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A contribution to a multidimensional analysis of trade competition

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Abstract: International trade grew substantially throughout the last decades and international relations became more important for the economic performance of the countries. Simultaneously new poles emerged in the international arena leading to growing competition for higher market shares. Therefore, trade competition is a critical dimension of analysis for applied international trade studies. We propose a conceptual framework for measuring this phenomenon by combining some critical previous contributions to build a multidimensional and more comprehensive concept, which defines trade competition as a function of the degree of both structural similarity and total exports overlap. Moreover, structural similarity should take into account three elements: sectoral shares similarity, inter-sectoral similarity (evaluating how different the distinct sectors are), and intra-sectoral similarity (proximity in terms of quality ranges exported). Several measures are proposed to empirically capture the concept suggested. Finally, we present an example including the exports of the three largest European economies to 122 destination markets in order to illustrate the application of the concept and the measures suggested.

Key words: trade competition, index, structural similarity, total exports overlap.

JEL Codes: F10, F14.

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1. INTRODUCTION

Economic globalization and the emergence of new poles in the world economy are among the most critical trends of (at least) the last three decades (Riad et al., 2012; Head and Mayer, 2013). As described by Kaplinsky and Messner (2008, p. 197), "the global economy is undergoing a profound and momentous shift". This profound geographical reconfiguration of international economic relations was driven by technological progress and the reduction of trade costs generated by the evolution in the transport sector and the liberalization trend that characterized the world economy in the second half of the twentieth century (Carter and Li, 2004). As a consequence of these transformations, international trade grew dramatically during the last decades and we are faced with a new scenario characterized by much more open and interdependent economies (Berthelon and Freund, 2008). Given the magnitude of actual trade flows and their importance for the overall economic performance of the countries (and the firms), the phenomenon of trade competition requires special attention and needs to be seen as a priority in the agenda of international trade research. Given the emergence of China as a major world trade player (Kaplinsky and Messner, 2008), the high attention that this case has received so far it is not surprising, with many studies analyzing the impact of the Chinese trade growth for other countries in several destination markets (e.g., Lall and Albaladejo, 2004; Lall et al., 2005; Blázquez-Lidoy et al., 2006; Greenaway et al., 2008; Jenkins et al., 2008; Schott, 2008; Jenkins, 2012; Giovannetti et al., 2013).

However, despite its central role for a correct analysis of a reality that is rapidly changing, this concept is not yet fully internalized by applied international trade literature. In fact, the many empirical studies already produced in this area do not benefit from a global conceptual framework, and are instead evaluated through different

empirical perspectives and measures. Each indicator used captures some important dimension of trade competition between two countries but lacks the consideration of other important elements. They are therefore, at best, partial measures of the phenomenon under consideration.

The most common approach to this subject evaluates the similarity in sectoral shares (structural similarity) as a proxy of trade competition (Wu and Chen, 2004; Blázquez-Lidoy et al., 2006; Langhammer and Schweickert, 2006; Schott, 2008; Duboz and Le Gallo, 2011; Vandenbussche et al., 2013). The Krugman Specialization Index (Krugman, 1991) and the Finger-Kreinin index (Finger and Kreinin, 1979) are commonly used as baseline indicators (Palan, 2010). Retaining this spirit but using an even simpler approach, other studies calculate correlation coefficients between the sectoral shares, the ranking of these sectoral shares, or the ranking of revealed comparative advantage measures (Lall and Albaladejo, 2004; Shafaeddin, 2004; De Benedictis and Tajoli, 2007).

Another dimension considered in the empirical literature is the level of intra-sectoral similarity, i.e., the proximity in terms of quality ranges exported. In fact, the growing pattern of vertical specialization (Fontagné et al., 2008; Kaitila, 2010; Vandenbussche et al., 2013) leads some researchers to consider measures that capture the similarity in terms of sectoral shares and quality ranges simultaneously (Antimiani and Henke, 2007). Crespo and Simões (2012) alert to the advantage of considering an even larger measure of structural similarity, which besides sectoral shares similarity also incorporates inter-sectoral similarity (evaluating how different the distinct sectors are) and intra-sectoral similarity.

Finally, in another important milestone in this literature, Jenkins (2008) puts the emphasis on the concept of competitive threat and highlights that a measure that attends

only to structural similarity and ignores the level of overlap between total exports of the two countries under comparison is strongly affected in its capacity to evaluate the critical aspects that are at the heart of the trade competition reality at the world level.

From all this, there is a clear need for new contributions in this research area, namely with the objective of providing innovative insights regarding the measuring of the phenomenon of trade competition between two countries. This is the main goal of this paper.

The approach developed in this study takes the Krugman Specialization Index as a starting point and incorporates the two main contributions of the study by Crespo and Simões (2012), thereby leading to a measure of structural similarity that accounts for the three critical dimensions of this phenomenon simultaneously: sectoral shares similarity, inter-sectoral similarity, and intra-sectoral similarity. By doing so, we are able to obtain a richer measure of structural similarity. However, this is not enough to capture the real concept of trade competition. For that we need to add to our measure of structural similarity a way to incorporate the overlap between total exports of the two countries (i.e., the ratio between the value of exports from the smaller country and the value of exports from the larger country). Inspired by Jenkins (2008), we propose an adjustment to our previous indicator, obtaining distinct indexes for each of the two countries under analysis.

While the common approach evaluates trade competition between two countries in a specific destination market, we complement our methodological proposal by considering not only a set of measures that correspond to this perspective but also indicators that aim to quantify the overall level of competition between two countries, i.e., in a group of countries to which they export. Formally, our approach is summarized through equations (1) to (3):

$$\text{Structural similarity}_{ihm} = f(\text{sectoral shares similarity, inter-sectoral similarity, intra-sectoral similarity}) \quad (1)$$

$$\text{Trade competition}_{ihm} = f(\text{structural similarity, total exports overlap}) \quad (2)$$

$$\text{Trade competition}_{ih} = f(\text{structural similarity, total exports overlap}) \quad (3)$$

where i and h are the exporting countries and m identifies a specific destination market. The remainder of the paper is structured as follows. Section 2 presents our measure of structural similarity. Section 3 introduces the overlap between total exports in the analysis of trade competition. Section 4 summarizes the measures proposed in this study according to the dimensions included in each index. Section 5 extends the previous approach by considering the level of trade competition between two countries in a group of destination markets. Section 6 illustrates our methodological proposal through an empirical example considering export data for Germany, France, and the United Kingdom. Section 7 presents some final remarks.

