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THE CHOICE OF MEASUREMENT INDEXES IN THE CASE OF TRADE COMPETITION MEASUREMENT

Monica-Iulia DUMITRESCU[a]

Abstract

This paper will be detailing several new perspectives for the trade competition analysis, namely the competition in a block of countries, the competition between two countries in all the markets, the competition that a country faces in a specific destination market or in all markets, the competition in a given market involving all the countries and, finally, the competition between all countries in all markets. The aim of this paper is to bring a methodological and empirical contribution to the measurement of trade competition. What we propose to do in this study is to further explore the measurement of trade competition and present several indexes that have already been used in this area of research. This paper also presents an empirical example where the most efficient indexes are applied in order to measure trade competition between several exporting countries to a chosen block of European markets.

Keywords: trade competition; structural similarity; export structures; trade competition indexes; competition measurement; Krugman index.
JEL Classification: B17, B27

Author's/Authors' Affiliation

[a] - Phd. Researcher, Department of Economics and International Affairs, Babes-Bolyai University, Faculty of Economic Sciences Business Management, Cluj-Napoca, Romania, iulia.dumitrescu@econ.ubbcluj.ro

1. Introduction

There are a lot of researchers that have studied the topic of trade competition measurement while accentuating the perspective of competition of two countries in a given market m. The following phase of research was based on exploring the existence of various typologies of competition between countries (Moreira et al. 2017, Lopes et al. 2014). The paper by Jenkins (2008) is a focus on one specific type of competition; the one faced by all exporters by one market. Also the study by Krugman, (1991) will be the foundation for this research and is the most used index for this field.

What we propose to do in this study is to further explore the measurement of trade competition. Several indexes that have already been used in this area of research will also be presented. From the multitude of indexes the ones that could prove more relevant to our subject of study will be presented in more detail in the following sections.

Based on the variety of research that has been done so far there is a debate among the researchers regarding the indexes more applicable in empirical examples for the acquirement of relevant results.

Alongside the measurement of trade competition through sectoral shares we will explore structural similarity as an intra-sectoral dimension in order to measure the quality in product specialization. Moreover we will measure inter-sectoral similarity to be able to reflect the degree of similarity between sectors (Moreira et al, 2017). All of these approaches are based on trade competition being measured through the exports of two countries (a,b) for a given destination market (m). The indexes used to measure the above types of competition are variations of the Krugman index.

2. Specialization indexes

The index presented by Meller and Contreras (2003) to study competition with China is the Index of Trade Conformity (ITC) which is measured as follows:

$$ITC = 100 * \sum_i \left\{ \frac{(X_{ia} + X_{ib})}{(\sum_i X_{ia} + \sum_i X_{ib})} \right\} * \{1 - \frac{(|x_{ia} - x_{ib}|)}{(x_{ia} + x_{ib})}\}$$

where X_i is the value of exports of product *i* and x_i is the share of product *i* in the total exports of the country, while *a* and *b* indicate two countries that are being compared. The ITC index is intended to measure the similarity between the composition of the exports of the two countries *a* and *b* that are being compared. However we can exchange the scale effect with the use of the share of each product in total exports. The issue is that so it can be understood

that the similarity between the exports of two countries as the share of exports that are common to both countries expressed as a proportion of their combined exports.

Another situation is when the value of exports of the two countries is similar but one country is much more specialised in those products that overlap. From practical examples we may observe that small exporters are likely to be more specialised than large ones. ESI-type indexes tend to be misleading when ranking the competitive threat to different countries and also poorly provide an appropriate measure of changes in the competitive threat faced by a particular country over time. The issue comes mainly from the fact that the index only measures the similarity in the composition of exports between two countries. If over time the composition of exports in both countries remains unchanged, then the ESI does not change.

Furthermore, in Palan, (2010) where the choice of indices in the case of specialization measuring is debated some of the most relevant indexes to our study have been selected.

