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A new method for calculating mirror data asymmetry in international trade

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Abstract

Research background: Some statistics are of a bilateral nature. This is how foreign trade data is organized. They are recorded both in the supplier and recipient countries, hence they are called mirror data. The data recorded at both trading partner countries are not the same for different reasons. Such differences between data on the same groups of transactions are often referred to as the asymmetry of mirror data. The information about the value of the flows of goods are of great importance in economic analyses and therefore their quality is particularly important.

Purpose of the article: The aim of this paper is to present a new measure of data asymmetry — the aggregated quantity index with value-based weights.

Methods: The proposed measure combines the quantity and the value of turn-over in individual trade relations. Such a measure makes it possible to eliminate basic deficiencies in value-based measures, while considering the specificity of trade in individual countries. The proposed measure of data asymmetry was confronted with several measures present in the literature and previously used by the Authors. The numerical example uses Comext data on intra-Community trade in 2017 provided by Eurostat.

Findings & Value added: The proposed measure performs better than all the previously used data asymmetry indices. It is to some extent immune to exchange rate differences and inconsis-

encies resulting from the inclusion of transport and insurance costs in the value of goods. In addition, it gives lower weights to unimportant trade directions than other data asymmetry indices. Since the new index has proved to be better than the measures previously used, it is worth applying to those trade relations where the data are not derived from customs documents, but from declarations made by businesses, as in the case of intra-Community trade.

Introduction

Reliable statistical data are the basis for economic analyses carried out at the national level or, more broadly, at the level of the European Union and the world. The official statistics services (Eurostat, national statistical offices) are constantly working to improve the quality, extend the scope or improve the availability of data. We live in times of intense data growth. At scientific conferences we discuss Big Data — the ways of collecting and processing very large information resources, as well as Dark Data — the unknown and untapped data. Fifty-five percent of an organization's data is “dark” — according to new global research by TRUE Global Intelligence (Splunk, 2019). Therefore, the reliability of information remains a fundamental aspect.

The specificity of international trade data lies in their bilateral nature: they are recorded simultaneously in two sources. This way of collecting information makes it possible to compare the quantities representing the same phenomenon and, at the same time, to identify possible discrepancies.

In principle, information from two sources relates to the same transactions and should fully overlap. However, this is not always the case and the data recorded at both trading partner countries are not the same for different reasons. Such differences between data on the same groups of transactions are often referred to as the asymmetry of mirror data. This phenomenon is characteristic of all international trade. However, the information about the value of the flows of goods are of great importance in economic analyses and therefore their quality is particularly important. Many attempts can be found in the literature to assess the quality of mirror data and the reasons for the occurrence of asymmetries in data. As an example, we present an analysis of data on intra-Community trade, i.e. the trade in goods between the EU Member States.

Data on intra-EU trade in goods are collected, aggregated, and disseminated by Eurostat in the form of Comext database. At the country level, declarations on exports (referred to as intra-Community Supplies, ICS) and imports of goods (intra-Community Acquisitions, ICA) are collected in the Intrastat system. Methodologies for data collection as well as ways of detecting and correcting errors vary from country to country. This is one of

the reasons for discrepancies in mirror data. The problem of the quality of such data has been discussed in the literature on numerous occasions e.g. by Parniczky (1980), Federico and Tena (1991), ten Cate (2014).

In the literature, the asymmetry of mirror data is generally examined in value terms, usually using a general (simple) index. According to the Authors, an aggregated index is a better tool for the task, because it takes into account all differences between the mirror values, both in the case of aggregation by commodity groups (e.g. CN chapters) and by export directions (Markowicz & Baran, 2019a, 2019b). However, it still does not take into account in any way the quantity (weight) of goods, and additionally it has some other disadvantages, e.g. it depends on the exchange rate or the method of transportation costs inclusion (CIF/FOB). Hence our search for other solutions and an attempt to construct an index without these defects.

The results of the study suggest that the value-weighted index proposed below also takes into account an additional aspect implicitly: the difference in the shares of individual directions in the total value and quantity of trade in goods of the examined country.

The research conducted by the authors is a follow-up work on the selection of tools for assessing the quality of mirror data. The aim of the article is to present a new approach in this area. The analysis uses a new aggregated quantity index weighted by the value of goods and compares the results with those obtained using different tools. The presented article is methodical in nature. It concerns the search for research tools. These searches are based on empirical research and on the evaluation of obtained results. The article is also practical in nature. It is intended to suggest rules of conduct for statistical and tax services. The results of the research indicate the directions of trade and commodity groups burdened with the largest errors.

