9399	0.9345	0.7648	1.0000	
COMP	0.9229	0.9101	0.9100	0.9026	0.8316	0.9928	1.0000

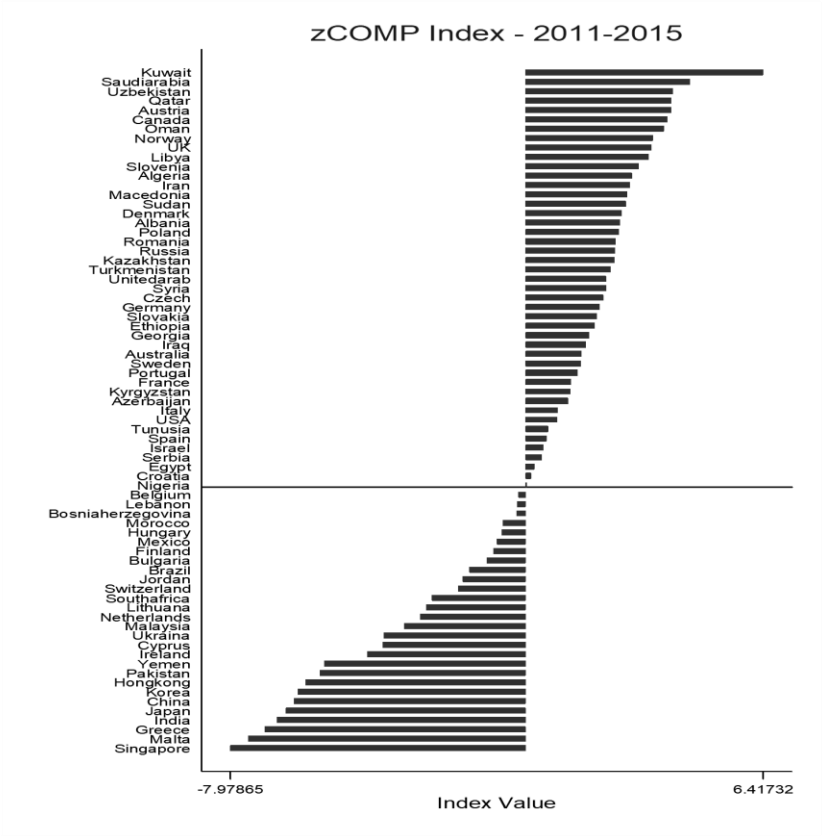
Source: Authors' calculations with the software package Stata.

The results of the composite index (zCOMP) for the period throughout 2011 and 2015 are presented in Graph-2. Yearly graphs of the results of the composite index may be seen from Appendix-3 to Appendix-7.

As shown in Graph-2, for the period throughout 2011 and 2015 in general, Turkey has the highest complementary trade structure with Kuwait, Saudi Arabia, Uzbekistan, Qatar and Austria. Examined the yearly graphs in Appendix, we expand this list by adding Oman, Syria, Iran, UK, Libya, Kazakhstan and Iraq. These countries import intensively the type of goods exported by Turkey. At the other polar, Singapore, Malta, Greece, India and Japan emerge as the partner countries with the lowest complementarity with Turkey. In addition to these countries, Turkey has competitive trade structure with Yemen, India, Hong Kong, Japan and China. Generally speaking, these countries do not import extensively the goods which Turkey exports intensively.