The Theil Index (Theil, 1967) is very similar to the Shannon Entropy Index (SEI), as it is a modification of it. The way it functions is through setting all sectoral shares of a country noted b_i in correlation with a panel of countries that act as a reference group *i*.

$$SEI = -\sum_{i=1}^{I} b_i \ln(b_i)$$

Even though Theil Index was built on information theory it has been adapted to be an index for the measurement of specialization and concentration by various authors; so it has changed from 1967 when it was developed by Theil until Brulhart and Traeger (2005) or Ezcurra and Pascual (2007).

$$T = \frac{1}{I}\sum_{i=1}^{I} \frac{b_i}{\overline{b_i}} \ln \frac{b_i}{\overline{b_i}}$$

When comparing the economic structures of the country b_i and the economic structure of the countries in the reference group *i* the Theil Index is zero when these values are identical. This index may provide misrepresented results because not all deviations of a country's economic structure from the reference level are weighted equally, thus leading to a distorted level of specialization that could furthermore compromise the research.

In respect with this index it is pointed out in that, a perfect relative specialization implies that the country is completely specialized in one industry while, $\overline{b_i} = \frac{1}{I}, \forall\, i$ but in that case, the Theil Index is equal to negative infinity; yet it converges towards *I*ln*I* if we allow for the existence of negligible small industries. If the economic structures of the country and the

reference group are identical, then the Theil Index is zero. What can be concluded is that for our study if one country would be exporting only one type of products then $T = -\infty$; while for the case of two countries that are being compared with identical exporting structures $T = 0$. Also if the country being analysed has more export types of products in small quantity than it has products of export with large quantity the Theil index takes negative values.

Another index that has also been developed for applications in economy but has been adapted by several authors to measure a countries specialization is the Ogive Index as implied by Tress (1938). The index was used for example by Palan (2010) to measure the distribution of employment across all sectors of a country and might be used in our research considering sectors of specialization of a country.

$$O = \sum_{i=1}^{I} I(b_i - \frac{1}{I})^2$$

In the case of the Ogive Index the equal number of specialization sectors across all countries can be taken as a standard for maximum dispersion. The index can take values from 0 as a minimum to a maximum of $\frac{I-1}{I}$. Since the entire numerator is squared the index puts more weight on sectors which deviate much from $\frac{1}{I}$ and also on countries sectoral shares that have either very high or very low values.

Taking these two variables into consideration we may say that the HHI (Hirschman-Herfindahl Index) is a better option, even if the two indexes are very similar.

Furthermore an index that calculates specialization through ranking by the values of each sector is the Crude Diversification Index as presented by Rodgers (1957) that initially derives from the Diversification Index (DIV). The way that it functions is that the export values of each specialization sector of a country *n* are calculated and then arranged from smallest to highest according to their size. The way the CDI differs from the DIV index is that is summarizes the progressive totals.

The index for the ranked specialization sector may be noted as: b_j' ($b_j' < b_{j+1}'$) for all sectors *j*. The actual Crude Diversification Index can be written as a sum of growing totals:

$$CDI = b_i' + \sum_{j=2}^{n}(b_j' + \sum_{k=1}^{j-1} b_k')$$

where b_i' takes values from j=2,…,I and k=1,…I. The specific feature of the index is that it compares only the degree of specialization even though in takes a panel of countries but it does not compare the shares of each sector by pairs.

Anotther index that is mainly based on the variance of the specializations sectors shares is the Index of Inequality in Productive Structure (IP) that was initially introduced by Cuadrado-Roura et al. (1999). The difference for this index is that is adds up the squared deviations of employment shares.

$$IP = \sum_{i=1}^{I}(b_i - \bar{b}_i)^2$$

The IP index weights the large absolute deviations more, like it would happen in our study for sectors with high exporting values. The index takes values from 0 to the highest value being $\frac{I-1}{I}$. The similarity between Krugman index and the IP index is that the measurement of specialization is not altered if sectors with very low export values are added.