2. STRUCTURAL SIMILARITY

a) Sectoral Shares Similarity

The Krugman Specialization Index (KSI) is one of the most widely used indexes of structural similarity (Palan, 2010) and is therefore taken as the starting point for this study. The KSI compares the share of each sector in two export structures. As defined in the Introduction let *i* and *h* be two countries exporting to a market *m* ($m = 1, 2, \ldots, M$) and *j* the sectoral index ($j = 1, 2, \ldots, J$). The index is expressed as follows:

$$K_{ihm} = \sum_{j=1}^{J} \left| v_{jim} - v_{jhm} \right|. \quad (4)$$

The weights of sector *j* in the export structure of *i* and *h* to *m* are expressed, respectively, as v_{jim} and v_{jhm}. Additionally, $v_{jim} = x_{jim}/x_{im}$, where x_{jim} are the

exports of sector j from i to m and x_{im} are the total exports from i to m. The same definitions apply to v_{jhm}. K_{ihm} ranges between 0 (perfect similarity between the two export structures) and 2 (maximum dissimilarity).

This index has two counter-intuitive characteristics. First, the admissible range does not provide an immediate quantitative message regarding the level of structural similarity. Second, despite being a measure of structural similarity, it increases with structural dissimilarity. In order to overcome these two problems, we consider as our baseline index a modified version of the KSI, expressed as:

$$E_{ihm} = 1 - \beta \sum_{j=1}^{J} \left| v_{jim} - v_{jhm} \right|. \quad (5)$$

The most common value for β is 0.5. We assume this value for β throughout. Therefore, E_{ihm} ranges between 0 and 1. In this first perspective, the level of structural similarity is maximum (i.e., $E_{ihm} = 1$) when the weights of each sector are equal in the exports of countries *i* and *h* to market *m*.

b) Inter-sectoral Similarity

The traditional approach to measure structural similarity (i.e., KSI or its adaptations) does not consider the degree of dissimilarity between sectors. With the aim of adjusting E_{ihm} in order to capture this dimension, we propose a generalized version of the procedure suggested by Crespo and Simões (2012). To that end, making use of the different levels of sectoral disaggregation that comprise a specific statistical nomenclature, we calculate the weighted average of the structural similarity indexes obtained at each level of sectoral disaggregation ($g = 1, 2, \dots, G$), with the weight of each level given by α^g:

$$S_{ihm} = \sum_{g=1}^{G} \alpha^g E_{ihm}^g \,, \tag{6}$$

with $\sum_{g=1}^{G} \alpha^g = 1$. E_{ihm}^g is calculated as in equation (5) for each level g.

This procedure allows us to take into account that some sectors are more similar in terms of their characteristics and production requirements. In comparison to E_{ihm}, S_{ihm} allows that distinct sectors at a higher level of sectoral disaggregation are classified as more similar if, when lower levels of disaggregation are considered, they belong to the same sector than when that does not occur.

The weights assigned to each level of disaggregation depend on the importance that the researcher gives to this dimension of structural similarity. Greater importance to this dimension implies more weight to less disaggregated levels of sectoral analysis.

c) Intra-sectoral Similarity

Several studies have reported an increasing specialization by quality ranges at the international level, suggesting that besides inter-sectoral differences between the specialization patterns of the countries, there are important intra-sectoral differences (Fontagné et al., 2008; Kaitila, 2010; Vandenbussche et al., 2013). In order to incorporate this aspect in the evaluation of the degree of structural similarity, it is necessary to measure the quality of the goods, which, by definition is a complex task. When we consider trade data, the use of unit export values as a quality proxy is the usual procedure to overcome this problem (Stiglitz, 1987).

To incorporate intra-sectoral similarity in the structural similarity index we evaluate the difference, for each sector, between the quality level of the exports from the two countries under consideration. To that end we calculate the index O_{ihm} as follows:

$$O_{ihm} = \sum_{j=1}^{J} \varepsilon_{jihm} Z_{jihm}, \tag{7}$$

with

$$\varepsilon_{jihm} = \frac{v_{jim}+v_{jhm}}{2}, \quad (8)$$

and

$$Z_{jihm} = \frac{Min\,[UV(x_{jim}),UV(x_{jhm})]}{Max\,[UV(x_{jim}),UV(x_{jhm})]}. \quad (9)$$

For sector j, $UV(x_{jim})$ and $UV(x_{jhm})$ are the unit values of the exports from i and h to m, respectively.

O_{ihm} works as an adjustment factor that reduces the level of structural similarity between i and h according to the average degree of intra-sectoral dissimilarity. In its turn, the degree of intra-sectoral similarity is calculated considering a weighted average of the differences, in each sector, in terms of quality ranges. The weights – expressed by ε_{jihm} – are the average share of j in the exports from i and h to m.

Therefore, the indicator capturing sectoral shares similarity and intra-sectoral similarity is obtained as:

$$A_{ihm} = O_{ihm}E_{ihm}. \quad (10)$$

When the unit export values of i and h to m are exactly the same, $Z_{jihm} = 1$. If this is the case for all products, $O_{ihm} = 1$ and, therefore, $A_{ihm} = E_{ihm}$. A greater difference in the unit export values implies a greater penalization on E_{ihm}, indicating a lower degree of structural similarity between i and h.

d) Structural Similarity – An Overall Index

In the above subsections we discussed indexes of structural similarity that incorporates three dimensions – sectoral shares, inter-sectoral, and intra-sectoral similarity. Now, in order to obtain an overall measure of structural similarity we construct an index that simultaneously includes all these dimensions:

$$C_{ihm} = \sum_{g=1}^{G-1} \alpha^g E_{ihm}^g + \alpha^G E_{ihm}^G O_{ihm}^G. \quad (11)$$

The index C_{ihm} takes its maximum value (i.e., $C_{ihm} = 1$) when the exports of i and h to market m are equal in terms of the three dimensions of structural similarity considered.

3. TOTAL EXPORTS OVERLAP

All the indexes discussed above are (partial or overall) measures of structural similarity. In this section we argue that the competition between two countries in a given market depends not only on the level of structural similarity but also on the value of total exports and, more specifically, on the degree of overlap between these two flows.

A simple example illustrates the point. Let us consider three countries – A, B, and C – and assume that the weights of all sectors are equal in the three countries, the only difference being the overall value of their exports, which is similar between A and B but very different between these countries and C. Although E_{ihm} indicates a similar level of structural similarity between all pairs of countries (in this case, maximum similarity), these situations are distinct and express different levels of trade competition.