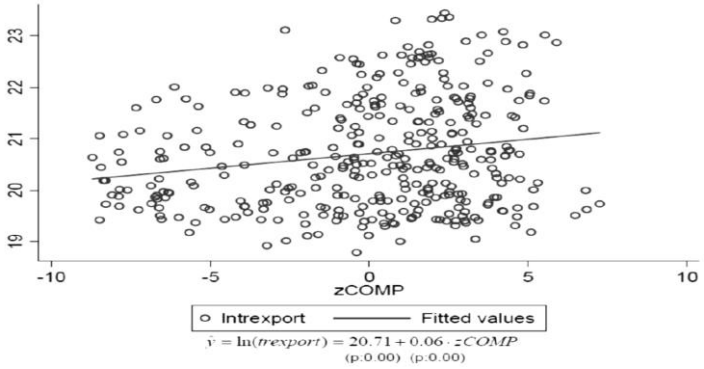
At this point, we should be cautious in interpreting the complementarity indices and resulting order of the partner countries: A complementarity index provides information on the similarity between the export structures of a country with the import pattern of another country. Thus, it only shows the trade potential between countries. A higher complementarity index does not necessarily mean that there exists intense trade between relevant countries. To see whether Turkey uses export potentials fully, we simply regress the log of the Turkey's exports to the partner countries on their complementarity index values. Graph-3, plotting this recent regression and fitted line, shows a positive and significant relationship between complementarity indices and exports of Turkey. To be more precise, when complementary indices of any country increases by 1, the exports of Turkey to that country seems to increase by 6 percent.

Graph 2: **The Results of the Composite Index (zCOMP) for the Period Between 2011 and 2015**



Source: Authors' calculations and visualisation with the software package Stata.

Graph 3: **Scatter Diagram (Fitted Line) of Exports of Turkey and (on) the Composite Index with its Partners**



Source: Authors' calculations and visualisation with the software package Stata.

That is to say, we should wait for a while before reaching the conclusion that Turkey exports extensively to the countries with higher complementarity. Trade between two countries depends on many factors and trade complementarity is only one of them. For example, total size of the importing country in terms of GDP or population, purchasing power of the importing country in terms of GDP per capita, trade barriers such as transport costs, delivery time, distance between

countries, cultural unfamiliarity, common language and market access barriers are factors affecting export flows from a country to destination countries.

In literature, the gravity models are used to study the bilateral trade flows (exports, imports or total trade) between countries. Newtonian physics claiming that attraction is bigger between larger and more closely positioned bodies inspires the gravity model in economics. In its most general formulation, it explains a flow F_{ij} (of goods, people etc.) from an area i to an area j as a function of characteristics of the origin (O_i), characteristics of the destination (D_j) and some separation measurement (S_{ij}) (Porojan, 2001)

$$F_{ij}=O_iD_jS_{ij} \quad i=1,\ldots,I;j=1,\ldots,J \tag{10}$$

Following the literature, this model can be written in log-linear form:

$$F_{ij}=X\beta+\varepsilon, \quad \varepsilon\approx N(0,\sigma^2) \tag{11}$$

As a dependent variable in this specification, exports, imports or total bilateral trade may be used. X is the vector of (logs of) explanatory variables like proxies for the size of the two economies (GDP, population and/or GDP per capita) and the distance between them (as proxy for transportation costs and other obstacles to trade). Some models include, along with distance, the areas of the trading partners (proxy for transport cost within the country), tariff and price variables, and a variety of proxies for "closeness" between the trading partners: contiguity, common language dummy (cultural affinity), trading bloc membership dummy (Porojan, 2001).

The aim of this study is to calculate the trade complementarity indices of Turkey with the partner countries and to interpret the results. In the coming study, by using these complementarity indices and other factors like economic size, per capital income, distance, common border etc., we aim to determine comprehensively the fundamental determinants of the Turkey's export pattern in the framework of gravity models.

5. Conclusion

In the international trade literature, several measures for comparing the commodity composition of trade flows are introduced. One stream of this literature focuses on producing trade complementarities between one country's exports with the other countries' imports. For this aim, several complementarity indices are proposed and applied for different countries and country groups. Generally speaking, if the similarity between the share of the commodities in the exports of a country and the share of the commodities in the import of another country is higher, it suggests a higher complementarity between trades of these countries.