To conclude, the choice of an index is a very important phase in any study. The results obtained after applying an index in an empirical study are clearly dependent on the type of index that has been chosen. Furthermore the results are the ones that indicate the final conclusions of a research paper, so for a relevant and correct conclusion the most suitable index should be chosen. In my opinion, from all of the indexes mentioned above that can be used to measure specialization the ones that I have considered using for this study were HHI and Krugman index. While both of these indexes fulfil the majority of the criteria needed for this type of research, the Hirschman-Herfindahl Index is not only an easily computable index so it can result problematic for the analysis regarding the absolute level of specialization. After analysing all the indexes that have been used or have been considered to be used as alternatives of specialization measurement the one that is most relevant for this study is the Krugman index.

For our study the proper estimation of specialization levels is important as we are focusing on the evolution of export structures over time.

The Krugman index is the most known index that is used to measure structural similarity and it compares the share of each sector when taking into consideration two export structures.

Let *a* and *b* be two countries exporting to a market $m(m = 1,2, \dots M)^3$ and i the sectoral index *i*(i= 1,2,…I), so the Krugman index would be expressed as:

$$K_{abm} = \sum_{i=1}^{I} | v_{iam} - v_{ibm} |$$

where v_{iam}, v_{ihm} are the weights of sector i in the export structure of *a* and *b* to market m. The way to obtain v_{iam} and v_{ibm} to calculate the fraction between the exports of sector *i* from *a* to *m* and the total exports from *a* to *m*. Therefore we can calculate $v_{iam} = x_{iam}/x_{im}$ and the same method for v_{ibm}. The Krugman index ranges between 0 and 2, with a complete similarity between two export structures if it equals 0 and very low to none when the value approaches 2. The higher the value of the index, the more the economic structure of one country deviates from the reference group and the more a country is considered to be specialized. The Krugman index is frequently noted as KSI meaning Krugman sectoral index. One of the specifics of the index is that its range does not clearly express quantitatively the level of structural similarity. Secondly the index increases with structural dissimilarity even though it is a structural similarity measuring index. The Krugman Index compared to the rest of the indexes presented does not get altered if a specialization sector with no exports is added or in the case of a sector with very low values.

In an attempt to obtain the indexes that could measure the perspectives of analyses desired, a study of the indexes used to measure specialization is necessary. Even though all indexes are very useful in this area, only some result to be as adaptable and fitting for this research.

The first perspective of approach for trade competition is the situation where two countries *a* and *b* compete in market *m*. The modified Krugman index is the baseline index which only considers sectoral shares.

Crespo and Simoes (2012) propose the consideration of an average of the Krugman Index calculated at different levels of sectoral disaggregation in order to evaluate not only the level of actual competition (traditionally evaluated through the Krugman Index) but also the potential one.

In order to calculate sectoral shares similarity Crespo and Simoes (2012) propose a modified Krugman index that can be expressed as:

$$E_{abm} = 1 - \beta \sum_{i=1}^{I} | v_{iam} - v_{ihm} |$$

The authors have chosen to use β as it is commonly used in studies as β=1/2; with values between 0 and 1. When E_{abm} =1 it means that there is a maximum similarity with the weights of each sector being equal in the exports of countries *a* and *b* to market *m*.

3. Measuring trade competition in a block of countries

The measurements of sectoral shares similarity, inter-sectoral similarity and intra-sectoral similarity can be applied to measure trade competition between countries *a* and *b* in market *m*. Another perspective aside competition between two countries in a given market can be the measurement of overall level of trade competition between two countries in a group of markets. What we can achieve is finding out the competitive threat that country *a* might represent to country *b* in all the markets in which they compete.

