More on Measuring the Overall Revealed Comparative Advantage

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Abstract: **The overall revealed comparative advantages approach aims to summarize the divergent expression of comparative advantages by commodity groups and countries. It represents an alternative to the traditional approach of Bella Balassa, Thomas Vollrath and others. The innovativeness of the overall revealed comparative advantages approach preconditions a certain prudence with regard to its use and interpretation. It is necessary to explore the potential of the approach in different conditions and different circumstances. It was found that the approach of overall revealed comparative advantages is resistant to the Euclidean distances and commodity classifications used for metrification. It has the potential to synthesize uniformly divergent changes in specialization by country and commodity groups and is a useful tool for the analysis of comparative advantages.**

Keywords **- Revealed comparative advantages, Specialization, Foreign trade**

1. Introduction

Comparative advantages are a key concept to explain the specialization in the exports of goods. On this basis, a number of research approaches have been developed, starting with B. Balassa, T. Vollrath, K. Laursen, J. Proudman, S. Redding and ending with the contemporary A. Hoen and J. Oosterhaven. The emphasis in them is placed on the study of the comparative advantages of a country concerning a given commodity (or commodity group) against another country (or group of countries). Given that the comparative advantages manifest themselves diversely (both as variations and as fluctuations), the natural question arises of what is the general trend, what is the natural manifestation and that is common for all goods and countries in today's international trade?

The developed approach of "overall revealed comparative advantages" creates conditions to answer these questions [7].It can be established on the basis of this approach that there is a significant asymmetry in the specialization of exports by country. It is expressed in the fact that a large group of countries have a relatively similar specialization in the export of mainly lower-processed goods. Conversely, a small group of countries has a substantially different specialization in the export of mainly highly processed goods. The innovativeness of the approach of overall revealed comparative advantagescalls for prudence in its use and interpretation. It is necessary to explore the potential of the approach in different conditions and different circumstances. The aim of this paper is to study the sensitivity of the overall revealed comparative advantages approach and the results obtained through it in respect of the used measure, commodity classifications and time.

At the basis of the study of comparative advantage is B. Balassa's approach [3]. It uses the category of "revealed comparative advantages"on the assumption that the realized trade flows are an approximation of the relative prices. The constructed specific index, known as Balassa's index, allows to measure the relative advantage or disadvantage of a country by a given commodity group with regard to the overall export market. The index is interpreted as a measure of the specialization in exports of an economy with regard toa certain commodity. The original expression of the index is as follows:

$$RCA = \left(X_{ij} / X_{it}\right) / \left(X_{nj} / X_{nt}\right) \qquad (1)$$

WhereRCA isBalassa's index of revealed comparative advantages; X – export; i – country; j – commodity or industry; t – commodity group (industries group); n – group of countries.

The popularity and wide use of Balassa's index arise from its simplicity and clear economic interpretation. At the same time the index is believed to have disadvantages. Balassa'sRCAindex is useful to evaluate whether a certain country has comparative advantages in the exports of a given commodity with regard to a certain group of countries. However, its use is limited and problematic in a number of aspects [9].

T.Vollrath [19] suggests an alternative approach to study the revealed comparative advantages. He puts forward three concepts for measuring revealed comparative advantages by country. These are the "relative trade advantages","relative export

advantage" logarithmand "revealed competitiveness". K.Laursen [13] suggests another index, which is believed to overcome the asymmetric nature of Balassa's index. J. Proudman and S. Redding propose to weigh the classic Balassa RCA index to the average index for the country [18]. Hoen and J. Oosterhaven believe that the disadvantages of the classic Balassa index stem from its multiplicative form [10]. That is why they suggest an additive form of the index. To overcome the shortcomings of the Balassa index other authors propose a more general solution [20]. They build a "normalized index of comparative advantage", starting from the point of neutral comparative advantages, the classic Balassaindex, the symmetrical SRCA index and the additive ARCA index.