To study the complementarity between Turkey's exports and its partners' imports, we firstly review the main complementarity indices proposed in the literature, and then apply them to the Turkey's trade with its partners. After calculating the indices in this way, we do not prefer to select one of these indices each of which has its own pros and cons. Instead, by attaching equal weights to normalized index values, we generate a composite complementarity index. The results show that Turkey has rather high complementary trade structure with oil-rich countries like Kuwait, Saudi Arabia, and Qatar and with some developed countries like Austria and UK. In contrast, complementarities with several countries like Singapore, Malta, Greece, India and Japan are rather low. In addition to the calculation of the specific complementary indices for several countries, we also attempt to see the relationship between complementary indices and Turkey's exports. The regression with a very basic specification and visual examination of the plot suggest a positive relationship between complementary index and Turkey's export. However, before concluding that Turkey has utilized all export opportunities by trading intensively with the destinations with higher complementary, we should expand our basic regression by adding all other relevant factors affecting Turkey's trade with its partners. This can be achieved by a gravity model framework, and it is the main motivation for the coming study.

Appendix

Appendix-1**: Descriptive Statistics for the Results of the Alternative Complementarity Indices for Years between 2011 and 2015**

Variable	Obs	Mean	Std. Dev.	Min	Max
COS2011	71	.6905196	.1111022	.4324382	.8609441
COS2012	71	.6456026	.1032657	.3893824	.8327965
COS2013	71	.6893387	.1231644	.3993165	.873426
COS2014	71	.6956535	.1209536	.4083565	.8864275
COS2015	71	.6902929	.1107319	.4281173	.8820857
EIS2011	71	.5781575	.0667032	.3992914	.6787204
EIS2012	71	.5664238	.0615719	.3888779	.6521727
EIS2013	71	.5832394	.0714667	.392819	.6859564
EIS2014	71	.5903863	.0696002	.3921305	.6993921
EIS2015	71	.5867611	.0637405	.400689	.6938192
TCI2011	71	.5781575	.0667032	.3992914	.6787205
TCI2012	71	.5664112	.0615621	.3888779	.6521728
TCI2013	71	.5832394	.0714667	.392819	.6859564
TCI2014	71	.5903756	.0695951	.3921304	.6993921
TCI2015	71	.586714	.0637429	.400689	.6938192
COR2011	71	.6351617	.1208326	.3538674	.8364338
COR2012	71	.5844284	.1115261	.3170303	.7985508
COR2013	71	.6336344	.134657	.3243541	.8485713
COR2014	71	.6378045	.1335846	.326471	.8623074
COR2015	71	.6262641	.1255515	.33131	.8558996
C2011	71	1.117401	.1877905	.6484442	1.597177
C2012	71	1.095754	.1956441	.6565563	1.655933
C2013	71	1.129001	.189512	.6485866	1.556507
C2014	71	1.129676	.1865752	.6346936	1.604115
C2015	71	1.104877	.1820178	.6698487	1.61295

Note: Since for Iraq in 2011, 2012 and 2013, and for United Arab Emirates in 2011, the complementary indices cannot be measured due to the unavailability of data, we presented the explanatory measures of only 71 countries, not 73.