This question was introduced by Jenkins (2008) by referring that structural similarity indexes capture only the composition of the exports of the two countries under comparison and that this procedure implies obtaining a single value for a pair of countries. According to Jenkins (2008, p. 1355), "no index which implies that Honduras is as much a competitive threat to China's export markets as China is for Honduran

exports is credible". To overcome this limitation, Jenkins (2008) introduces two new indicators: the static and the dynamic index of competitive threat. These indexes reflect the proportion of total exports of a country concentrated in products in which the other country is globally competitive.

Following a different perspective, we incorporate the overlap between total exports by adjusting the structural similarity indicators. Obviously, accounting for this dimension implies obtaining not a single value per pair of countries but instead a value for each of the two countries under comparison. We start by proposing an adjustment to E_{ihm} in order to take into account the level of total exports overlap between the two countries under analysis, which is expressed as:

$$\mu_{ihm} = \frac{\text{Min}\,[x_{im}, x_{hm}]}{\text{Max}\,[x_{im}, x_{hm}]}. \tag{12}$$

The extension in which the structural similarity index is adjusted depends, once again, on the importance given to this dimension. Thus, we have[1]:

$$B_{ihm} = \left(1 - \frac{1-\mu_{ihm}}{\lambda}\right) E_{ihm}. \tag{13}$$

The influence of the total exports overlap decreases as the parameter λ increases ($\lambda \geq 1$), with B_{ihm} converging to E_{ihm}. On the contrary, when $\lambda = 1$, the impact is fully captured and therefore $B_{ihm} = \mu_{ihm} E_{ihm}$.

In this case, trade competition is maximum when both the weights of each sector and total exports are equal in the two countries. In all the cases in which $x_{im} \neq x_{hm}$ we will have a trade competition index assuming different values for the countries under analysis ($B_{\underline{i}hm}$ for country i and $B_{i\underline{h}m}$ for country h). This is an important characteristic of this dimension. In the following steps of our methodological approach, when we

[1] In generic terms, we could consider λ_{ihm}. However, it seems reasonable to assume a constant value for λ.

combine this dimension with other dimensions we will also obtain different values for countries i and h. $B_{\underline{i}hm}$ and $B_{i\underline{h}m}$ are based on the following reasoning: for the larger exporter, the trade competition index is equal to B_{ihm}, while for the smaller exporter the index corresponds to E_{ihm} plus a proportion of the difference between E_{ihm} and B_{ihm}. They are given by:

$$B_{\underline{i}hm} = \begin{cases} B_{ihm}\ if\ x_{im} > x_{hm} \\ E_{ihm} + \gamma(E_{ihm} - B_{ihm})\ if\ x_{im} \leq x_{hm} \end{cases} \quad (14)$$

and

$$B_{i\underline{h}m} = \begin{cases} B_{ihm}\ se\ x_{hm} > x_{im} \\ E_{ihm} + \gamma(E_{ihm} - B_{ihm})\ se\ x_{hm} \leq x_{im} \end{cases}. \quad (15)$$

When $\gamma = 1$, $B_{\underline{i}hm}$ and $B_{i\underline{h}m}$ range between 0 and 2.

If we wish to take into account all the dimensions of structural similarity – sectoral shares similarity, inter-sectoral similarity, and intra-sectoral similarity – and the degree of total exports overlap, we can obtain a new index of trade competition:

$$U_{ihm} = \sum_{g=1}^{G-1} \alpha^g B_{ihm}^g + \alpha^G\ B_{ihm}^G O_{ihm}^G, \quad (16)$$

where:

$$B_{ihm}^g = \left(1 - \frac{1-\mu_{ihm}}{\lambda}\right) E_{ihm}^g. \quad (17)$$

Since B_{ihm}^g varies by country, we can also obtain indicators U_{ihm} for each country. $U_{\underline{i}hm}$ and $U_{i\underline{h}m}$ are calculated using the same logic of U_{ihm}:

$$U_{\underline{i}hm} = \sum_{g=1}^{G-1} \alpha^g B_{\underline{i}hm}^g + \alpha^G B_{\underline{i}hm}^G O_{\underline{i}hm}^G \quad (18)$$

and

$$U_{i\underline{h}m} = \sum_{g=1}^{G-1} \alpha^g B_{i\underline{h}m}^g + \alpha^G B_{i\underline{h}m}^G O_{i\underline{h}m}^G. \quad (19)$$

4. TAKING STOCK

Table 1 summarizes all the indicators presented until this moment, highlighting the dimensions captured by each of them. Each of these indicators is a trade competition index between i and h in market m and hereinafter will be designated in generic terms as TCI_{ihm}.

[Insert Table 1 here]

5. TRADE COMPETITION IN A GROUP OF MARKETS

We discussed above the case of competition between two countries in a given market. Taking as starting point a narrow concept of competition based only on sectoral shares, we have gradually extended this framework by taking into account additional dimensions of this phenomenon, thereby developing a methodological proposal that is better able to allow a more in-depth knowledge of trade competition.

The main goal of the present section is to take a step forward by presenting an indicator that evaluates the degree of trade competition between two countries in a group of markets (instead of only one).[2] By broadening the spectrum of analysis, we gain an overall picture about the competitive threat that one country represents to another in all markets in which they compete.

Going from TCI_{ihm} to TCI_{ih} indicators introduces a new methodological problem. Each country (potentially) exports to $(M-1)$ countries. However, this group of

[2] According to the purpose of the analysis, this group of markets can include all destination markets or only a subgroup.

destination countries is not equal, there is one element that is different. In fact, while country i can export to country h, country h can export to country i. Our suggestion to overcome this problem involves the direct comparison of the bilateral flows between countries *i* and h in their respective export structure.

To analyze the level of trade competition between countries *i* and *h* in their exports to a group of destination markets, we calculate an overall index based on a weighted average of trade competition in each individual market. This index is expressed as follows:

$$L_{ih}^{TCI} = \sum_{\substack{m=1 \\ m\neq i,h}}^{M} TCI_{ihm}\delta_{ihm} + TCI_{i-h}\left(1 - \sum_{\substack{m=1 \\ m\neq i,h}}^{M} \delta_{ihm}\right) \quad (20)$$

with TCI_{i-h} being the index of trade competition, calculated in the same way as TCI_{ihm}, which compares the exports from i to h with the exports from h to i. In turn, δ_{ihm} is given by:

$$\delta_{ihm} = \frac{(\delta_{im}+\delta_{hm})}{2}, \quad (21)$$

where $\delta_{im} = \frac{x_{im}}{\sum_{m=1}^{M} x_{im}}$ and $\delta_{hm} = \frac{x_{hm}}{\sum_{m=1}^{M} x_{hm}}$.