B. Balassa's approach, beingthe most commonly used approach, and the indicesbased thereon, have specific characteristics. First, the indicators refer to the comparative advantages of a single commodity, commodity group or industry. Secondly, Balassa's approach provides analytical possibilities for characterizing the export of a country, the degree of processing of the exported goods, etc. versus a group of countries. A characteristicfeatures of the traditional approaches for the study of RCA is that they use a specific marketas a scale. All the advantage / disadvantage characteristics are rescaled with regard to the specific market (in space, time, etc.). The above features of the Balassa approach limit the possibilities to generalize the process of specialization in the world economy as a whole. The overall revealed comparative advantages approach has the potential to answer these questions.

2. Measuring the overall revealed comparative advantages

The overall revealed comparative advantage approach is based on the well-grounded and tested mathematical concept of "Euclidean space". If we assume that the range of exported goods of a country is a multidimensional Euclidean space (feature space), and the individual countries are points (objects) thereof, the "distance" from onecountry to another with regard to the respective characteristics can be deemed to be a measure of **overall revealed comparative advantage for all goods** or **Euclidean distance by specialization in exports**. The relative share of the exports of a given commodity group versus the total exports is suggested to be used for metrifying Euclidean distances. In this case it is not appropriate to use Balassa's approach (relative share of exports of a given commodity group versus the total exports of a country), as this would lead to inconsistency.

When studying the comparative advantages of a country with regard to the total export market (Balassa'sapproach), the scaling of the exports of a given product group with the scale of export market of a given country is entirely correct and appropriate. However, looking for a summary of all commodity groups and countries (overall revealed comparative advantagesapproach), the relative shares should be comparable to one another. Therefore, the relative share of exports of a given commodity group with regard to the total exports is used for metrifyingEuclidean distances. In this case, the Euclidean distance of specialization in exports is presented as follows [7]:

$$s_{il} = \sqrt{\sum_{j=1}^{p}\left[\left(X_{ij} / X\right) - \left(X_{lj} / X\right)\right]^2} \qquad (2)$$

Wheres_{il} is the Euclidean distance of export specialization between country *i* and country*l*;i,l=1,…,n; n – number of countries; X – export; j – commodity groups; j=1,...,p; p – number of commodity groups; p-measuring space;

A key element in the overall revealedcomparative advantages approach is the aggregation of Euclidean distances by commodity groups and countries. In this case, it is most appropriate to apply the hierarchical cluster analysis, which is a widely known and well-developed multidimensional method for classification of units into groups based on multiple features [4]. If we assume that all Euclidean distances by commodity groups and countries are a dissimilarity matrix, the grouping of countriesby summarized export specialization can be performed throughthe cluster analysis. In this way the countries participating in the world export market will be divided into relatively homogeneous groups of specialization in exports. This grouping will in turn become the basis for drawing conclusions about the revealed comparative advantages in today's international trade.

From the brief summary of the overall revealed comparative advantages approach it becomes clear that there may be variations in its application, including the used measure of Euclidean distance, the classifications by commodity groups, etc. The question is how the different variations in the application of the overall revealed comparative advantages approach influence the results and interpretation of the specialization in exports. Some possible variations of the Euclidean distance by specialization in exports and commodity classifications applied to differentiate the level of processing of exported goods are discussed further in this paper.

Besides Euclidean distance, a possible metrification option is the squared Euclidean distance. Many authors even believe that the square of the Euclidean distance possesses a better contrast [1]. In this case, the distance by specialization in exports is presented as follows:

$$s_{il} = \sum_{j=1}^{p} \left[\left(X_{ij} / X \right) - \left(X_{lj} / X \right) \right]^2 \quad (3)$$

A modified version of (3) is suggested to characterize the specialization of the regions in the European Union [17]. They believe that through the square of the Euclidean distance differences between objects can be presented more clearly. It is therefore recommended thatnot the Euclidean distance but the square of the Euclidean distance is used to measure the distance in n-dimensional space. However, it should be borne in mind that it is possible to overexposethe differences, in particular when working with large integers.