Each country can potentially export to market *m*(M – 1) / countries. While each country has a different exporting pattern it will have a different number of destinations of export, different values for *m*. A method to defeat this situation implies the comparison of the bilateral flows between countries *a* and *b* directly.

$$L_{ab}^{TCI}=\sum_{\substack{m=1\\ m\neq a,b}}^{M} TCI_{abm}\,\delta_{abm}+TCI_{a-b}\left(1-\sum_{\substack{m=1\\ m\neq a,b}}^{M}\delta_{abm}\right)$$

When trying to measure the level of trade competition between two countries in their exports to a group of destination markets, we base our index on a weighted average of trade competition in each individual market. The generic term that will be used is TCI which stands for Trade Competition Index between *a* and *b* in market *m*. TCI_{a-b} is being used as the index of trade competition that can be obtained as the traditional TCI_{abm} index. TCI_{abm} is comparing the exports from *a* to *b* with exports from *b* to *a*. Meanwhile δ_{abm} can be calculated as following:

$$\delta_{abm}=\frac{\delta_{am}+\delta_{bm}}{2}$$

with $\delta_{am}=\frac{x_{am}}{\sum_{m=1}^{M} x_{am}}$ and $\delta_{bm}=\frac{x_{bm}}{\sum_{m=1}^{M} x_{bm}}$.

Therefore maximum overall competition would require a maximum similarity in the trade flows for each destination market in the empirical results.

We can also measure trade competition between two countries in all markets. This is a measure we can apply if we want to measure the competition between countries *a* and *b* in all the markets. We could for example take the countries Spain and Portugal and see the way they compete in overall terms. The evolution of this index would be the fact that now we are not only comparing countries a and b but also all the markets they export to. When trying to calculate the index we are once again using bilateral flows to calculate trade competition but this time reported to all the countries of export. The index may be the following:

$$TCI_{ab}=\sum_{m=1}^{M} TCI_{abm}\gamma_{abm}\ ,$$

Where we would calculate the weighted average of the trade competition indexes between *a* and *b* in each specific destination market *m*. M would be the total number of destination markets and γ_{abm} can be calculated as:

$$\gamma_{abm} = \frac{1}{2}\left[\frac{x_{am}}{x_a}+\frac{x_{bm}}{x_b}\right]$$

and is the simple average of the share of market *m* in the exports of *a* and *b*. In this case x_a and x_b are the total exports of *a* and *b*; also x_{am} and x_{bm} represent the exports of *a* and *b* to market *m*.

When measuring competition faced by a country in a specific destination market one tries to measure the degree of competition that a country *a* faces in market *m* from all the other countries exporting to *m*. As in the figure above if we were to measure the degree of competition that country *a* faces in market *m* from all the remaining countries(*b … K*) that are also exporting to *m*.

We main obtain an index to obtain this approach based on the index used to measure the competition between two countries in all markets. The calculation of the weights considered would however be different. If now we have to take into consideration all the other countries exporting to market *m* that these would now correspond to the share of each of these countries (*b … K*) in the total of exports that arrive to *m*. By using these weights we can give a greater representation to the trade competition indicators that correspond to countries with a higher share of the exports to *m*; except the exports from *a* to *m*:

$$\mu_{abm} = \frac{x_{bm}}{\sum_{\substack{b=1 \\ b \neq a}}^{K} x_{bm}}$$

Above x_b are the total exports of *b* and x_{bm} is representing the exports of *b* to market *m*.

The index that expresses this way of analysing competition is:

$$TCI_{am} = \sum_{\substack{b=1 \\ b \neq a}}^{K} TCI_{abm}\, \mu_{abm}$$

If for example the national Chamber of Commerce of Portugal wishes to export to Romania they would need to know what kind of competition they are facing in the Romanian market.