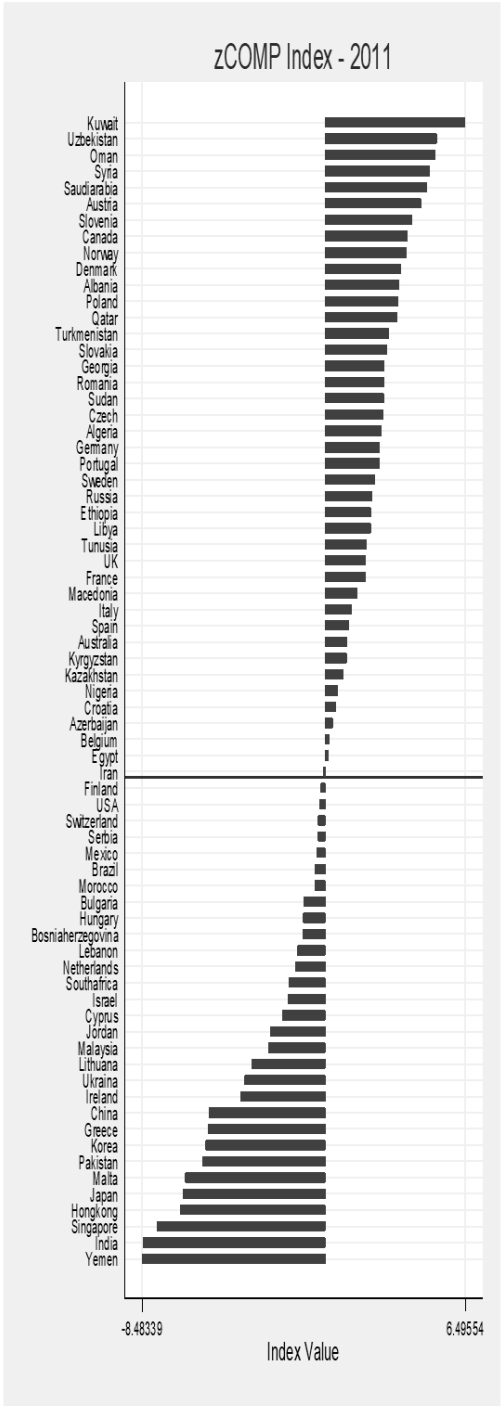
Source: Authors' calculations with the software package Stata.

Appendix-2**: Correlations between the Results of the Alternative Complementarity Indices for Years between 2011 and 2015**

	COS2011	**EIS2011**	**TCI2011**	**COR2011**	**C2011**
COS2011	1.0000				
EIS2011	0.8804	1.0000			
TCI2011	0.8804	1.0000	1.0000		
COR2011	0.9955	0.8604	0.8604	1.0000	
C2011	0.5958	0.7006	0.7006	0.5650	1.0000
	COS2012	**EIS2012**	**TCI2012**	**COR2012**	**C2012**
COS2012	1.0000				
EIS2012	0.8380	1.0000			
TCI2012	0.8380	1.0000	1.0000		
COR2012	0.9915	0.7955	0.7956	1.0000	
C2012	0.6028	0.6377	0.6376	0.5976	1.0000
	COS2013	**EIS2013**	**TCI2013**	**COR2013**	**C2013**
COS2013	1.0000				
EIS2013	0.8704	1.0000			
TCI2013	0.8704	1.0000	1.0000		
COR2013	0.9938	0.8397	0.8397	1.0000	
C2013	0.5869	0.7277	0.7277	0.5400	1.0000
	COS2014	**EIS2014**	**TCI2014**	**COR2014**	**C2014**
COS2014	1.0000				
EIS2014	0.8827	1.0000			
TCI2014	0.8827	1.0000	1.0000		
COR2014	0.9939	0.8510	0.8511	1.0000	
C2014	0.5486	0.6622	0.6621	0.5029	1.0000
	COS2015	**EIS2015**	**TCI2015**	**COR2015**	**C2015**
COS2015	1.0000				
EIS2015	0.8886	1.0000			
TCI2015	0.8885	1.0000	1.0000		
COR2015	0.9922	0.8480	0.8482	1.0000	
C2015	0.4789	0.6010	0.5992	0.4319	1.0000