In some studies on the metrification of Euclidean distances the following formula [8] is used:

$$s_{il} = \sqrt{\sum_{j=1}^{p} \left[X_{ij} - X_{lj} \right]^2} \quad (4)$$

Through this approach it is established once again that there is a significant asymmetry in the specialization of exports by countries including for 2011, expressed in the fact that a large group of countries have a relatively similar specialization in exports and a small group of countries have substantially different specialization of exports. A presumption arises of uniformity or equivalence of the two approaches for summarizingthe specialization in exports.

Let us transform the expression (2) as follows:

$$s_{il} = \sqrt{\sum_{j=1}^{p} \left[\left(X_{ij} / X \right) - \left(X_{lj} / X \right) \right]^2} = \sqrt{\sum_{j=1}^{p} \left[\frac{X_{ij}}{X} - \frac{X_{lj}}{X} \right]^2} =$$

$$= \sqrt{\sum_{j=1}^{p} \frac{1}{X^2} \left[X_{ij} - X_{lj} \right]^2} = \sqrt{\frac{1}{X^2} \sum_{j=1}^{p} \left[X_{ij} - X_{lj} \right]^2} =$$

$$= \frac{1}{X} \sqrt{\sum_{j=1}^{p} \left[X_{ij} - X_{lj} \right]^2} \quad (5)$$

Several conclusionscan be made from the resulting expression (5). First, the place of a country in Euclidean space by specialization in exports will depend both on the degree of processing of the exported goods and on the volume of exported goods. Secondly, P. Krugman's concept [12] of scale and scope effects is confirmed. Thirdly, theoretically both approaches are equivalent in terms of the summary of specialization in exports. The difference is in the position of countries in the multidimensional Euclidean space, but not in the correlation between them.

A key point in the study of comparative advantages is the commodity classification used to present exportsbythe level of goods processing. The most preferred classification for the study of comparative advantage is the Standart International Trade Classification [6]. Some authors prefer the SITC version, modified by the World Trade Organization. It is believed that it improves the possibilities to separate the low-processed from the highly-processed goods. Other studies on the specialization of exports use the double-code Combined Nomenclature [16]. In studies of specialization in exports of major emerging markets International Standard Industrial Classification is used [14]. In some studies of revealed comparative advantages the possibilities of classification under theBroad Economic Categories for presenting the specialization in the export of low-processed and the highly-processed goodsare mentioned.

The SITC is built on the principle stage of completion of the product and satisfy the requirements of grouping countries by specialization in exports. The classification has good separation options for grouping countries exporting low-processed products and countries exporting highly-processed products. Some authors, however, believe that in certain cases SITC creates prerequisites for distortion of the specialization [11]. For example, some goods from one classification group could, without technological difficulties, be exchanged for the same use, e.g. goods of glass, paper, plastics, metals and ceramics. At the same time their production technologies are radically different.

The WTO has increasedthe options for separation of exports of low-processed and highly-processed goods by developing its own version of the SITC. This classification includes three large groups: primary products, processed products and other products. For this purpose the sections, divisions and groups of the original SITC have been regrouped. It is believed that the compiled SITC has better capabilities for separation of low-processed and highly-processed goods.

The Harmonized Commodity Description and Coding System and the related CNhave been developed based on the nature of the goods and their degree of completeness. The HS is detailed enough to satisfy customs needs. However, the HS is not suitable for analytical purposes, including research into specialization in exports. The main argument is that the principle of "degree of processing of the

material" used in this classification is technical rather than economic in nature.

The ISIC usesthe classification principle "production and economic activity." Through it the goods are presented by major sectors of production. The classification is suitable for the study of revealed comparative advantages combined with the sectoral specialization of the local economy.

