DISCREPANCIES BETWEEN MIRROR DATA ON INTRA-COMMUNITY TRADE: THE CASE OF POLAND

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Abstract: The content presented in the article is a continuation of the research on the quality of data concerning intra-Community trade. Several measures used in literature to assess differences between mirror data are presented. The research was inspired by the works by Morgenstern (1963), Federico and Tena (1991), and Ferrantino and Wang (2008). These previous works contain some directions on how Intrastat data should be analysed. Based on this the analysed data on intra-Community trade in goods for 2017. The dynamics of intra-Community trade were also examined. The obtained results can be utilised by practitioners from both the domain of official statistics and the revenue authorities. In the article discrepancies in data on Polish foreign trade are studied in the context of Poland-EU partner country (bilateral relations) and Poland-EU partners (one-to-many relations). The aim of the article is to compare the results of selected literature studies with those obtained on the basis of the analysis of the latest data on intra-Community trade in Poland (mainly in 2017) and EU member states.

Keywords: intra-Community trade, official statistics, mirror data.

1. Introduction

Data on intra-Community trade (and international trade more generally) are mirrored. This means that they are recorded in two sources, by the exporting side and by the importing side. Unfortunately this can be seen both as an advantage and a disadvantage on certain occasions. On the one hand, there exist discrepancies between the data on the same transactions. This is a serious problem in the use

of such data in various types of macroeconomic analysis. On the other hand, it is possible to identify these discrepancies and try to solve the problem by adjusting the data within the framework of bilateral agreements. The literature on the subject proposes various methods of examining the quality of data concerning foreign trade in goods with a different spatial and temporal scope (e.g. Parniczky, 1980; Guo, 2010; Ferrantino and Wang, 2008). The authors also conducted research in this area (Baran and Markowicz, 2018; Markowicz and Baran, 2019a). The research uses different methods (e.g. individual and aggregate indicators). These methods are used to study trade in relations between two countries (country-country bilateral trade, or one-to-one relations), between a country and a group of countries (country-to-countries or one-to-many relations), or even between groups of countries (countries-to-countries, many-to-many relations).

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2. Literature review

The analysis of mirror data in foreign trade has long been the focus of researchers' attention (Parniczky, 1980; Tsigas, Hertel, and Binkley, 1992; Guo, 2010; Hamanaka, 2012; Carrère and Grigoriou, 2014). The authors of the cited works pointed to the lack of convergence of data recorded in the two sources. Some of them explained this by the lack of reliability of public statistics data, while others believed that these were only wrongly declared export destinations or commodity groups and thus opted for the correctness of public statistics data. Some authors even suggested tax and customs fraud as the cause of data asymmetry.

Different indicators are used in the literature to assess the quality of the mirror data. For several years, the authors of this article have also been studying the inconsistencies of these data, using indices proposed in the literature and their own proposals (Markowicz and Baran, 2019ab, 2019c). The use of data quality indices makes it possible to classify e.g. countries and product groups by quality level. However, it is difficult to determine whether a particular level of an index indicates low or high quality data. That is why the authors searched in the literature for proposals to evaluate this level. The research was inspired by the works by Morgenstern (1963), Federico and Tena (1991), and Ferrantino and Wang (2008). These works contain some directions on how Intrastat data should be analysed.

It is believed that the first researcher to take seriously the observation of data asymmetry in foreign trade was Morgenstern (1963), who studied the differences in data

on world exports and imports in selected years of the period 1909-1960. He proposed three indices for measuring trade relations between pairs of countries (the symbols have been changed compared with the original work by Morgenstern, 1963, p. 170):

$$W_{1i} = \frac{I_{ij} - E_{ji}}{I_{ij}} 100, \tag{1}$$

$$W_{2i} = \frac{E_{ij} - I_{ji}}{E_{ij}} 100, \tag{2}$$

$$W_{3i} = \frac{b_1 - b_2}{b_1} 100, \tag{3}$$

where: I_{ij} – imports of country i according to i's statistics, i.e. declared in country i (equals exports of country j declared in country i), I_{ji} – imports of country j declared in country j (exports of country i declared in country j), E_{ij} – exports of country i declared in country i (imports of country j declared in country i), E_{ji} – exports of country j declared in country j (imports of country i declared in country j), b_1 – balance of trade of country i according to i, b_2 – balance of trade of country i according to j.