In this case, maximum overall competition requires the existence of maximum similarity in the trade flows for each destination market.

L_{ih} can be based on any of the TCI_{ihm} discussed in the previous sections. We will designate the L_{ih} obtained from E_{ihm} as L_{ih}^{E}, from A_{ihm} as L_{ih}^{A}, and so on.

6. AN EXAMPLE

Throughout the previous sections we proposed a conceptual framework to measure the degree of trade competition between two countries. In order to illustrate the methodology, we now present an empirical example. We analyze the trade competition

between the three largest European economies – Germany (DE), France (FR), and the United Kingdom (GB). As destination markets we include, in addition to these countries, a total of 119 markets (i.e., $M = 122$), corresponding to the near totality of trade flows from these countries (Germany: 99.67%; France: 99.25%; and the United Kingdom: 99.28%).[3] Trade data (in value and volume) – concerning 2011 – 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.

Applying the methodological proposal presented in Sections 2 to 5 to these data produces a large amount of very rich evidence. We will focus the analysis on the index described in Section 5 (L_{ih}) because this is built from the previous ones, and it is therefore possible to see how the different dimensions add to the understanding of the level of competition between each of the three pairs of countries.

(i) Sectoral Shares Similarity

[3] In addition to Germany, France, and the United Kingdom, the set of destination countries includes: Afghanistan (AF), Albania (AL), Algeria (DZ), Andorra (AD), Angola (AO), Argentina (AR), Australia (AU), Austria (AT), Azerbaijan (AZ), Bahrain (BH), Bangladesh (BD), Belarus (BY), Belgium (BE), Benin (BJ), Bosnia and Herzegovina (BA), Brazil (BR), Bulgaria (BG), Cameroon (CM), Canada (CA), Cayman Islands (KY), Chile (CL), China (CN), Colombia (CO), Congo (CG), Democratic Republic of Congo (CD), Costa Rica (CR), Cote d'Ivoire (CI), Croatia (HR), Cuba (CU), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Dominican Republic (DO), Ecuador (EC), Egypt (EG), Equatorial Guinea (GQ), Estonia (EE), Ethiopia (ET), Finland(FI), Gabon (GA), Ghana (GH), Gibraltar (GI), Greece (GR), Guinea (GN), Hong Kong (HK), Hungary (HU), Iceland (IS), India (IN), Indonesia (ID), Iran (IR), Iraq (IQ), Ireland (IE), Israel (IL), Italy (IT), Japan (JP), Jordan (JO), Kazakhstan (KZ), Kenya (KE), South Korea (KR), Kuwait (KW), Latvia (LV), Lebanon (LB), Liberia (LR), Libya (LY), Liechtenstein (LI), Lithuania (LT), Luxembourg (LU), Malaysia (MY), Mali (ML), Malta (MT), Mauritania (MR), Mauritius (MU), Mexico (MX), Moldova (MD), Morocco (MA), the Netherlands (NL), New Caledonia (NC), New Zealand (NZ), Nigeria (NG), Norway (NO), Oman (OM), Pakistan (PK), Panama (PA), Peru (PE), Philippines (PH), Poland (PL), Portugal (PT), Qatar (QA), Romania (RO), Russian Federation (RU), Saudi Arabia (SA), Senegal (SN), Serbia (XS), Singapore (SG), Slovakia (SK), Slovenia (SI), South Africa (ZA), Spain (ES), Sri Lanka (LK), Sudan (SD), Sweden (SE), Switzerland (CH), Syria (SY), Taiwan (TW), Tanzania (TZ), Thailand (TH), Togo (TG), Tunisia (TN), Turkey (TR), Turkmenistan (TM), Ukraine (UA), United Arab Emirates (AE), United States (US), Uruguay (UY), Uzbekistan (UZ), Venezuela (VE), Vietnam (VN), British Virgin Islands (VG), and Yemen (YE).

We will start with the L_{ih} based on E_{ihm} which is the index most frequently used in the literature to analyze structural similarity and which, for this reason, will provide a benchmark to measure the impact of the remaining dimensions of trade competition considered.

The results in the first line of Table 2 show that when we consider a group of destination markets that represent almost the total exports of these countries, there are very high levels of similarity in the exports structures of these countries.

[Insert Table 2 here]

Second, Germany-France (DE-FR) is the country pair that shows the highest overall level of structural similarity ($L^{E}_{DE,FR}$ = 0.434). The other two pairs reveal lower levels of structural similarity: Germany-United Kingdom (DE-GB) ranks second with $L^{E}_{DE,GB}$ = 0.356 followed by France-United Kingdom (FR-GB) with $L^{E}_{FR,GB}$ = 0.332. In Figure 1, for each of the three country pairs, we show the values of E_{ihm} and the average weight of each individual market m (i.e., δ_{ihm}). An interesting finding emerging from this figure is the strong association between the average weight of each market and E_{ihm}. The correlation coefficients are 0.546 in the case of the link between $E_{FR,DE,m}$ and $\delta_{FR,DE,m}$, 0.425 for $E_{DE,GB,m}$ and $\delta_{DE,GB,m}$, and 0.409 for $E_{FR,GB,m}$ and $\delta_{FR,GB,m}$. This pattern suggests that the most important destination markets are those in which each pair competes more fiercely (for the pairs DE-GB and FR-GB, Switzerland is the exception).

[Insert Figure 1 here]

(ii) Inter-sectoral Similarity

The incorporation of inter-sectoral similarity requires assigning weights to the different levels of sectoral disaggregation (HS2, HS4, and HS6). To minimize the subjectivity in this process, we tested three alternative sets of values for these weights ($\alpha_1, \alpha_2,$ and α_3) – see Table 2 – gradually increasing the importance attributed to less disaggregated levels (HS2 and HS4). Each of these alternatives leads to a different S_{ihm} indicator ($S_{ihm}{}^{(1)}$, $S_{ihm}{}^{(2)}$, and $S_{ihm}{}^{(3)}$) and consequently to a different L_{ih}.

The results shown in Table 2 support two main conclusions. First, in comparison to the evidence drawn from L_{ih}^{E}, there is an increase in the level of trade competition found in all pairs of countries. Second, this increase is more pronounced for the pair FR-GB. $L_{FR,GB}^{E}$ is 0.332 while, for example, $L_{FR,GB}^{S^{(2)}}$ rises to 0.376. This represents a growth of 13.0%, which compares with increases of 9.4% and 11.7% for DE-FR and DE-GB, respectively. This evidence is not surprising since this is the pair ranking last when we measure trade competition using an index that includes only sectoral shares (defined according to HS6).