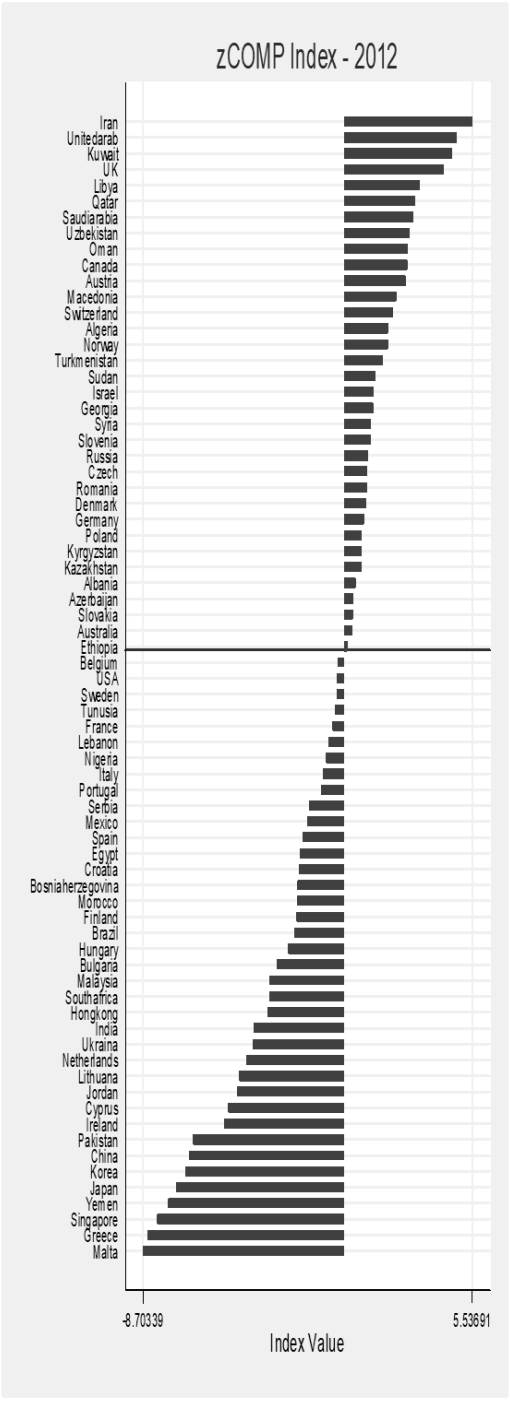
Source: Authors' calculations with the software package Stata.

Appendix-3: **The Results of the Composite Index (zCOMP) for Year 2011**



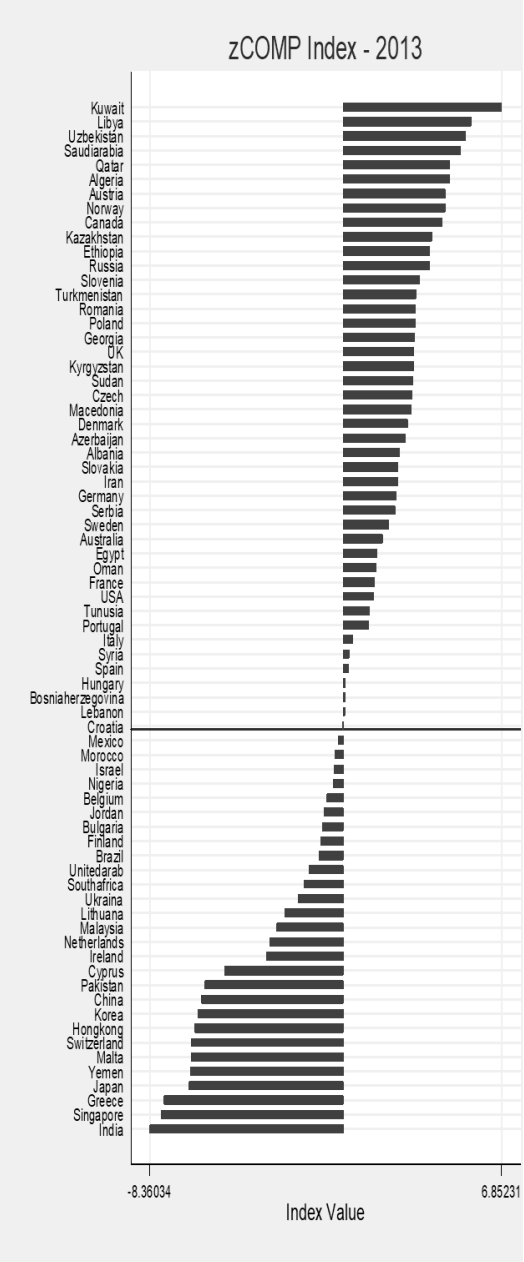
Source: Authors' calculations and visualisation with the software package Stata.