Morgenstern stated that, with large discrepancies in the mirror data, i.e. large values for indices W_{1i} and W_{2i}, foreign trade statistics should be considered unreliable. As a limit in this case, he assumed 25%. If the indices are lower than –25% or higher than +25%, he considered the data concerning the trade of a given pair of countries incorrect. Morgenstern also argued that an absolute value of the index greater than 50% indicates that there are also other causes of error than the unilateral inclusion of transport and customs costs. In EU statistics, the value of imports is shown on CIF terms, i.e. including the costs of transport and insurance to the border of the recipient country (Główny Urząd Statystyczny [GUS], 2018).

Table 1. Conclusions based on the signs of indices (1) and (2)

W_{1i} (%) (1)	W_{2i} (%) (2)	Conclusion
+	+	Overstatement by country i (or understatement by country j) of country i's trade statistics in both directions (exports and imports)
+	–	Overstatement of imports values (or understatement of exports values) by both countries (i and j)
–	+	Overstatement of exports values (or understatement of exports values) by both countries (i and j)
–	–	Understatement by country i (or overstatement by country j) of trade statistics in both directions (exports and imports)

Source: own elaboration based on (Morgenstern, 1963).

Federico and Tena have a different opinion than Morgenstern (1991, pp. 260--262). These authors state that Morgenstern's conclusion may not necessarily be true, as his method only checks the 'accuracy of geographical data'. In fact, the incorrect classification of individual trade flows, either divided by goods or by country, results in a parallel misclassification of the opposing sign in a different category. As these authors state, data aggregation mostly eliminates this problem. A better method to check on the reliability of the aggregates is a comparison between the total value of the country's trade (according to its own statistics) and the sum of these flows recorded by the partner countries (according to their own statistics). Federico and Tena (1991) claim that the results of their tests are in favour of the reliability of the official statistics and that the discrepancies between mirror data are mainly a result of including transportation costs (*CIF* vs. *FOB* models). In general, these authors group the reasons for discrepancies in data relating to trade flows in the statistics of the partner countries into three headings: 'unavoidable' (*CIF* vs. *FOB*), 'structural' (differences in criteria for producing statistics which could be eliminated by standardisation; differences in classification of goods), and 'actual errors' (cases where the data recorded differ from the actual flow). The reasons for these errors include lack of registration due to smuggling (underestimation of trade especially in the importing country due to high duty, cf. also: Fisman and Wei, 2004; Javorcik and Narciso, 2008), inaccurate declarations due to negligence or fraud (erroneous weight, value, classification) and errors made by statistical offices (in estimation of levels of prices, exchange rates).

According to Federico and Tena (1991), only a few studies systematically tested the reliability of international trade statistics, typically using the pairing method (i.e. comparing pairs of countries). The most comprehensive survey (37 countries, 1909-1913) was conducted by Zuckermann (1921). Federico and Tena (1991) stated that the survey carried out by them was intended to eliminate errors due to geographical imputation. Therefore they did not compare countries in pairs but used an index – the ratio of the total value of exports (imports) of the *i*-th country according to its statistics and the sum of the same flows according to the statistics of the trade partners (countries *j*):

$$E_i = \frac{\sum_{j=1}^{N} E_{ij}}{\sum_{j=1}^{N} I_{ji}}, \tag{4}$$

$$I_i = \frac{\sum_{j=1}^{N} I_{ij}}{\sum_{j=1}^{N} E_{ji}}. \tag{5}$$

The symbols in the formulae have been harmonised in the whole article. The summation index in the numerators of (4) and (5) has also been changed from *i* as in original text by Federico and Tena to *j* (*i* – the country considered; *j* – its partner countries). These indices show the share of transportation costs (called

freight factor). In the surveys for the periods of 1909-1913, 1928, and 1935 they established norms for the measures. It appears that the exports ratio E_i (4) should take values from 80-100%, and the imports ratio I_i (5) should take values from 100-120%. The article (Federico and Tena, 1991) indicates that for some countries the indices do not fall within the set limits, but the aggregate results for all countries are better than expected and stable over time.