In Table 3, we present some complementary evidence. For each pair, the destination markets were ranked according to their average weight in total exports from the smallest to the largest value and then divided into ten groups (the number of destination markets for each pair is 121 and, except for the first group – less relevant markets – which includes 13 countries, the other nine groups have 12 countries each). For the three pairs the 24 most important markets (Groups 9 and 10) absorb more than 80% of total exports. For each group we selected a set of indicators ($E_{ihm}, S_{ihm}{}^{(2)}, A_{ihm}, B_{ihm}{}^{(2)}, U_{ihm}{}^{(5)}$) and present their average values ($\bar{E}_{ihm}, \bar{S}_{ihm}{}^{(2)}, \bar{A}_{ihm}, \bar{B}_{ihm}{}^{(2)}, \bar{U}_{ihm}{}^{(5)}$, respectively).

[Insert Table 3 here]

In the last three columns of Table 3 we calculate, for each group of destination markets, the ratios between the average values of TCI_{ihm} indexes and the average values of E_{ihm}. From this evidence we obtain a deeper understanding about the causes of the higher increase of the L_{ih}^{S} indicators (in comparison to L_{ih}^{E}) for the pair FR-GB. First, this occurs in a more pronounced way in the cases of the 49 less important markets (Groups 1 to 4). Second, the pattern also emerges in the 48 more important markets (Groups 7 to 10), although with smaller differences than those found for the other two pairs.

(iii) Intra-sectoral Similarity

Table 4 contains the results for L_{ih} based on A_{ihm} – accounting for sectoral shares similarity and intra-sectoral similarity – and C_{ihm} – also including inter-sectoral similarity. To that end, we use alternative values for the parameters involved in these indexes.

[Insert Table 4 here]

A first important finding is that there is a stronger similarity in the quality ranges of the products exported by Germany and France, meaning that the gap between L_{ih}^{A} and L_{ih}^{E} is lower for this country pair and higher for the case of France-United Kingdom ($\frac{L_{DE,FR}^{A}}{L_{DE,FR}^{E}}$ = 0.630 compares with $\frac{L_{DE,GB}^{A}}{L_{DE,GB}^{E}}$ = 0.572 and $\frac{L_{FR,GB}^{A}}{L_{FR,GB}^{E}}$ = 0.524). Complementing this result with the evidence from Table 3, we see that the difference (in relative terms) between $\bar{A}_{ihm}$ and $\bar{E}_{ihm}$ is smaller for the pair DE-FR than for the other two pairs and that this higher similarity is found for all ten groups of countries with the exception of Group 6.

Turning now to L_{ih} based on C_{ihm}, what occurs in this case is a consequence of what we concluded from the pieces we have gathered until this moment: France-United Kingdom

is the pair with the highest increase in their level of structural similarity when we incorporate inter-sectoral similarity; Germany-France is the pair with the highest similarity in terms of sectoral shares and quality ranges. As the weights given to HS2 and HS4 increase, we observe a convergence between $L^{C}_{FR,GB}$ and the L^{C}_{ih} for the other two country pairs (i.e., $L^{C}_{DE,FR}$ and $L^{C}_{DE,GB}$).

(iv) Total exports overlap

The L^{B}_{ih} indexes attend simultaneously to sectoral shares similarity and total exports overlap (Table 5). With $\lambda = 1$ (full incorporation of the total exports overlap dimension), from $L^{B(1)}_{ih}$ it is possible to conclude that there is a more pronounced decrease in the indicators that involve Germany ($L^{E}_{DE,FR}$ = 0.434 drops to $L^{B(1)}_{DE,FR}$ = 0.198; $L^{E}_{DE,GB}$ = 0.356 drops to $L^{B(1)}_{DE,GB}$ = 0.125). This occurs because German exports are 149% higher than French exports and 205% higher than exports from the United Kingdom.

[Insert Table 5 here]

In the case of $L^{B(2)}_{ih}$ and $L^{B(3)}_{ih}$ the indicators suffer a lower decrease. Nevertheless, the qualitative impact is similar concerning the ranking of the more penalized country pairs. We can see in Table 3 that in all but one group of countries (Group 2), it is for the pair FR-GB that we find a narrower gap between $\bar{E}_{ihm}$ and $\bar{B}_{ihm}{}^{(2)}$. Nevertheless, concerning the other two pairs we do not find a coherent pattern, with the ranking depending on the group we are considering.

Regarding L^{U}_{ih}, the overall trade competition indexes capturing simultaneously the three dimensions of structural similarity and total exports overlap, we calculate nine

alternatives resulting from varying the values given to $\alpha_1, \alpha_2, \alpha_3$, and λ. From the results obtained in Table 5 we conclude that it is for the country pair DE-GB that L_{ih}^{U} registers the strongest decrease (in all 9 variants of L_{ih}^{U} calculated). This arises from a combination of effects: (i) DE-GB is the pair revealing more pronounced differences in total exports; and (ii) an intermediate position in all other dimensions of structural similarity (sectoral shares similarity, inter-sectoral similarity, and intra-sectoral similarity). Another interesting result is a shorter gap between $L_{DE,FR}^{U}$ and $L_{FR,GB}^{U}$ than between $L_{DE,FR}^{E}$ and $L_{FR,GB}^{E}$. This occurs because the pair DE-FR is more similar in terms of sectoral shares and quality ranges while the pair FR-GB is closer in terms of inter-sectoral similarity and total exports.

(v) An Analysis by Exporting Country

Finally, Table 6 contains evidence concerning the idea introduced in Section 3 that to measure competition for one pair of countries, instead of only one index we should have a different value for each of the countries under consideration. For this analysis, we have selected some L_{ih}^{B} and L_{ih}^{U} indicators with different values for the parameters.