In another case we can measure the degree of competition that a country a faces in all markets from all the other countries. If we were to model an index that could measure the level of competition faced by country *a* in the full range of destination markets we need to start with the equation used at the previous point. Taking the index from - competition faced by a country in a specific destination market; and calculate the weighted average of the values obtained for all destination markets in which the corresponding weight is the share of *m* in the total exports of *a*:

$$TCI_a = \sum_{m=1}^{M} TCI_{am}\, \delta_{am}$$

and where δ_{am} is:

$$\delta_{am} = \frac{x_{am}}{x_a}$$

In this case x_a are the total exports of *a* and x_{am} represents the exports of *a* and to market *m*.

Another interesting perspective is measuring competition in a given market among all countries. Here we have a situation where the degree of competition in market m among all the countries exporting to that country is trying to be measured. Since this perspective focuses on the competition in a singular market *m* we have to take into account the competition among all countries that export to *m*. First of all we can base our index on the TCI_{abm} index that has been used so far:

$$TCI_m = \sum_{a=1}^{K} \sum_{\substack{b=1 \\ b > a}}^{K} TCI_{abm}\, \tau_{abm}$$

where:

$$\tau_{abm}=\frac{x_{am}+x_{bm}}{\sum_{a=1}^{K}\sum_{\substack{b=1\\b>a}}^{K}(x_{am}+x_{bm})}$$

For this index the relative importance of each country pair in total exports to *m* is used as weights. Also for calculatingτ_{abm}: x_{am} and x_{bm} represent the exports of *a* and *b* to market *m*.

We may also calculate the competition in this perspective by using the index from 2.5- competition faced by a country in a specific destination market (TCI_{ab}):

$$TCI'_m=\sum_{a=1}^{K} TCI_{am}\,\tau'_{am}$$

and the share of exports from *a* to *m* in the total exports to *m* is assumed as weight:

$$\tau'_{am}=\frac{x_{am}}{x_m}$$

If we took a country *a* to be for example Germany and we would like to measure the degree of competition in the German market we would find out that the biggest exporting countries are: China, Netherlands, France and USA. Clearly while applying the index these four countries would be given a bigger importance as they represent a larger fraction of exports to Germany and they account for a more important part of trade competition in the German market.

Measuring global competition is the sixth perspective of trade competition. The great challenge in this situation is to try to measure the degree of competition that all countries could have in all the markets. According to Vania et al (2014) in their working paper there are four different modalities to obtain the index trying to measure global competition.

First of all the most natural way to obtain the index would be further developing the *TCI* index that has been used for the first type of competition measurement; in the case of competition between two countries *a* and *b* in a given market *m*:

$$TCI=\sum_{a=1}^{K}\sum_{\substack{b=1\\b>a}}^{K}\sum_{m=1}^{M} TCI_{abm}\,\sigma_{abm}$$

For this index the weights are given by the share of the sum of exports from *a* and *b* to *m* in total trade. For σ_{abm} we have the calculation of each country-pair that receives a weight again according to its level of exports.

$$\sigma_{abm} = \frac{x_{am} + x_{bm}}{\sum_{a=1}^{K} \sum_{\substack{b=1 \\ b>a}}^{K} \sum_{m=1}^{M} (x_{am} + x_{bm})}$$

If for example we would take the country pair Portugal and Spain we would assume the weights as the share of the sum of Portuguese and Spanish exports in the worldwide exports.

Also we can view these exports of two countries: *a* and *b*, or Spain and Portugal like in the anterior example; in a more detailed way, taking into consideration the sectoral angle (where v_{jam}, v_{ham}, v_{kam} are the weights of sector *j,h,k* in the export structure of country *a* in market *m*).

4. An application

In the previous chapters several methodological options have been presented with the approach of measuring the degree of trade competition between two countries. For a better understanding of the theoretical measurements we purpose an empirical example. We analyse the trade competition among eight economies that are predicted to be the ruling world economies in 2050—China (CH), India (IN), United States of America (US), Indonesia (ID), Brazil (BR), Russia (RU), Mexico (MX), Japan (JP) in 2016 (Hawksworth et al., 2017). As destination markets we chose the four most powerful European economies Germany (DE), France (FR), the United Kingdom (GB), Italy (IT) alongside to the eight previous economies (i.e., M = 14).