Appendix-4: **The Results of the Composite Index (zCOMP) for Year 2012**



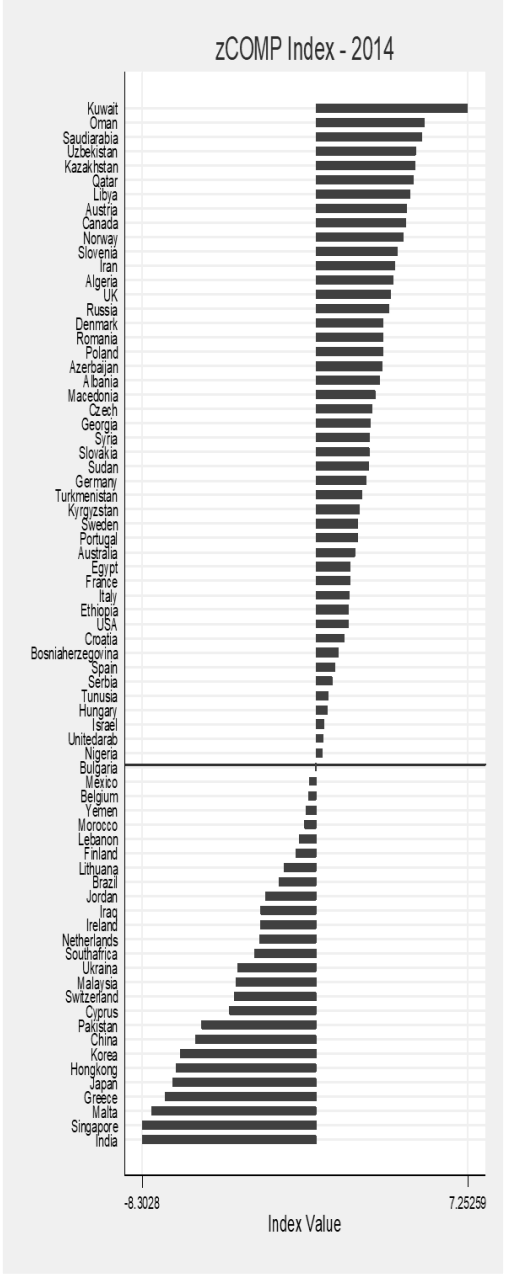
Source: Authors' calculations and visualisation with the software package Stata.

Appendix-5: **The Results of the Composite Index (zCOMP) for Year 2013**



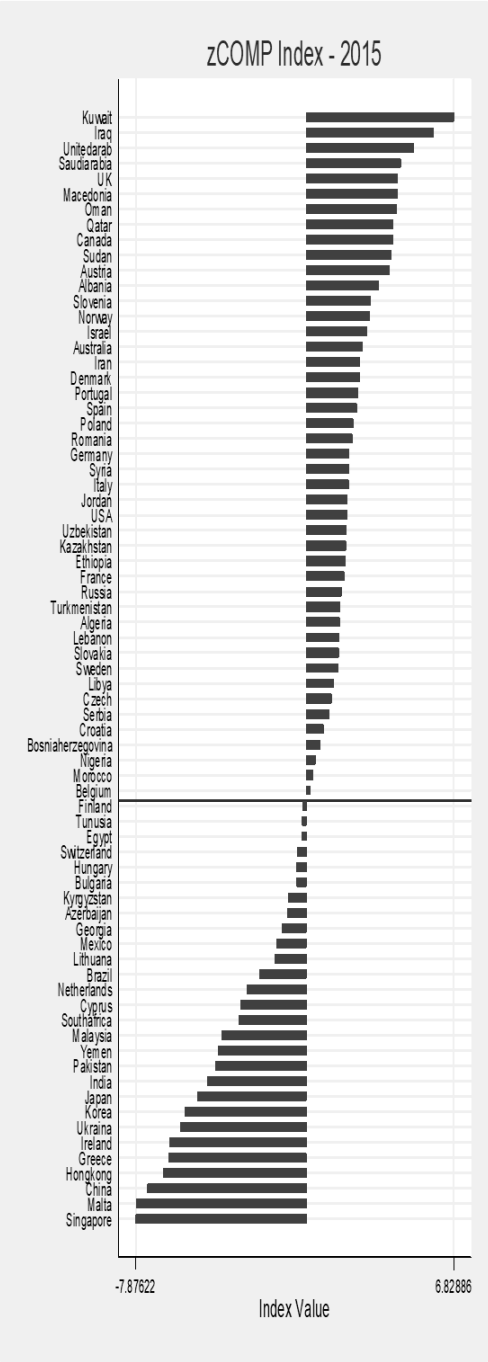
Source: Authors' calculations and visualisation with the software package Stata.