The paper consists of 5 parts. The first part presents the review of literature on mirror data asymmetry research in international trade. Both first works in this area and newer publications are presented. Due to the methodical character of the article, an important chapter is research methodology. It presents ways of assessing the quality of mirror data, both found in the literature and Authors' own. Our new proposal is the aggregated quantity index with value-based weights (value-weighted quantity-based quality index). We apply the index in two versions: for one-to-many trade relations and for bilateral trade. This is the main value added of the current paper in comparison to previous papers. The next chapter presents the results regarding the performance of the new index in the case of trade between all the EU-Member States and an analysis of individual countries — the cases of Poland, Germany, and France are taken into consideration. The Discussion section highlights a combination of two aspects: statistical and tax-

related. It was pointed out that the research results have both methodical (in terms of measuring the asymmetry of mirror data) and practical dimensions (improving the reliability of statistical data and the ability to detect tax irregularities). It was emphasized that the ongoing discussion in the literature does not clearly indicate the best solutions for studying mirror data asymmetry. The Conclusions section points out the results of the research to date, as well as the questions concerning the choice of methods and research plans.

Literature review

It seems that Morgenstern (1963) was the first researcher to observe data asymmetry in foreign trade in a systematic way. He investigated the differences in data on world exports and imports. He proposed tools to study them (absolute and relative difference) for all countries in general and certain indices to study pairs of countries (trade partners).

Another noteworthy work by Tsigas *et al.* (1992) indicates the proportion in the data resulting from the difference in transport and insurance costs in the declared values of exports and imports. The export data of one country should be equal to the corresponding import data of another country. However, due to the different approaches to transportation and insurance costs (CIF and FOB, i.e. inclusion/exclusion of transportation costs), the data to be compared should be in a certain proportion that can be standardised. These authors have taken this ratio into account in their models in order to look for other reasons for data discrepancies. Carrère and Grigoriou (2014) also mention the CIF/FOB ratio as a primary factor for mirror data discrepancies, but along with Hummels and Lugovskyy (2006) they state that this ratio is neither the main reason for discrepancies, nor an overall indicator of certain reasons behind the misreported values. Besides, all those authors use data on prices and quantities of goods in their approach. It should be noted, however, that the price can be properly applied only for a precisely specified commodity sold by a particular entity and not for aggregated data. Therefore, such a situation is not possible in our research.

The methods for studying differences in mirror data proposed in the literature on the subject are used to study country-to-country (one-to-one) or country-to-countries (one-to-many) relations. Proposed methods and studies for pairs of countries were conducted by Morgenstern (1963), Parniczky (1980), Ferrantino and Wang (2008), Guo (2010), Hamanaka (2012), Carrere and Grigoriou (2014), HMRC Trade Statistics (2014). A simple abso-

lute difference between the declared values of exports and imports in the trading partner countries, the relative growth, and data asymmetry index were used. The latter was proposed using different formulae. A similar measure, called the data discrepancy index, was used in the work by Baran and Markowicz (2018). The approach to data quality testing presented by Ferrantino and Wang (2008) is also proposed in the analysis of official statistics (Eurostat 2017). Some studies focus on the analysis of the differences in data between a country and a group of countries (Federico & Tena, 1991, Hamanaka, 2012).

It appears that no methodology has been developed so far to test the quality of mirror data, which would be accepted by all researchers in this area. There has been a discussion on this subject in the literature for many years. Morgenstern (1963) concluded that, with large differences in foreign trade figures, mirror data should be considered unreliable. He even proposed certain standard levels for the values of indices at which the data are considered correct. Morgenstern also claimed that certain index values indicate that there are also other causes of errors, apart from the unilateral inclusion of transport costs and duties.

The discussion with Morgenstern was undertaken by Federico and Tena (1991). They believe that the method used before Morgenstern only checks on the ‘accuracy of geographical data’. According to them, data aggregation eliminates this problem, and a better check on the reliability of the aggregated data is to compare the sum of the trade values of a country and the sum of the respecting flows recorded by the partner countries. According to Federico and Tena (1991), the results of their research confirm the reliability of the data and the asymmetry in the data results mainly from differences in the method of accounting for transportation costs. According to the authors, the reasons for data discrepancies can be divided into three groups: unavoidable (CIF/FOB), structural (different criteria for compiling statistics) and actual errors (data differs from actual flow). The errors include declaration errors due to negligence or fraud (errors may relate to weight, value, goods classification) and errors made by statistical offices (estimation of official prices, exchange rates). The lack of registration due to smuggling is often cited as the cause of data errors (Federico & Tena, 1991, Fisman & Wei, 2004, Javorcik & Narciso, 2008).