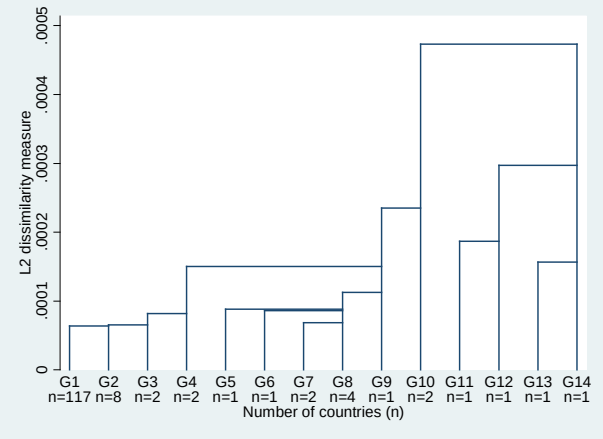
Obviously, the opportunities to present exports by the degree of processing of goods are numerous. However, as noted by M. Jovanovic [11],the results of the study of specialization are sensitive to the classifications used. It is entirely possible that the same export represented by different classifications indicates different conclusions concerning the comparative advantages, respectively the specialization. It is therefore necessary to verify to what extent the application of various classifications to the same empirical data on exports will lead to a different interpretation of specialization.

3. Sensitivity of overall revealed comparative advantages

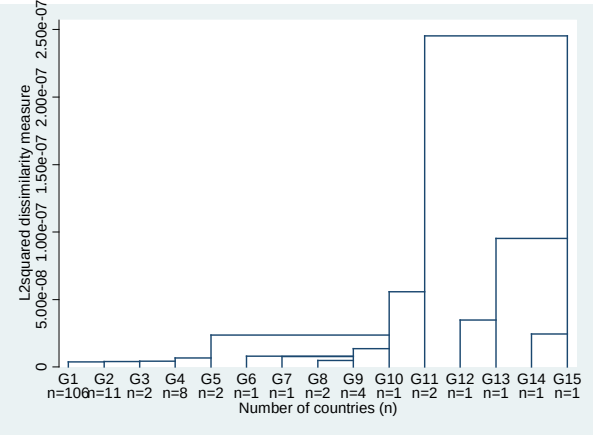
In order to test the sensitivity of the overall revealed comparative advantages approach against the used Euclidean spaces and commodity classifications, a comparative analysis is carried out through the dendograms resulting from the hierarchical cluster analysis. Two independent sources of statistical data on the worldwide exports are used. The first source is the World Bank database *World Integrated Trade Solution (WITS*. The statistical data on exports has been obtained from the "general trade" system, without re-export, FOB, USD, current prices, criterion for determining the country of export: country of consumption. The second source is the *WTO statistics database* (WSDB). The statistical data on exports has been obtained from the "general trade" system, without re-export, FOB, USD, current prices, criterion for determining the country of export: country of consumption.The WITS statistical data are presented under the SITC. The*WSDB*statistical data are presented under the modified SITC. The latter divides the goods into primary, processed and others, and is a compilation of the sections, divisions and groups of SITC.

To evaluate the Euclidean distances of exports specialization we use Stata 10.0 and a especially developed applied software. To group the countries into a relatively homogeneous clusters of export specialization we use the hierarchical cluster analysis. The *Calinski-Harabasz pseudo-F index*and the*Duda-Hart Je(2)/Je(1) index* [15] are used as a criterion for determining the number of groups. The "average linkage between groups", ensuring disjoint relatively homogeneous groups is used to form the groups [5]. The results are displayed in Figure 1.