The analysis of discrepancies in bilateral trade (country-country relationship) was carried out by Ferrantino and Wang (2008). They were interested in the trade between China, Hong Kong and the United States between 1995 and 2006. In their opinion, it has long been known that international trade data provided by importers and exporters are unlikely to be the same and in fact may differ significantly from each other for a number of different reasons. According to Tsigas, Hertel and Binkley (1992), such analyses have been carried out since the 19th century. These authors examined how the discrepancies between mirror data on the trade between the USA and China changed over the period 1995-2005.

In the context of the official statistics actions to improve data quality, the differences in data collected from two sources should decrease. If this is not the case, it may be affected by reasons which are not obvious (e.g. the intentional concealment of real transactions or the recording of artificial transactions).

3. Data and results

The research was conducted with the use of data from the Eurostat Comext database. The values of intra-Community supplies of goods (ICS) and intra-Community acquisitions of goods (ICA) of individual EU countries in 2017 were used. In the case of dynamic analyses the authors used data from 2005, 2008, 2011, 2015, and 2017.

Based on the work by Morgenstern (1963), indices (1)-(3) for Poland's trade relations with individual EU countries were calculated for data from 2017 (Table 2).

Nearly all W_1 and W_2 absolute values are lower than 25%. According to Morgenstern (1963) this is evidence of good data quality. The boundary level was exceeded in the case of Poland's relations with Cyprus (93.9% and 65.7%), Malta (62.2% and 58.9%), and only slightly in the case of relations with Luxembourg (39.3% and 26.5%) and Ireland (W_2 = 42.8%); one can conclude that the quality of data on trade in goods with EU countries is mostly good. For W_3, Morgenstern (1963) did not propose any norm. The analysis of the Poland-Germany relation reveals low estimates for W_1 and W_2 and a very high estimate for W_3. This appears to be due to the high value of trade between these countries, namely only one of the four aggregates of declared values (ICA and ICS declared in Poland followed by ICA and ICS declared in Germany) that is different from the others has an impact on the high value of the trade balance ratio. This means that it is impossible to establish a threshold level.

Table 2. Values of indices for trade relations Poland (i) – EU member state (j) in 2017

| Member state j	W_{1i} (%)	W_{2i} (%)	W_{3i} (%)	Member state j	W_{1i} (%)	W_{2i} (%)	W_{3i} (%)
AT	−2.7	15.7	−243.2	HU	−8.2	12.1	64.3
BE	−6.1	6.2	−25.0	IE	11.6	42.8	−25.9
BG	−10.9	12.7	34.3	IT	−12.0	4.2	−177.6
CY	93.9	65.7	−40.3	LT	−21.1	5.4	42.3
CZ	−15.0	1.9	30.0	LU	39.3	26.5	65.4
DE	2.7	10.6	−839.8	LV	−6.5	11.2	21.1
DK	7.6	14.1	29.9	MT	62.2	58.9	68.3
EE	5.4	17.7	21.5	NL	−12.0	4.8	−59.8
ES	−8.2	7.3	143.9	PT	−4.9	5.1	25.8
FI	12.0	17.3	114.9	RO	−11.0	−2.0	5.4
FR	−2.5	11.7	52.0	SE	19.5	16.9	3.4
GB	4.6	16.4	25.1	SI	−18.7	0.1	−56.9
GR	−11.1	14.3	36.8	SK	−15.6	8.0	603.2
HR	−13.7	−7.6	−5.7	EU27	−2.5	9.7	110.7

Source: own calculations.