Proposals for methods of mirror data quality testing presented in the literature generally concerned the index of intensity and if aggregation was used, it concerned goods or countries, but when adding together the values of exports and imports (and not differences between them) separately. In the opinion of the authors, this causes the elimination of positive and nega-

tive differences and, consequently, the understatement of the index, and thus overstatement of data quality.

It should be noted that measuring and assessing differences between mirror data on international trade is an issue that several authors have addressed through econometric models and optimisation techniques. Among the works presenting models used to analyse the quality of foreign trade data are those of ten Cate (2007) and Ferrantino *et al.* (2012).

According to the Authors, such analyses, both with the use of data quality indices and econometric models, may support the work whose main objective is not the assessment of data quality itself, but the use of data for econometric modelling of international market phenomena, e.g. using spatial models (LeSage & Llano-Verduras, 2014, Rasoulinezhad, 2018, Bahmani-Oskooee *et al.* 2020). The results of such a modelling depend directly on the quality of the data used, so it is important to define it well, as well as to monitor and work continuously to improve the quality of international trade databases.

Research methodology

The study compared three types of indicators of mirror data quality — an aggregated value-based index (1), an aggregated quantity-based index (2) based on traded commodity weight (quantity), and a new proposal by the Authors, a value-weighted aggregated index for quantity (3).

The formulae are as follows. We only give formulae for exports (or ICS in our use case). The respective formulae for imports (or ICA) can be derived similarly. An aggregated value-based data quality index for exports is given by:

$${}_Z W_E^{AU}(v) = \frac{\sum_{i=1}^n |w^{E_{AB_i}} - w^{I_{B_iA}}|}{w^K} \quad (1)$$

where:

$w^{E_{AB_i}}$ – declared value of exports from country *A* to the *i*-th country of a group (here: of the remaining EU countries),

$w^{I_{B_iA}}$ – declared mirror value of acquisitions of goods shipped from country *A* to the *i*-th member of the group, as reported in the receiving country statistics,

$w^K = \sum_{i=1}^n \frac{(w^{E_{AB_i}} + w^{I_{B_iA}})}{2}$ – a hypothetical true value of the above said exports.

In Markowicz and Baran (2020b) the Authors prove that the index given by formula (1) is an equivalent to AER index proposed by Ferrantino and Wang (2008).

A slightly changed formula (1) provides us with a similar index using commodities' weights (quantities) instead of the value, which will later be referred to as an aggregated quantity-based data quality index:

$${}_Z W_E^{AU}(m) = \frac{\sum_{i=1}^n |m^{E_{AB_i}} - m^{I_{B_iA}}|}{m^K} \quad (2)$$

where:

$m^{E_{AB_i}}$ – declared quantity of exports from country A to the i -th country of a group,
 $m^{I_{B_iA}}$ – declared mirror quantity of acquisitions of goods shipped from country A to the i -th member of the group, as reported by the receiving country,

$m^K = \sum_{i=1}^n \frac{(m^{E_{AB_i}} + m^{I_{B_iA}})}{2}$ – a hypothetical true quantity of the above said exports.

Our newly proposed aggregated quantity index with value-based weights (value-weighted quantity-based quality index) is calculated following the formula:

$${}_Z W_{ME}^{AU} = \frac{\sum_{i=1}^n |m^{E_{AB_i}} - m^{I_{B_iA}}| \cdot L_i}{K} \quad (3)$$

where:

i – number of country B_i (in our case $i = 1, 2, \dots, 27$)

$m^{E_{AB_i}}$ – declared weight of goods exported from country A to country B_i ,

$m^{I_{B_iA}}$ – declared mirror weight of goods imported to country B_i from country A , reported in country B_i ,

$L_i = \frac{w^{E_{AB_i}} + w^{I_{B_iA}}}{\sum_{i=1}^n (w^{E_{AB_i}} + w^{I_{B_iA}})}$ – correction factor – the share of country B_i in the exports of country A .

$K = \sum_{i=1}^n \frac{(m^{E_{AB_i}} + m^{I_{B_iA}})}{2} \cdot L_i$ – the sum of average (hypothetical) quantity of exports and mirror imports from country A to countries B_i corrected with L_i factors.