[Insert Table 6 here]

There are interesting results to highlight. First, the gap between $L_{DE,FR}^{B(2)}$ and $L_{\underline{DE},FR}^{B(2)}$ is very small ($L_{DE,FR}^{B(2)}$ = 0.316; $L_{\underline{DE},FR}^{B(2)}$ = 0.322). Second, the same occurs between $L_{DE,GB}^{B(2)}$ and $L_{\underline{DE},GB}^{B(2)}$ ($L_{DE,GB}^{B(2)}$ = 0.240; $L_{\underline{DE},GB}^{B(2)}$ = 0.251). These two results arise because German exports for each destination market are higher than the values presented by France and the United Kingdom in almost all individual markets. As a consequence $L_{DE,\underline{FR}}^{B(2)}$ and $L_{DE,\underline{GB}}^{B(2)}$ increase by 72.9 % and 91.6% in comparison to $L_{DE,FR}^{B(2)}$ and $L_{DE,GB}^{B(2)}$,

respectively. Third, for approximately two thirds of the destinations markets, total exports are higher for France than for the United Kingdom. For this reason, in comparison to $L^{B(2)}_{FR,GB}$, the indicator for the United Kingdom – $L^{B(2)}_{FR,\underline{GB}}$ – increases more than for France – $L^{B(2)}_{\underline{FR},GB}$ ($L^{B(2)}_{FR,GB} = 0.261$; $L^{B(2)}_{\underline{FR},GB} = 0.310$; $L^{B(2)}_{FR,\underline{GB}} = 0.355$). Nevertheless, the gap between $L^{B(2)}_{\underline{FR},GB}$ and $L^{B(2)}_{FR,\underline{GB}}$ is smaller than what we found before in the pairs involving Germany. Fourth, the findings for the indicators L^{U}_{ih} are similar to those using the L^{B}_{ih} indicators.

7. CONCLUSION

The main goal of the present study was the methodological discussion of a set of measures that allow a broader understanding of the concept of trade competition. We defined this concept as being a function of both structural similarity and total exports overlap while, in turn, the first concept encapsulates three dimensions: (i) sectoral shares similarity, as in the standard Krugman Specialization Index or similar measures; (ii) intra-sectoral similarity; and (iii) inter-sectoral similarity. Building on this multidimensional concept, we propose indexes that allow the quantification of the trade competition phenomenon both in a specific destination market and in a group of markets.

In order to provide an empirical example of the methodology proposed, we considered evidence from the three largest European economies – Germany, France, and the United Kingdom.

As our main contribution is a methodological one, the challenge now concerns the application of the measures suggested in this paper to a broad range of different countries and time periods. This is a critical step toward a better understanding of a

complex and dynamic phenomenon with evident implications for the countries in terms of competitiveness and growth. In the methodological sphere, further research must be devoted to a detailed identification of the contribution of the different dimensions considered to the final level of trade competition between the countries. However, perhaps the main ideas to retain from this study is that the study of trade competition is a fundamental issue in the context of the empirical analysis of international trade and that the development of better measures for this concept is a critical task for international trade researchers.

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TABLE 1

Trade Competition Indexes

TCI_{ihm}	Structural similarity			Total exports overlap	Parameters
	Sectoral shares similarity	Inter-sectoral similarity	Intra-sectoral similarity		
E_{ihm}	x				β
S_{ihm}	x	x			$\beta, \alpha^G (g = 1, \dots, G)$
A_{ihm}	x		x		β
C_{ihm}	x	x	x		$\beta, \alpha^G (g = 1, \dots, G)$
B_{ihm}	x			x	β, λ
U_{ihm}	x	x	x	x	$\beta, \alpha^G (g = 1, \dots, G), \lambda$

TABLE 2

Trade Competition Indexes Considering Sectoral Shares Similarity and Inter-sectoral Similarity for the Three Country Pairs

TCI_{ihm}	α_1	α_2	α_3	$L^{TCI}_{DE,FR}$	$L^{TCI}_{DE,GB}$	$L^{TCI}_{FR,GB}$	$\frac{L^{TCI}_{DE,FR}}{L^{E}_{DE,FR}}$	$\frac{L^{TCI}_{DE,GB}}{L^{E}_{DE,GB}}$	$\frac{L^{TCI}_{FR,GB}}{L^{E}_{FR,GB}}$
E_{ihm}				0.434	0.356	0.332	1.000	1.000	1.000
${S_{ihm}}^{(1)}$	0.025	0.075	0.9	0.448	0.370	0.347	*1.032*	1.040	**1.045**
${S_{ihm}}^{(2)}$	0.1	0.15	0.75	0.474	0.397	0.376	*1.094*	1.117	**1.130**
${S_{ihm}}^{(3)}$	0.2	0.3	0.5	0.515	0.439	0.419	*1.188*	1.235	**1.260**

Note: Bold is used for the country pair having the highest value of the ratio $\frac{L^{TCI}_{ihm}}{L^{E}_{ihm}}$; and italics for the pair with the minimum value.

FIGURE 1

The Relationship between E_{ihm} and the Average Weight of a Destination Market (δ_{ihm})