Based on the research carried out by Federico and Tena (1991), indices (4) and (5) were calculated. Their construction (aggregation of the values of exports or imports of the partner countries) is intended to show that the dispersion in the data is due to differences in transportation costs and does not lead to 'geographical' errors. For EU countries (in 2017) ICS index (Figure 1), as well as the ICA index (Figure 2) were calculated. The boundaries proposed by Federico and Tena (1991) regarding freight factor are depicted with solid horizontal lines. In the case of exports they delimit the range 80–100% (costs are with buying side), while for imports the delimited range is 100–120%. However, for numerous countries the value of the ICS index is greater than the value of the ICA index, which contradicts the conclusions of Federico and Tena (1991). For the EU countries combined, they are 103% and 97% respectively. The suggested ranges contain only 8 (ICS) and 11 (ICA) index values.

Following the example of the work by Ferrantino and Wang (2008), the checked how the discrepancies of mirror data change over time. The years 2005, 2008, 2011, 2014, and 2017 were chosen for analysis. The article analysed the changes in the values of ICS and mirrored ICA in Poland's relations with individual EU countries
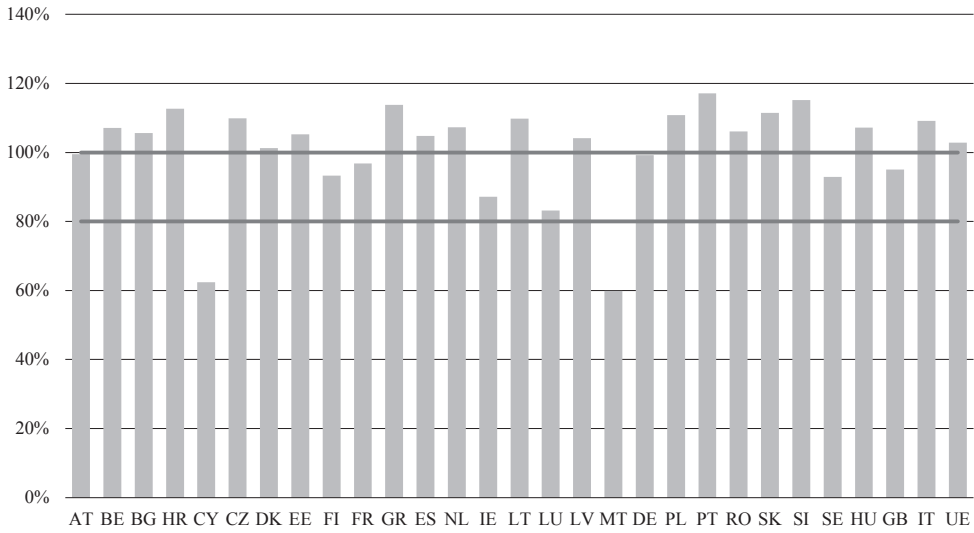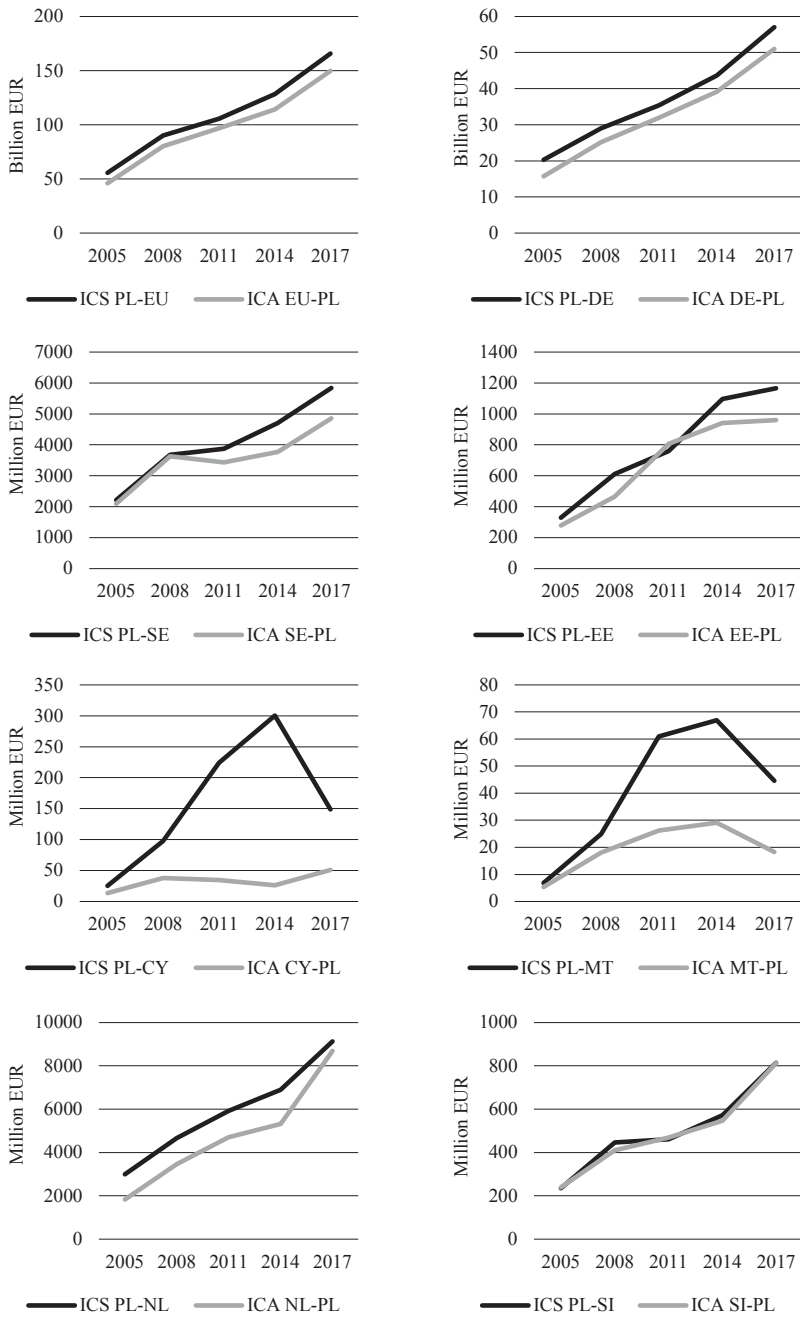
Fig. 1. ICS index E_i (4) for individual relations Poland-EU country, and for Poland-EU combined in 2017