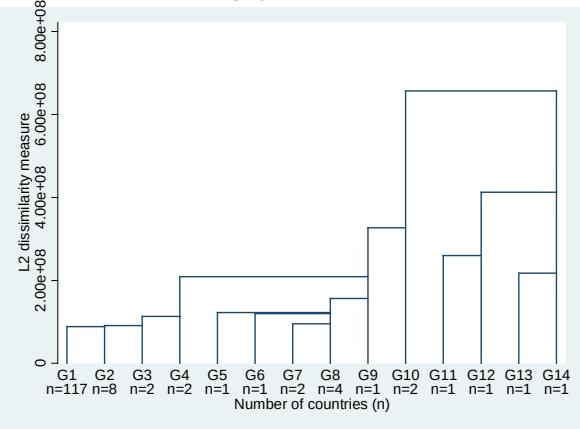
Three cluster analyses have been conducted, respectively, three dendograms have been drawn to compare the results of applying the different Euclidean spaces to characterize the exports specialization. The first cluster analysis was made in 2011, the exports were presented under SITC, Euclidean space was used (2). The second cluster analysis was carried out in 2011, the exports were presented under SITC, Euclidean space was used (3). The third cluster analysis was conducted in 2011, the exports were presented under SITC, Euclidean space was used (4). The dendograms are presented on figures 1a, 1band 1c.



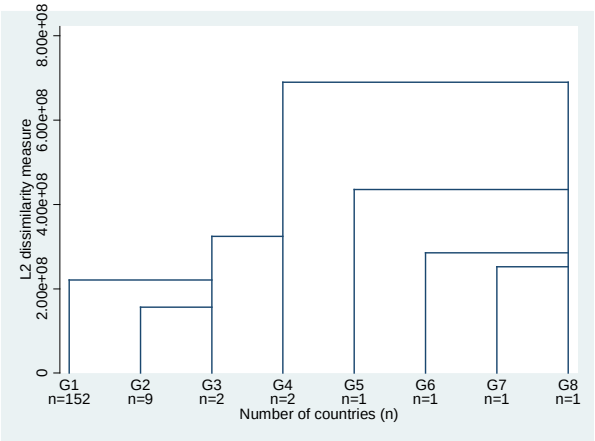
a) 2011, SITC, measuring by (2)



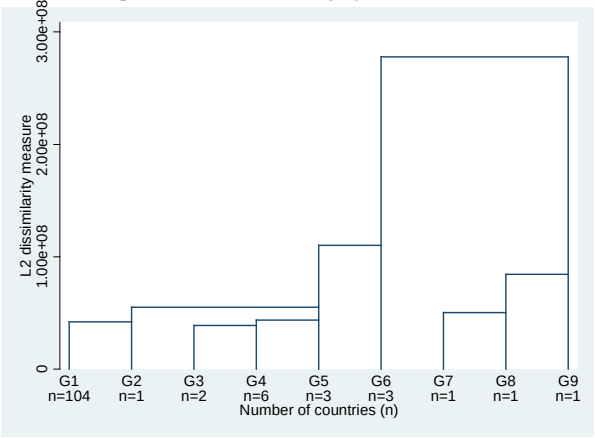
b) 2011, SITC, measuring by (3)



c) 2011, SITC, measuring by (4)



d) 2011, compiled SITC, measuring by (2)



e) 1995, SITC, measuring by (2)

Figure 1. Dendogram of overall revealed comparative advantages

The comparative analysis of the three dendograms shows that the three used Euclidean spaces result in a similar interpretation of the overall revealed comparative advantages, respectively exports specialization. The comparison between the first and the second dendograms clearly shows that there is a significant asymmetry, reflected in the fact that a big group of countries has a similar specialization. The first group G1 comprises 117 countries with a similar specialization, respectively 106 countries. On the other hand, a small group of countries has a substantially different exports specialization. The groups from G2 to G14, respectively from G2 to G15, include no more than 11 countries in each group. As expected, the use of the square of the Euclidean distance results in further asymmetry in exports specialization, without changing the overall pattern. A comparison of the first and third dendrogram leads to the conclusion that the use of relative shares or absolute volumes of exports in determining the Euclidean distances result in similar interpretations of the overall revealed comparative advantages. The only difference is in the location of the countries grouped by specialization in export in the multidimensional Euclidean space. All three dendrograms lead to the conclusion that a very large group of countries (almost 90% of countries) are in one cluster (G1) and are at relatively small Euclidean distances. At the same time a small group of countries is classified in other clusters. This group of countries is at a greater Euclidean distance from the first group. Within the second group the distances between countries and clusters are much greater than between the countries of the first group. These results allow us to conclude that there is a significant asymmetry in the summarised specialisation of the countries. It can be concluded that the use of different metrics of Euclidean distances leads to different overall revealed comparative advantages. However, the interpretation of the normal tendency in the manifestation of specialization in exports does not change significantly.