The formulas given above are designed for the case of one-to-many trade relations. In case of a bilateral trade analysis, we need indices prepared for one-to-one relations. In Markowicz and Baran (2020b), the Authors propose a variant of (1) that is aggregated by CN (Combined Nomenclature) chapter (i.e. a commodity group) number — given by the formula (4) below. Similarly, now we propose the formula (5) as a version of (3).

A bilateral version of (1) is given by:

$${}_Z W_E^{AB}(v) = \frac{\sum_{i=1}^n |E_i^{AB} - I_i^{BA}|}{K} \quad (4)$$

where:

E_i^{AB} – declared value of exports within CN chapter i from country A to country B ($i = 1, \dots, 97$ – CN chapter number),

I_i^{BA} – declared mirror value of imports within CN chapter i from country A to country B as reported by country B ,

$K = \sum_{i=1}^n \frac{E_i^{AB} - I_i^{BA}}{2}$ – a hypothetical true value of the above said exports,

while a bilateral version of (3) is given by:

$${}_Z W_{ME}^{AB} = \frac{\sum_{i=1}^n |m_i^{EAB} - m_i^{IBA}| \cdot L_i}{K} \quad (5)$$

where:

i – CN chapter number, $i = 1, 2, \dots, 97$,

m_i^{EAB} – declared weight of exports within CN chapter i from country A to country B ,

m_i^{IBA} – declared mirror value of imports within CN chapter i from country A to country B as reported by country B ,

$L_i = \frac{w_i^{EAB} + w_i^{IBA}}{\sum_{i=1}^n (w_i^{EAB} + w_i^{IBA})}$ – correction factor – the share of i -th chapter in country A 's exports to country B ,

$K = \sum_{i=1}^n \frac{m_i^{EAB} + m_i^{IBA}}{2} L_i$ – the sum of average (hypothetical) quantity of exports and mirror imports from country A to country B corrected with L_i .

All the indices (1)-(5) take values from the $[0, 2]$ range. Values close to 0 indicate best data quality (no significant difference between mirror data).

The empirical examples provide some results of a study on trade between European Union countries. We used 2017 data on ICS and mirror ICA for all EU Member States (Comext database, Eurostat).

Results

Performance of the new index — the case of trade between all EU member states

Index values (1), (2) and (3) have been calculated for individual EU Member States using their export data and mirrored data on imports from them.

The results are summarised in Figure 1. The results were sorted in ascending order of the value-weighted quantity-based index (3).

Fig. 1 shows the values of the indices used to measure the quality of mirror data (1-3) calculated for all EU Member States. The compared values calculated for most countries vary considerably, but it was not possible to confirm the rule that, among the countries surveyed, any of the indices had values clearly higher or lower than the others. Most often the highest value was taken by the aggregated index for weight, while the lowest value was taken by the aggregated value-based index more often than by the other ones. This result contradicts the assumption that the weight (quantity) of goods in trade between EU Member States is more accurately reported than the value of goods (the quantity is neither affected by exchange rates nor by inclusion of transportation cost).

One reason for this may be the fact that the statistical thresholds are set in value. In such a case, for goods with a low level of processing (low unit price), a large quantity of the goods may be below the threshold on one side of the transaction and still not be declared. Most often, it is true for the small foreign contractors of a large entity that do not report the acquisition of goods from it.

The newly proposed index at least partially compensates for the disadvantages of the approaches based on value or weight only. This is particularly evident in the countries with the lowest quality of mirror data (highest index values; Malta, Cyprus, Luxembourg — incidentally, these three are among the smallest countries in the EU). The observed values of the proposed index are relatively much smaller than the index for weight values in these countries (Fig. 2). The average level (measured by the median) of the index (3) is significantly lower than the average level of the index (2), while at the same time the whole range of its values is shifted to the left and closer to the range obtained for the index (1). There has been a particular improvement in the case of two outlier observations, i.e. the index values for Malta and Cyprus, which have fallen to a level close to (in the case of Cyprus) and slightly higher (Malta) than observed for the index (1).

It should be noted that the way the index for value is calculated makes goods with a high unit value (highly processed goods) more influential. On

the other hand, transactions with goods of low unit value (low value and high weight, low-processed goods) have a greater impact on the value of the index for weight. If transactions are not reported on one side, there is a large imbalance in value or weight, but the absence of a statistical threshold for weight means that transactions below the threshold — thus escaping the statistics and at the same time strongly affecting the increase in value of the index — may involve goods of a very high weight.