Source: own calculations.
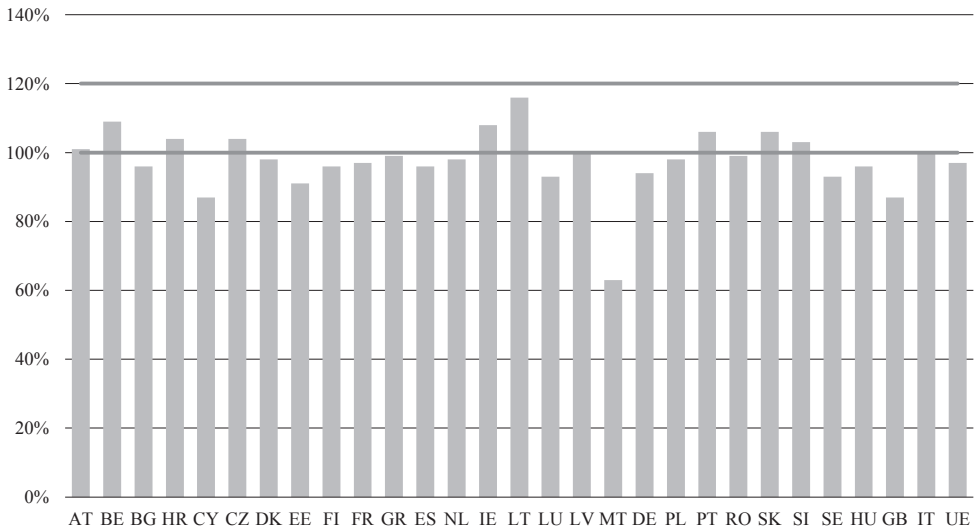
Fig. 2. ICA index I_i (5) for individual relations Poland-EU country, and for Poland-EU combined in 2017

Source: own calculations.