Trade data (in value and volume) is drawn from Eurostat using the Harmonized Commodity Description and Coding System (HS nomenclature). The largest level of sectoral disaggregation is HS6. Additionally, for incorporating inter-sectoral similarity, exports data (in value) classified in terms of HS2 and HS4 are also considered.

We will be applying the methodological option that has proven to be the most relevant to this study in the 3rd section and producing examples for each of the 5 competition perspectives presented in the previous chapter. All off the data produced will illustrate the applicability of the indexes proposed for all the possibilities of competition.

Trade competition between two countries for one destination market

Firstly we focus on the perspective where we measure the competition between two countries a and b in market m. The trade competition assumes the exports of these countries in a given destination market. The economies chosen for this example are USA, India and China regarding with the destination market Germany. In the table below we have the values for E-HS6 that is the result of the modified Krugman index applied on the data from Eurostat for the highest level of disaggregation-HS6; S2 is the value for intersectoral similarity; A is the obtained value for intrasectoral similarity and C2 is the total similarity including all factors.

Table 1: USA, India, China exports to Germany

DE	CH-US	CH-IN	IN-US
E - HS6	0.252	**0.270**	0.185
S2	0.286	**0.311**	0.227
A	0.105	0.163	0.077
C2	0.176	**0.231**	0.146

Source: Designed by the author based on own calculations. Data sources: European Commission (EUROSTAT) (2016)

The values obtained for the three country pairs produce some interesting conclusions. Analysing the E-HS6 level we may observe that the Chinese and Indian economies result to be most similar, followed at a quite small difference by the Chinese and American similarity. After including the intersectoral similarity and intrasectoral similarity factors the difference becomes clearer with TCI_{CHINDE}=0.231. An interesting factor is that China and India are most similar at intersectoral level.

Trade competition between two countries in all the markets

Through this method we can measure the competition between countries *a* and *b* in all the markets. Applying this index we will compare countries *a* and *b* and also all the markets they export to. Considering the fact that this is an example we will take the same three countries as used in the previous example: China, India, United States and the four European markets: Germany, Italy, France and United Kingdom.

Table 2: USA, India, China exports to Germany, France, Italy and UK

IN-US

TCI	DE	FR	IT	UK
E6	0.055977	0.039239	0.021756	**0.07899**
S2	0.068646	0.045672	0.026407	**0.090153**
A	0.023153	0.013683	0.005933	**0.02755**
C	0.044028	0.026505	0.014539	**0.051573**

IN-CH

TCI	DE	FR	IT	UK
E6	0.039797	0.058382	0.054362	**0.113655**
S2	0.045848	0.06814	0.064053	**0.1297**
A	0.02403	0.034363	0.032331	**0.067148**
C	0.034023	0.050125	0.047529	**0.094819**

US-CH

TCI	DE	FR	IT	UK
E6	0.039278	0.043191	0.034521	**0.093739**
S2	0.044615	0.049653	0.055416	**0.107513**
A	0.016376	0.014894	0.009141	**0.038184**
C	0.027439	0.02843	0.036381	**0.065847**

Source: Designed by the author based on own calculations. Data sources: European Commission (EUROSTAT) (2016)

Above we have three tables with each country pair: India-United States, China-India and China- United States. It is very interesting to notice that through comparing either of India, China or United States in pars of two, in the same 4 countries as destination markets for their exports it is clear that the highest (marked with bold) competition between India-United States, China-India, China- United States lies in the British market. Comparing the results in the United Kingdom market, between all three country pairs, the highest similarity is between China and India, therefore the highest competition.