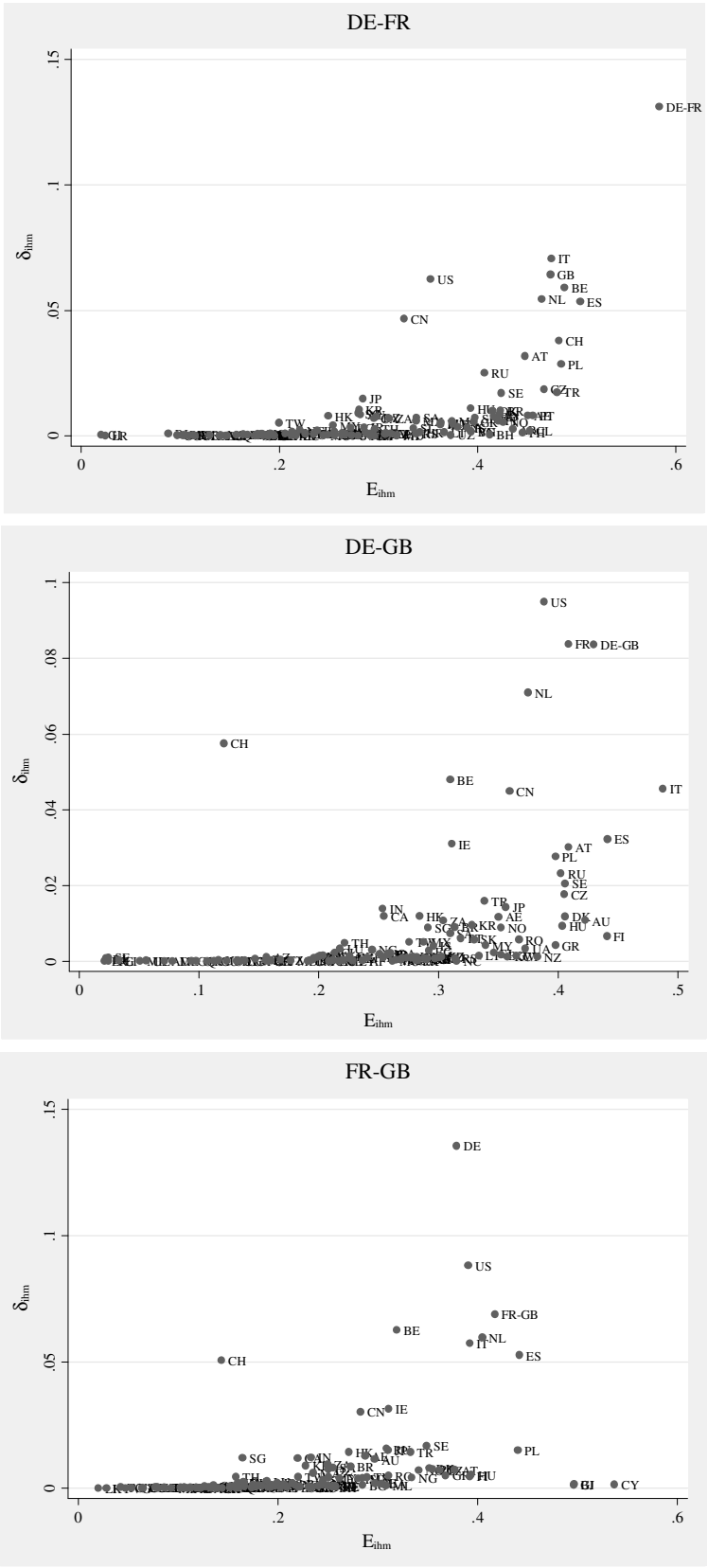

TABLE 3

Trade Competition Indexes per Groups of Destination Markets

	TCI_{ihm}	$\overline{TCI}_{DE,FR,m}$	$\overline{TCI}_{DE,GB,m}$	$\overline{TCI}_{FR,GB,m}$	$\frac{\overline{TCI}_{DE,FR,m}}{\bar{E}_{DE,FR,m}}$	$\frac{\overline{TCI}_{DE,GB,m}}{\bar{E}_{DE,GB,m}}$	$\frac{\overline{TCI}_{FR,GB,m}}{\bar{E}_{FR,GB,m}}$
Group 1	E_{ihm}	0.195	0.136	0.089	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.236	0.178	0.127	*1.210*	1.309	1.418
	A_{ihm}	0.066	0.037	0.019	0.340	0.272	*0.216*
	$B_{ihm}^{(2)}$	0.125	0.097	0.070	*0.642*	0.714	0.786
	$U_{ihm}^{(5)}$	0.089	0.074	0.058	*0.457*	0.547	0.654
	Weight	0.227%	0.114%	0.191%			
Group 2	E_{ihm}	0.177	0.143	0.141	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.216	0.187	0.187	*1.220*	1.310	1.329
	A_{ihm}	0.061	0.038	0.041	0.345	*0.264*	0.290
	$B_{ihm}^{(2)}$	0.121	0.101	0.100	*0.685*	0.709	0.707
	$U_{ihm}^{(5)}$	0.088	0.076	0.079	*0.495*	0.535	0.563
	Weight	0.361%	0.241%	0.370%			
Group 3	E_{ihm}	0.197	0.194	0.141	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.232	0.245	0.193	*1.178*	1.264	1.368
	A_{ihm}	0.075	0.059	0.039	0.383	0.305	*0.273*
	$B_{ihm}^{(2)}$	0.146	0.141	0.111	0.741	*0.728*	0.785
	$U_{ihm}^{(5)}$	0.104	0.104	0.093	*0.527*	0.537	0.658
	Weight	0.550%	0.450%	0.593%			
Group 4	E_{ihm}	0.239	0.245	0.207	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.281	0.294	0.257	*1.176*	1.199	1.242
	A_{ihm}	0.102	0.094	0.075	0.425	0.384	*0.363*
	$B_{ihm}^{(2)}$	0.165	0.175	0.157	*0.689*	0.713	0.758
	$U_{ihm}^{(5)}$	0.122	0.129	0.119	*0.509*	0.527	0.574
	Weight	0.917%	0.898%	0.984%			
Group 5	E_{ihm}	0.257	0.226	0.237	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.298	0.273	0.280	*1.160*	1.207	1.181
	A_{ihm}	0.111	0.088	0.100	0.434	*0.390*	0.421
	$B_{ihm}^{(2)}$	0.167	0.158	0.192	*0.650*	0.700	0.813
	$U_{ihm}^{(5)}$	0.122	0.119	0.143	*0.476*	0.524	0.604
	Weight	1.270%	1.286%	1.468%			
Group 6	E_{ihm}	0.321	0.293	0.274	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.365	0.344	0.316	*1.138*	1.174	1.153
	A_{ihm}	0.159	0.125	0.144	0.496	*0.428*	0.526
	$B_{ihm}^{(2)}$	0.238	0.197	0.210	0.741	*0.675*	0.766
	$U_{ihm}^{(5)}$	0.181	0.147	0.168	0.562	*0.503*	0.611
	Weight	2.242%	1.773%	2.188%			
Group 7	E_{ihm}	0.328	0.288	0.237	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.372	0.333	0.283	*1.134*	1.157	1.192
	A_{ihm}	0.172	0.130	0.092	0.525	0.452	*0.389*
	$B_{ihm}^{(2)}$	0.226	0.199	0.188	*0.687*	0.692	0.792
	$U_{ihm}^{(5)}$	0.175	0.148	0.137	0.533	*0.514*	0.579
	Weight	4.948%	3.884%	4.512%			
Group 8	E_{ihm}	0.358	0.335	0.333	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.401	0.384	0.384	*1.120*	1.148	1.154
	A_{ihm}	0.198	0.167	0.170	0.555	*0.499*	0.511
	$B_{ihm}^{(2)}$	0.247	0.211	0.254	0.691	*0.632*	0.763
	$U_{ihm}^{(5)}$	0.194	0.163	0.200	0.542	*0.488*	0.600
	Weight	8.367%	8.791%	7.924%			
Group 9	E_{ihm}	0.383	0.348	0.275	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.426	0.391	0.319	*1.110*	1.121	1.157
	A_{ihm}	0.216	0.188	0.122	0.563	0.538	*0.444*
	$B_{ihm}^{(2)}$	0.257	0.250	0.230	*0.671*	0.717	0.834
	$U_{ihm}^{(5)}$	0.201	0.193	0.170	*0.523*	0.554	0.617
	Weight	14.433%	17.475%	14.666%			
Group 10	E_{ihm}	0.457	0.370	0.345	1.000	1.000	1.000
	$S_{ihm}^{(2)}$	0.497	0.411	0.387	*1.088*	1.111	1.122
	A_{ihm}	0.296	0.219	0.187	0.647	0.594	*0.543*
	$B_{ihm}^{(2)}$	0.324	0.238	0.269	0.708	*0.644*	0.781
	$U_{ihm}^{(5)}$	0.267	0.192	0.210	0.584	*0.521*	0.608
	Weight	66.654%	65.070%	67.053%			

Note: $\overline{TCI}_{DE,FR,m}$, $\overline{TCI}_{DE,GB,m}$, $\overline{TCI}_{FR,GB,m}$ designate the average value of each index for each group of countries.