Fig. 3. Values of ICS from Poland to selected EU member states (declared in Poland) vs. its mirror ICA (declared in those EU member states)

Source: own calculations.

and with all the EU combined. Selected relations are shown in Figure 3, and four different scenarios were observed:
*   Discrepancies stable in time (Poland-EU and Poland-Germany),
*   Growing discrepancies (Poland-Sweden, Poland-Estonia),
*   Large, unstable discrepancies (Poland-Cyprus, Poland-Malta),
*   Tiny and/or diminishing discrepancies (Poland-the Netherlands, Poland--Slovenia).

It seems that only when the differences in data from two sources are neither small nor diminishing can the impact of not obvious causes (intentional concealment of real transactions or artificial recording of inexistent transactions) be presumed (scenarios 2 and 3).

4. Conclusions

Summarizing the literature review as well as the results of the conducted research, the following conclusions can be drawn:
*   In the literature, there are various proposals for measuring the quality of data concerning foreign trade in goods (including intra-EU trade). However, there is no established methodology that was thoroughly tested or at least applied in a wide range of cases.
*   Few researchers propose norms for the proposed indicators (i.e. which value ranges indicate good data quality). Even if such norms exist, they do not always conform to what was observed in the data on intra-Community trade in goods.
*   Nevertheless, both the indicators proposed in the literature and their norms can be used in a study of a different temporal, spatial or relational scope (they can also be modified). The authors showed that in the above section.
*   Newer literature is increasingly pointing to tax fraud (hiding transactions, declaring non-existent transactions) as the reason for data discrepancies beyond statistical considerations (data collection system). This can be observed in the data and to some extent measured with the appropriate indices.

In Poland, several initiatives have been conducted both in terms of the data adequacy of public statistics (changes in the functioning of the Intrastat system) and the reduction of irregularities in tax declarations (mainly related to VAT). The most recent issues in this respect concern:
*   Introducing the obligation to present JPK_VAT file (Standard Audit File for Tax, SAF-T). Such a file can automatically be processed in the tax administration's IT systems; the expected effects are to reduce the number of submitted documents and shorten the inspection time.
*   White List of VAT Taxpayers –on the webpage of the Ministry of Finance; since September 2019 it enables verification of the reliability of contractors; since January 2020, taxpayers are required to pay an invoice of more than PLN 15,000 to an account included in the list.

• Split payment mechanism introduced in November 2019 for selected commodity groups to replace prior reverse charge mechanism; VAT is payable to a special account, which enhances security.

All these measures lead to better data on intra-Community trade, and research on the quality of data on foreign trade in goods contributes to the detection of irregularities. The size and nature of these irregularities may encourage statistical offices to conduct activities aimed at improving the quality of data, and at the same time, the tax administration can use this knowledge to detect potential areas of interest more precisely.

References

Baran, P., and Markowicz, I. (2018). *Behavioral economics and rationality of certain economic activities. the case of intra-community supplies*. In K. Nermend, M. Łatuszyńska (Ed.), *Problems, Methods and Tools in Experimental and Behavioral Economics*, *Proceedings of Computational Methods in Experimental Economics (CMEE) 2017 Conference* (pp. 285-299). Cham: Springer.

Carrère, C., and Grigoriou, Ch. (2014). Can mirror data help to capture informal international trade? *Policy Issues in International Trade and Commodities Research Study Series*, (65).

Federico, G., and Tena, A. (1991). On the accuracy of foreign trade statistics (1909-1935). Morgenstern revisited. *Explorations in Economic History*, *28*(3), 259-273.