To compare the results of using different commodity classifications another cluster analysis was conducted for 2011 (Figure 1d). The export is presented under the compiled SITC, Euclidean distance is used (2). Comparing dendrograms 1a and 1d gives reason to conclude that when summarizing the specialization of all goods and countries, the used classificationsdo not materially affect the interpretation of overall revealed comparative advantages. Both dendograms indicate a substantial asymmetry in the specialization in exports.

The insensitivity of the results to the classifications used has its explanation. When studying the revealed comparative advantages of individual commodity groups and countries (Balassa's approach), the classifications used can cause interference. But when it comes to a summary of specialization for all commodity groups and countries,the overall revealed comparative advantages approach is not significantly affected by the applied classifications.

It is also interesting to establish to what extent the specialization of exports is sustainable over time and to what extent the proposed approach is sensitive to international export market that is different in volume and structure. For this purpose, we compare the overall revealed comparative advantages for 2011 with those for 1995. The year 1995 was chosen as a benchmark because it was crucial for international trade and specialization of exports, because of the establishment of the WTO and the entry into force of its rules. A cluster analysis was conducted for this purpose in 1995 (Figure 1e); exports are represented under SITC, Euclidean distance is used (2).

The comparative analysis of the dendrogram gives grounds for several conclusions. First, the comparison of the overall revealed comparative advantages for 1995 and 2011 gives reason to conclude that in the course of 16 years the functioning of the WTO has not substantially altered the asymmetry in specialization of countries

participating in international trade. The large relative share of countries specializing in exports of raw materials and low-processed products remained steady in the period 1995-2011 At the same time, the relative share of countries specialized in the export of highly-processed products remained within 10-15%. Secondly, there is reason to believe that the overall revealed comparative advantages approach retains its capabilities with respect toa different volume and structure of export markets and different number of countries participating in the study.

4. Conclusion

It was found that the proposed approach of overall revealed comparative advantages is resistant to the Euclidean distancesand commodity classificationsusedfor metrification. Irrespective of the fact that the different variants of overall revealed comparative advantages result in different groupings of countries in terms of export specialization, the interpretation of the overall trend remains the same. Consequently, the overall revealed comparative advantages approach used for research purposes has unequivocally proven the asymmetric specialization of exportsassumed by many authors [2]. The essence of asymmetric specialization of exports is expressed in the fact that on the one hand a very large group of countries is specialized in exports of mainly lower-processed products, while on the other hand, a small group of countries is specialized in the export of highly processed products. This feature of international trade is sustainable and has not changed significantly in recent decades.

The results of the application of the overall revealed comparative advantages approach are not surprising. The essence of the approach is consistent with the basic principles of the New Trade Theory and P. Krugman'shypotheses. The approach provides empirical evidence for the theoretically proven scale and scope effect in the area of trade and specialization of exports.

In conclusion, the concept of overall revealed comparative advantages has the potential to synthesize disparate changes in specialization by country and commodity groups. The approach leads to consistent results with respect to the metrics used, commodity classifications and the impact of time. It demonstrates the clearly asymmetric nature of exports in today's international trade. We are confident that the overall revealed comparative advantages approach is a useful tool for the analysis of export specialization in today's international trade. It is even more appropriate under the conditions of increasing globalization, including in terms of the economy and the ongoing related processes on the international exports market. Given the link between of the comparative advantages and divergence, it is necessary to focus attention on the specialization of exports, especially of the less developed countries. Efforts are needed to achieve a more equal distribution of wealth through the contemporary liberal international trade, including through the management of export specialization.

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