TABLE 4

Trade Competition Indexes Considering Sectoral Shares Similarity, Inter-sectoral Similarity, and Intra-sectoral Similarity for the Three Country Pairs

TCI_{ihm}	α_1	α_2	α_3	$L^{TCI}_{DE,FR}$	$L^{TCI}_{DE,GB}$	$L^{TCI}_{FR,GB}$	$\frac{L^{TCI}_{DE,FR}}{L^{E}_{DE,FR}}$	$\frac{L^{TCI}_{DE,GB}}{L^{E}_{DE,GB}}$	$\frac{L^{TCI}_{FR,GB}}{L^{E}_{FR,GB}}$
E_{ihm}				0.434	0.356	0.332	1.000	1.000	1.000
A_{ihm}				0.273	0.203	0.174	**0.630**	0.572	*0.524*
${C_{ihm}}^{(1)}$	0.025	0.075	0.9	0.303	0.233	0.205	**0.699**	0.655	*0.616*
${C_{ihm}}^{(2)}$	0.1	0.15	0.75	0.354	0.283	0.257	**0.817**	0.796	*0.773*
${C_{ihm}}^{(3)}$	0.2	0.3	0.5	0.435	0.363	0.340	*1.004*	1.021	**1.022**

Note: Bold is used for the country pair having the highest value of the ratio $\frac{L^{TCI}_{ihm}}{L^{E}_{ihm}}$; and italics for the pair with the minimum value.

TABLE 5

Trade Competition Indexes Considering Structural Similarity and Total Exports Overlap for the Three Country Pairs

TCI_{ihm}	α_1	α_2	α_3	λ	$L^{TCI}_{DE,FR}$	$L^{TCI}_{DE,GB}$	$L^{TCI}_{FR,GB}$	$\frac{L^{TCI}_{DE,FR}}{L^{E}_{DE,FR}}$	$\frac{L^{TCI}_{DE,GB}}{L^{E}_{DE,GB}}$	$\frac{L^{TCI}_{FR,GB}}{L^{E}_{FR,GB}}$
E_{ihm}					0.434	0.356	0.332	1.000	1.000	1.000
$B_{ihm}{}^{(1)}$				1	0.198	0.125	0.190	0.456	*0.352*	**0.572**
$B_{ihm}{}^{(2)}$				2	0.316	0.240	0.261	0.728	*0.676*	**0.786**
$B_{ihm}{}^{(3)}$				3	0.355	0.279	0.285	0.819	*0.784*	**0.857**
$U_{ihm}{}^{(1)}$	0.025	0.075	0.9	1	0.140	0.082	0.117	0.324	*0.232*	**0.353**
$U_{ihm}{}^{(2)}$	0.025	0.075	0.9	2	0.222	0.158	0.161	**0.512**	*0.443*	0.484
$U_{ihm}{}^{(3)}$	0.025	0.075	0.9	3	0.249	0.183	0.176	**0.574**	*0.514*	0.528
$U_{ihm}{}^{(4)}$	0.1	0.15	0.75	1	0.162	0.100	0.147	0.374	*0.281*	**0.442**
$U_{ihm}{}^{(5)}$	0.1	0.15	0.75	2	0.258	0.192	0.202	0.596	*0.539*	**0.608**
$U_{ihm}{}^{(6)}$	0.1	0.15	0.75	3	0.290	0.222	0.220	**0.669**	*0.625*	0.663
$U_{ihm}{}^{(7)}$	0.2	0.3	0.5	1	0.197	0.128	0.194	0.454	*0.359*	**0.585**
$U_{ihm}{}^{(8)}$	0.2	0.3	0.5	2	0.316	0.245	0.267	0.729	*0.690*	**0.804**
$U_{ihm}{}^{(9)}$	0.2	0.3	0.5	3	0.356	0.285	0.291	0.821	*0.800*	**0.876**

Note: Bold is used for the country pair having the highest value of the ratio $\frac{L^{TCI}_{ihm}}{L^{E}_{ihm}}$; and italics for the pair with the minimum value.

TABLE 6

Trade Competition Indexes – An Analysis by Exporting Country

TCI_{ihm}	γ	$L^{TCI}_{DE,FR}$	$L^{TCI}_{\underline{DE},FR}$	$L^{TCI}_{DE,\underline{FR}}$	$\frac{L_{\underline{DE},FR}}{L_{DE,\underline{FR}}}$	$L^{TCI}_{DE,GB}$	$L^{TCI}_{\underline{DE},GB}$	$L^{TCI}_{DE,\underline{GB}}$	$\frac{L^{TCI}_{\underline{DE},GB}}{L^{TCI}_{DE,\underline{GB}}}$	$L^{TCI}_{FR,GB}$	$L^{TCI}_{\underline{FR},GB}$	$L^{TCI}_{FR,\underline{GB}}$	$\frac{L^{TCI}_{\underline{FR}-GB}}{L^{TCI}_{FR-\underline{GB}}}$
E_{ihm}		0.434				0.356				0.332			
$B_{ihm}{}^{(2)}$		0.316				0.240				0.261			
$B_{\underline{i}hm}{}^{(2)}$	2		0.322				0.251				0.310		
$B_{i\underline{h}m}{}^{(2)}$	2			0.546	1.697			0.461	1.838			0.355	1.143
$U_{ihm}{}^{(2)}$		0.222				0.158				0.161			
$U_{\underline{i}hm}{}^{(2)}$	2		0.225				0.164				0.190		
$U_{i\underline{h}m}{}^{(2)}$	2			0.381	1.692			0.302	1.846			0.220	1.157
$U_{ihm}{}^{(5)}$		0.258				0.192				0.202			
$U_{\underline{i}hm}{}^{(5)}$	2		0.263				0.199				0.239		
$U_{i\underline{h}m}{}^{(5)}$	2			0.446	1.696			0.367	1.842			0.276	1.155
$U_{ihm}{}^{(8)}$		0.316				0.245				0.267			
$U_{\underline{i}hm}{}^{(8)}$	2		0.322				0.256				0.316		
$U_{i\underline{h}m}{}^{(8)}$	2			0.548	1.700			0.470	1.838			0.364	1.152

Note: The remaining parameters assumed for each TCI_{ihm} indicator included in this table can be found in Table 5.