In the light of the above considerations, the structure of total exports from each country to the other Member States was examined in terms of value and weight. The shares within the two arrangements are not the same. For example, Fig. 3–5 show the share of exports from all EU Member States to Germany, the Netherlands and Denmark, respectively. In the case of trade with Germany (Fig. 3), the share in value terms is generally higher than the corresponding share in volume terms. For the Netherlands (Fig. 4) the situation is the opposite. For trade with Denmark (Fig. 5), the share of ICS to this country is relatively low and balanced, although there is a disproportion similar to this for Germany; the share in terms of value is often greater than the share in terms of quantity.

An analysis of individual countries — the cases of Poland, Germany, and France

In the second example, the trade in goods of three large EU countries (Poland, Germany, and France) with individual EU partner states was analysed (Comext data for 2017 were used). Since Poland is not a member of the Eurozone, it was not possible to check whether the value of the index is significantly lower for pairs of countries using different currencies (in this case all pairs fall into that category). To achieve this goal, we provided a similar analysis for Germany and France, both large EU Member States with strong economies as well as two prominent members of the Eurozone.

Aggregated index (4) and the newly proposed (5) were calculated for every pair of an EU country and Poland.

Next, the obtained values of the indices were compared on a diagram (the X axis — the values of the ‘old’ index, the Y axis — the values of the ‘new’ index) — as we can see in Figure 6, the majority of EU Member States are positioned below the dashed line, i.e. the values of the indices satisfy the condition. Most countries belong to the group for which the new index is lower than the old one. The most significant differences are observed for Cyprus, Portugal, Malta, Greece, and Ireland. One possible explanation for this is that transportation costs added by purchasers are ignored in (5), so the problem of discrepancies between mirror data resulting

from reporting different values in CIF and FOB regimes by the two sides of the same transaction no longer takes place.

On the other hand, the biggest differences above the dotted line are for Luxembourg, Austria, and Finland. The reason for this is still to be determined based on a thorough analysis of the respective bilateral trade structures. One of the most probable reasons could be a specific share of low-processed goods in the total sum of discrepancies, e.g. resulting from a high proportion of small businesses selling/buying Polish produce on a scale that requires no reporting in the Intrastat system.

The next two figures show the values of both indices calculated for Germany and all its trade partners (Fig. 7) and for France and its partners (Fig. 8). Both these countries are in the Eurozone. As a result, it could be expected that since most pairs of partner countries in both cases use the same currency, there will be no benefit from the new index. That is, we expected more points above the dashed line (and differences caused by reasons other than exchange rate). It is the case for France. Most of the countries have scored worse in terms of the new index in trade with France. The reason for the differences in this case is probably due to the structure of trade in goods. We suspect that even groups of goods with a relatively small share in the value of trade may be a source of large differences in quantities. This is because companies that exceed a relatively small threshold in trade value are required to report, but there is no such limitation in the case of weights. Therefore, quite large quantities of goods may remain unreported on one side of many transactions. Quite a different situation can be observed for Germany (Fig. 7). In this case we observe only a small group of six, mostly euro-area countries that perform worse in terms of the new index. It is similar to the situation observed earlier for Poland. This proves, to some extent, that in most cases quantity-based reporting is more accurate and leads to better recognition of the true amount of the worth being traded.

Tab. 1 contains all the partner states of Poland, Germany, and France for which values of the new index (5) were higher than values of the old index. Usually, these are not the most important trading partners of the three, so it is easier to generate large relative discrepancies in these cases. An intriguing fact is that among the pairs of countries with the highest difference between index (5) and index (4) are the pairs Germany-Belgium and Germany-the Netherlands. An in-depth research is needed to determine the reason for this.

Discussion

The literature review shows that the observation of data asymmetry in foreign trade is interesting in two aspects: from the point of view of official statistics and tax collection. Therefore, the results of research in this area have methodical (defining the ways of measuring the asymmetry of mirror data) and practical (improving the reliability of statistical data and the ability to detect tax irregularities) implications. The involvement of both public statistics and tax services in activities that may improve the reliability of data on the trade of goods in the European Union is being raised. The authors of some works have even indicated tax and/or customs fraud, i.e. lack of declaration of certain transactions or misevaluation of goods exported to the EU countries as one of the prominent causes of data asymmetry (Federico & Tena, 1991; Fisman & Wei, 2004; Javorcik & Narciso, 2008, Carrère & Grigoriou, 2014).

The missing data on intra-EU trade in goods are estimated on a national basis. Hence, there are often large differences in the information recorded in two sources — on the supplier and acquirer sides. There has been a discussion in the literature on the quality of mirror data in international trade.