Ferrantino, M. J., and Wang, Z. (2008). Accounting for discrepancies in bilateral trade: The case of China, Hong Kong, and the United States. *China Economic Review*, *19*(3), 502-520.

Fisman, R., and Wei, S. J. (2004). Tax rates and tax evasion: evidence from 'missing imports' in China. *Journal of Political Economy*, *112*(2), 471-496.

Główny Urząd Statystyczny [GUS]. (2018), *Handel zagraniczny. Statystyka lustrzana i statystyka asymetrii*. Warszawa.

Guo, D. (2010). *Mirror Statistics of International Trade in Manufacturing Goods: The Case of China*. (UNIDO Research and Statistics Branch Working Paper 19/2009).

Hamanaka, S. (2012). Whose trade statistics are correct? Multiple mirror comparison techniques: a test of Cambodia. *Journal of Economic Policy Reform*, *15*(1), 33-56.

Javorcik, B. S., and Narciso, G. (2008). Differentiated products and evasion of import tariffs. *Journal of International Economics*, *Elsevier*, *76*(2), 208-222.

Markowicz, I., Baran, P. (2019a). ICA and ICS-based rankings of EU countries according to quality of mirror data on intra-Community trade in goods in the years 2014-2017. *Oeconomia Copernicana*, *10*(1), 55-68. DOI: 10.24136/oc.2019.003

Markowicz, I., and Baran, P. (2019b). Intra-community trade asymmetries based clustering and linear ordering of combined nomenclature chapters using generalized distance measure (GDM). *Econometrics. Ekonometria*, *23*(3), 50-58.

Markowicz, I., and Baran, P. (2019c). Quality of Intrastat data. Comparison between "old" and "new" EU member states. *Acta Universitatis Lodziensis. Folia Oeconomica*, *2*(341), 69-80, DOI: http://dx.doi.org/10.18778/0208-6018.341.05

Morgenstern, O. (1963). *On the Accuracy of Economic Observations* (2nd ed.). New Jersey: Princeton University Press.

Parniczky, G. (1980). On the inconsistency of World Trade statistics. *International Statistical Review*, *48*(1), 43-48.

Tsigas, M. E., Hertel, T. W., and Binkley, J. K. (1992). Estimates of systematic reporting biases in trade statistics. *Economic Systems Research*, *4*(4), 297-310.

Zuckermann, S. (1921). *Statistischer Atlas zum Welthandel*. Vol. 1. Berlin: Otto Elsner Verlagsgesellschaft M.B.H.

ROZBIEŻNOŚCI W HANDLU WEWNĄTRZWSPÓLNOTOWYM: PRZYPADEK POLSKI

Streszczenie: Prezentowane w artykule treści są kontynuacją badań prowadzonych nad jakością danych dotyczących handlu wewnątrzwspólnotowego. Studia literaturowe pozwoliły na wskazanie propozycji oceny poziomu jakości danych. Inspiracją do przeprowadzonych badań były publikacje autorów takich jak: Morgenstern (1963), Federico i Tena (1991) oraz Ferrantino i Wang (2008). To w nich znaleziono pewne wskazówki. Na tej podstawie analizie poddano dane dotyczące obrotu towarowego między krajami unijnymi w 2017 roku. Zbadano także zmiany zachodzące w czasie. Wyniki takich badań mogą być wykorzystane w zakresie zarówno statystyki publicznej, jak i podatkowym. W artykule podjęto temat analizy rozbieżności danych w handlu Polski w relacjach Polska–kraj UE (relacje dwustronne) i Polska–kraje UE (relacja kraj–kraje, nazwana zagregowaną). Celem badania jest porównanie wyników wybranych badań literaturowych z wynikami uzyskanymi na podstawie analizy najnowszych danych dotyczących obrotu wewnątrzwspólnotowego Polski (głównie 2017 rok) oraz krajów unijnych.

Słowa kluczowe: handel wewnątrzunijny, statystyka publiczna, dane lustrzane.