Appendix 6: **The Results of the Composite Index (zCOMP) for Year 2014**



Source: Authors' calculations and visualisation with the software package Stata.

Appendix 7: **The Results of the Composite Index (zCOMP) for Year 2015**



Source: Authors' calculations and visualisation with the software package Stata.

References

Akca, A. (2010). A Comparative Analysis of the EU and Turkey: Macroeconomic Convergence and Trade Similarity. (Unpublished Master Thesis). Middle East Technical University, Ankara

Aquino, A. (1978). Intra-Industry Trade and Inter-Industry Specialization as Concurrent Sources of International Trade in Manufactures. *Review of World Economics*, 114(2), 275-296.

De Benedictis, L. and Tajoli, L. (2007). Economic Integration and Similarity in Trade Structures. *Empirica*, 34(2), 117-137.

De Castro, T. (2012). Trade Cooperation Indicators: Development of BRIC Bilateral Trade Flows. *International Review of Business Research Papers*, 8(1), 211-223.

Drysdale, P. (1969). Japan, Australia, New Zealand: The Prospect for Western Pacific Economic Integration. *Economic Record*, 45(3), 321-342.

Drysdale, P. and Garnaut, R. (1982). Trade Intensities and the Analysis of Bilateral Trade Flows in a Many-Country World : A Survey. *Hitotsubashi Journal of Economics*, 22(2), 62-84.

Huot, N. and Kakinaka, M. (2007). Trade Structure and Trade Flows in Cambodia: a Gravity Model. *ASEAN Economic Bulletin*, 24(3), 305-319.

Legendre, P. and Legendre, L. (1998). *Numerical Ecology, Volume 24*, (2nd ed.) Amsterdam: Elsevier

Linnemann, H. and Van Beers, C. (1988). Measures of Export-Import Similarity, and the Linder Hypothesis Once Again. *Review of World Economics*, *124*(3), 445-457.

Map, T. (2016). Trade Statistics for International Business Development. In Geneva, Switzerland: International Trade Centre (United Nations Conference on Trade and Development-World Trade Organization). Accessed at Several Dates from: http://www.trademap.org/

Porojan, A. (2001). Trade Flows and Spatial Effects: The Gravity Model Revisited. *Open Economies Review*, 12(3), 265-280.

Shinyekwa, I., and Othieno, L. (2013). Comparing the Performance of Uganda's Intra-East African Community Trade and Other Trading Blocs: A Gravity Model Analysis. *Economic Policy Research Centre*. *Research Series,* (112).

Sohn, C. H. (2005). Does the Gravity Model Explain South Korea's Trade Flows?. *The Japanese Economic Review*, 56(4), 417-430.

Somerfield, P. J. (2008). Identification of the Bray-Curtis Similarity Index: Comment on Yoshioka (2008). *Marine Ecology Progress Series*, 372, 303-306.

TÜİK (2016). Foreign Trade Statistics. In Ankara, Turkey. Accessed at Several Dates from http://www.tuik.gov.tr.