The literature proposes different approaches to the study of mirror data quality in international trade. Different relationships between trade partner countries are studied. These are one-to-one relations (i.e. bilateral trade; e.g. Morgenstern, 1963; Parniczky, 1980), one-to-many relations (meaning trade of a single country with a group of countries treated as one entity; e.g. Federico & Tena, 1991; Ferrantino & Wang, 2008). Different approaches to measuring data asymmetry are applied. Some authors use indicators based on the value of goods exchange (Javorcik & Narciso, 2008), or based on the quantity of the shipped goods (Markowicz & Baran, 2020a), while others use an approach based on price and quantity indices calculated for specific commodity groups (Carrère & Grigoriou, 2014; Yurik *et al.*, 2020). Data aggregation methods differ as well. Export and import values can be aggregated separately (Morgenstern, 1963) or the absolute values of the differences between export and mirror import are aggregated (Ferrantino & Wang, 2008; Markowicz & Baran 2019a). There are only few studies on mirror statistics quality in international trade. Perhaps the reason is problems with data acquisition, but the choice of analysis methods is also a problem.

The Authors made their contribution in the form of a proposal to study the quality of data expressed not only in value but also in quantity (weight of goods). We have also proposed an original data discrepancy index, combining both approaches.

The use of data in the form of large aggregates reduces the analysis, in particular the differences between mirror data are often blurred. Therefore, we are against the use of general indices. However, we support the use of aggregated indicators, where data is aggregated by country or commodity group in a balanced manner.

It should be emphasized that the discussion on the analysis of the asymmetry of mirror data in international trade, undertaken by a small group of researchers, is difficult because it deals with a complex matter. This discussion concerns both the quality of statistical data from business entities' declarations and the reliability of customs and tax data. To date, there have been no methods developed to eliminate the asymmetry of mirrored data. However, several methods of analysis of this asymmetry are proposed. It is not clear which methods are appropriate and which are not. There is a discussion in the literature on this issue, to which the authors of the article have also contributed.

Conclusions

It should be emphasised that statistical data are important in economic research. They are the starting point of analyses. There are numerous methodical problems connected with data regarding the activity of economic entities. Such a problem is the incompleteness of data due to the statistical thresholds introduced in the declarations of export and import of goods within the EU (Markowicz & Baran, 2020a). Another example is the need to maintain statistical secrecy in the case of a small number of entities in the goods subgroup (Roszko-Wójtowicz *et al.*, 2019).

Commodity groups' shares in value and shares in quantity of goods in the same relation differ significantly. Although in theory the discrepancies between reported quantities should be lower than the discrepancies between respective values of foreign trade transactions, it is not always the case. The values of quantity-based indices often exceed the values of value-based indices, which may result from a value-oriented definition of statistical thresholds.

However, the examples show that the proposed index has mostly lower values than the previously used measure, especially for pairs of distant countries. This may partially be explained by the fact that it is not possible to report a quantity of goods containing transportation and insurance costs i.e. it is an effective way to avoid the main reasons of discrepancies present in the case of reporting the value of goods.

The use of purely value-based or purely quantity-based approaches appears restrictive in preferring selected groups of goods and export directions. Therefore, in the opinion of the authors, combining the value and quantity in a single index or in a sequence of calculated indices appears to be preferable.

In conclusion, let us repeat that our research has both methodical and practical aspects. The first of them concerns the search for an ‘proper’ methodology for studying mirror data asymmetries. Previously proposed methods found in the literature and derived by the Authors all have their own pros and cons. So far, there has been no generally accepted approach to mirror data quality. Doubts include the type of data used — value or quantity, the type of indicators — general or aggregated, the method of data aggregation — summing up the value of exports and imports separately or summing up the absolute value of differences between them, the scope of data aggregation — by country, by commodity group or total. The authors are still looking for answers to these questions (doubts). They also plan further research in this area. Further work on this topic will focus on the reasons for the biggest differences between the aggregated index (4) and the new value-weighted index (5). Special attention will be paid to countries for which the new index has a much higher value than the old one. Based on a quick research into Comext data for the pair France-Latvia (the point labelled LV in Fig. 8), we assume that the main reason for this is that there are numerous CN chapters for which the share of data reported by only one party is high. These are mainly CN chapters with a small share in the value of trade in goods, which should be partially offset by using a weighting system, but the scale of the imbalance itself is too large for the effect to be easily compensated for. However, this observation must be confirmed as part of a broader analysis. We will undertake such an analysis in our future works.