Competition faced by a country in a specific destination market

In this situation we measure the degree of competition that a country *a* faces in market *m* from all the other countries exporting to *m*. As explained before in the above example we measure the degree of competition that China faces in the German market from all the remaining countries (India, United States, Indonesia, Brazil, Russia, Mexico and Japan).

Table 3: Competition faced by China in German market

China in DE market

TCI	CH-IN	CH-US	CH-ID	CH-BR	CH-RU	CH-MX	CH-JP
E6	0.021679	**0.139509**	0.007928	0.005016	0.0075606	0.010252	2.5E-05
S2	0.024975	**0.158466**	0.009265	0.006387	0.0092729	0.012715	2.92E-05
A	0.01309	**0.058164**	0.004141	0.002218	0.0017379	0.004226	9.6E-06

C2	0.018534	**0.127855**	0.006424	0.004288	0.0049059	0.008196	1.8E-05

Source: Designed by the author based on own calculations. Data sources: European Commission (EUROSTAT) (2016)

Table 3 presents the competition faced by China in the German market, by all the other exporting countries to Germany. The country that China is the most similar with is United States clearly determined with higher values in all situations. The Chinese and American export pattern to the German market is very similar including intersectoral similarity and intrasectoral similarity.

Competition that a country faces in all markets

In this case we measure the degree of competition that a country a faces in all markets from all the other countries. For this empirical example it means measuring the competition that China is facing from all the countries (India, United States, Indonesia, Brazil, Russia, Mexico and Japan) in the European market (Germany, Italy, France, United Kingdom).

Table 4: Competition faced by China from India, USA, Indonesia, Brazil, Russia, Mexico, Japan in EU market

E6

TCI	**CH-IN**	**CH-US**	**CH-ID**	**CH-BR**	**CH-RU**	**CH-MX**	**CH-JP**
DE	1.87E-05	**0.000121**	6.85E-06	4.34E-06	6.54E-06	8.86E-06	2.16E-08
FR	0.005183	**0.028402**	0.001131	0.00096	0.001036	0.001456	0.005567
IT	0.006712	**0.017806**	0.00027	0.001307	0.001961	0.000937	0.005431
UK	0.011854	**0.067857**	0.002167	0.001243	0.00109	0.002803	0.01121

S2

TCI	**CH-IN**	**CH-US**	**CH-ID**	**CH-BR**	**CH-RU**	**CH-MX**	**CH-JP**
DE	2.16E-05	**0.000137**	8.01E-06	5.52E-06	8.02E-06	1.1E-05	2.53E-08
FR	0.006049	**0.032652**	0.001382	0.001185	0.00123	0.001924	0.006631
IT	0.007908	**0.028584**	0.000891	0.001762	0.002589	0.001268	0.006612
UK	0.013528	**0.077828**	0.002569	0.001603	0.001272	0.003406	0.013598

A

TCI	**CH-IN**	**CH-US**	**CH-ID**	**CH-BR**	**CH-RU**	**CH-MX**	**CH-JP**
DE	1.13E-05	**5.03E-05**	3.58E-06	1.92E-06	1.5E-06	3.65E-06	8.3E-09
FR	0.003051	**0.009794**	2.68E-05	0.000317	0.000346	0.000395	0.001984
IT	0.003992	**0.004715**	2.91E-07	0.000426	0.000368	0.000292	0.001636
UK	0.007004	**0.027642**	0.001031	0.000507	0.000391	0.001292	0.004465

C2

TCI	**CH-IN**	**CH-US**	**CH-ID**	**CH-BR**	**CH-RU**	**CH-MX**	**CH-JP**
DE	1.6E-05	**0.000111**	5.55E-06	3.71E-06	4.24E-06	7.09E-06	1.53E-08

FR	0.00445	**0.026458**	0.000554	0.000703	0.000712	0.001129	0.003943
IT	0.005868	**0.018766**	0.000689	0.001101	0.001395	0.000785	0.003766
UK	0.00989	**0.047666**	0.001717	0.001051	0.000748	0.002273	0.008539

Source: Designed by the author based on own calculations. Data sources: European Commission (EUROSTAT) (2016)

As the values indicate, for either of the situations, considering only the simple weights or also including the intersectoral similarity and intrasectoral similarity perspectives, the most similar markets are China and Unites States. This means that in all of the European markets China and United States are the most competitive.