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Annex

Table 1. Values of indices for Poland's, Germany's, and France's partner countries for which index (5) was higher than index (4)

EU Member States	PL		EU Member States	DE		EU Member States	FR	
	Index (5)	Index (4)		Index (5)	Index (4)		Index (5)	Index (4)
AT	0.3630	0.2279	BE	1.0645	0.4131	AT	0.2528	0.1940
EE	0.2553	0.2472	CZ	0.2523	0.2499	BE	0.2011	0.1160
FI	0.4756	0.3227	HU	0.5285	0.1777	BG	0.5437	0.2012
HR	0.1219	0.1191	MT	1.8111	1.3244	CY	1.8943	0.8821
HU	0.1937	0.1583	NL	0.6338	0.3989	CZ	0.2707	0.1691
LU	0.7577	0.5311	PT	0.3417	0.2710	FI	0.2507	0.1871
NL	0.1508	0.1407				GB	0.1645	0.1374
SI	0.1803	0.1564				HU	0.6825	0.2522
						IT	0.0961	0.0893
						LT	0.5696	0.5567
						LV	0.6783	0.1675
						MT	1.5543	0.9882
						PL	0.2198	0.1497
						PT	0.2430	0.1914
						SE	0.2226	0.1648
						SI	0.4583	0.3397
						SK	0.3509	0.2997

Figure 1. All three index values for every EU Member State

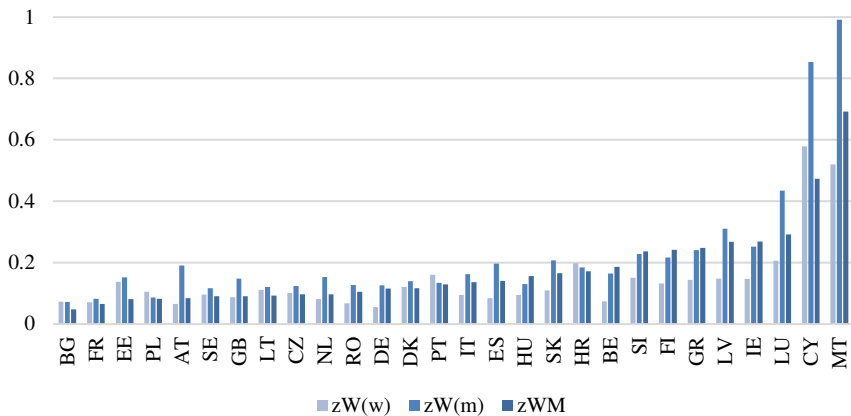


Figure 2. Distribution of the values of the compared indices (1)-(3)

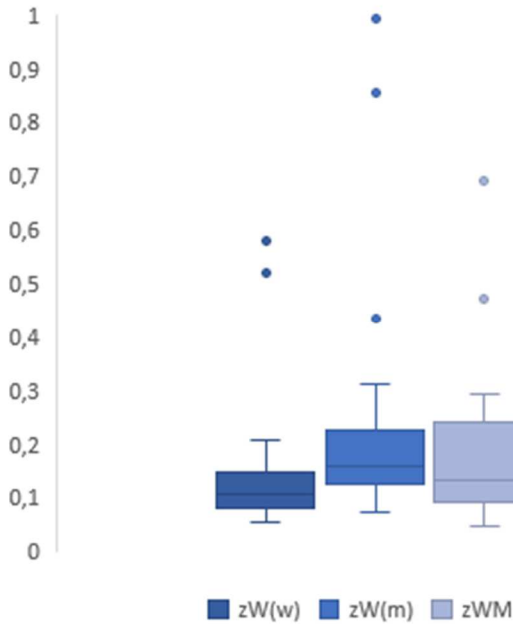


Figure 3. The share of ICS to Germany in the total ICS of the individual EU Member States in terms of value and quantity

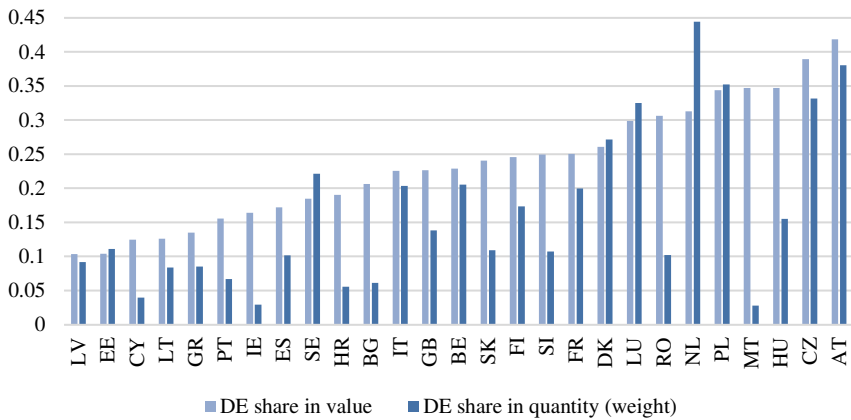


Figure 4. The share of ICS to the Netherlands in the total ICS of the individual EU Member States in terms of value and quantity

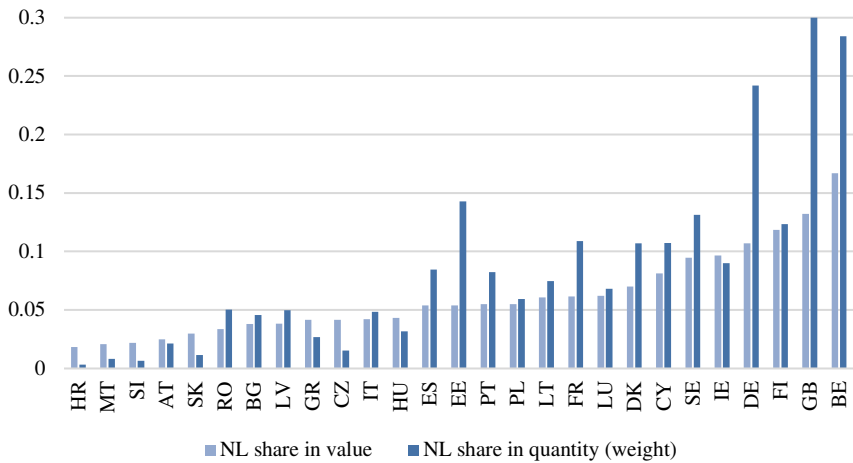


Figure 5. The share of ICS to Denmark in the total ICS of the individual EU Member States in terms of value and quantity

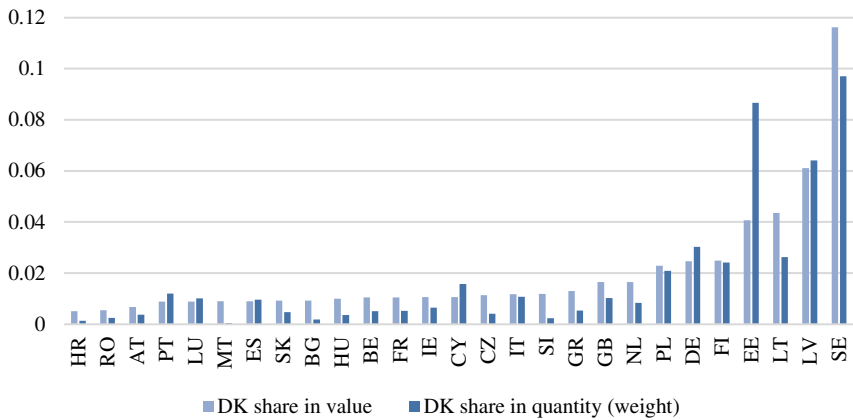


Figure 6. New value-weighted quantity-based index (5) vs. value-based index (4) calculated for Poland's exports to all EU Member States

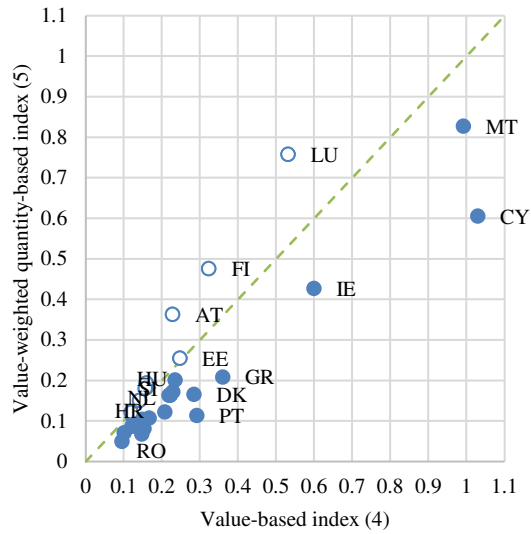


Figure 8. New value-weighted quantity-based index (5) vs. value-based index (4) calculated for France's exports to all EU Member States