Competition in a given market among all countries

In this situation we will measure the degree of competition in market m among all the countries exporting to that country. This perspective focuses on the competition in a singular market *m*, that in our example will be Germany and the competition among all countries that export to *m* (China, India, United States, Indonesia, Brazil, Russia, Mexico and Japan).

Table 5: Competition between all exporting countries to the German market

TCI DE	BR-CH	BR-ID	BR-IN	BR-JP	BR-MX	BR-RU	BR-US	CH-ID	JP-US
E6	0.000728	0.001241	0.002556	0.000735	0.001673	0.001542	0.009463	0.001167	**0.032211**
S2	0.000928	0.001546	0.003053	0.000918	0.001999	0.002039	0.011667	0.001363	**0.035647**
A	0.000322	0.000463	0.000908	0.000191	0.000743	0.000734	0.004106	0.000609	**0.017563**
C2	0.000623	0.000962	0.001817	0.00051	0.001301	0.001433	0.00765	0.000945	**0.024661**

TCI DE	ID-JP	ID-MX	ID-RU	ID-US	IN-JP	IN-MX	IN-RU	IN-US	JP-MX	JP-RU
E6	0.000667	0.001056	0.000651	0.007524	0.002061	0.002816	0.000962	0.016747	0.001714	0.001158
S2	0.00082	0.001388	0.001022	0.010076	0.002558	0.003445	0.001457	0.020537	0.002138	0.001358
A	0.000195	0.000309	8.76E-05	0.002328	0.0007	0.001194	0.000238	0.006927	0.000788	0.000268
C2	0.000466	0.000828	0.000599	0.00618	0.001538	0.002228	0.000914	0.013172	0.001443	0.000691

TCI DE	CH-IN	CH-JP	CH-MX	CH-RU	CH-US	ID-IN	MX-RU	MX-US	RU-US
E6	0.003139	5.33E-05	0.001497	0.001085	0.019949	0.003919	0.003198	0.023961	0.007163
S2	0.003616	6.24E-05	0.001856	0.00133	0.02266	0.004581	0.003463	0.028721	0.008223
A	0.001895	2.05E-05	0.000617	0.000249	0.008317	0.001911	0.001698	0.012064	0.004141
C2	0.002683	3.78E-05	0.001197	0.000704	0.013936	0.003075	0.002337	0.019799	0.005957

Source: Designed by the author based on own calculations. Data sources: European Commission (EUROSTAT) (2016)

All the exporters to Germany have been considered as country pairs and calculated to see the overall similarity, intersectoral similarity and intrasectoral similarity perspectives. From

all the perspectives the most similar in export structure to Germany have resulted to be the economies of Japan and United States.

5. Conclusion

There is a wide range of indexes that can be used to measure competition but not all result in being as efficient when measuring trade competition. One property that was fundamental when choosing the index to be further used in the measurement of all types of competition was the adaptability to be modified. None of the initially presented indexes provide inter-industry linkages therefore creating the need for a modified version of the most applicable index that is relevant to this study. The Krugman index was modified in order to measure all the types of competition, covering the competition between two countries in a certain market up to global competition and has provided relevant results. Further development of the topic would be widening the spectrum of competition. In order to obtain a complete study the geographical spectrum should be further researched.

To conclude, with the combined research done until this point a broad perspective on trade competition can be reached. Structural similarity is a very important component in trying to measure competition from any perspective (taking into account the competition between two markets in a certain market *m*, or any of the above presented types of competition) and through an empirical example it can reveal a relevant assessment.

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