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THE STRUCTURE OF EXPORTS AND REVEALED COMPARATIVE ADVANTAGE OF THE WORLD LARGEST EXPORTERS

STRUKTURA TOWAROWA EKSPORTU A PRZEWAGA KOMPARATYWNA W HANDLU NAJWIĘKSZYCH EKSPORTERÓW ŚWIATOWYCH

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Summary: The aims of this paper are to estimate the revealed comparative advantage of the largest world exporters – the USA, Germany and China – in the years 2000-2014 and compare the comparative advantage index with the structure of their exports. The classical RCA and the modified RCA_{DVA} index (based on value added) were used for estimating revealed comparative advantage in foreign trade. The analysis shows that the USA had comparative advantage in the trade of agricultural products and services. Germany and China had comparative advantage in the trade of manufactured products. It was ascertained that the correlation between the share of a given good or service in total exports of the countries under study and the RCA_{DVA} index was positive. The structure of Chinese exports was the most consistent with the comparative advantage index, whereas the structure of US exports was the least consistent with this index.

Keywords: trade in value added, revealed comparative advantage RCA, exports.

Streszczenie: Celem artykułu jest określenie przewagi komparatywnej trzech największych eksporterów światowych w ich handlu zagranicznym w latach 2000-2014 oraz porównanie jej ze strukturą towarową ich eksportu. Do określenia poziomu przewagi komparatywnej wykorzystano indeks RCA w klasycznej i zmodyfikowanej postaci (RCA_{DVA}), opartej na wartości dodanej. Analiza przeprowadzona w pracy pokazała, że USA dysponowały przewagą komparatywną w handlu produktami rolnymi oraz usługami, natomiast Niemcy i Chiny dysponowały taką przewagą w handlu przetworzonymi produktami przemysłowymi. Udało się także stwierdzić, że we wszystkich krajach występowała dodatnia korelacja pomiędzy udziałem poszczególnych dóbr i usług a indeksem RCA_{DVA}. Najbardziej zgodną z indeksem przewagi komparatywnej strukturę eksportu miały w badanym okresie Chiny, a najmniej USA.

Słowa kluczowe: handel według wartości dodanej, przewaga komparatywna w handlu.

1. Introduction

The article aims to determine the comparative advantage of the three largest world exporters: the United States, Germany and China in foreign trade and to check whether the structure of their exports is consistent with their comparative advantage.

Such an advantage can be determined based on the RCA comparative advantage index, which indicates the position in the export of particular goods or services of a given country. However, due to the fragmentation of production processes characteristic of the contemporary global economy, it was decided to use a slightly modified formula of this index.

The division of individual production stages between entities operating in different countries (fragmentation of production) causes that goods and services produced by individual countries contain not only the national value, but also the foreign value derived from imported intermediate goods. As numerous studies show (e.g.: [Hummels, Ishii, Yi 2001; Johnson, Noguera 2012; Stehrer, Foster, de Vries 2012]), the share of foreign value added in the export of particular countries is increasing. Therefore it is proposed to measure foreign trade not on the basis of the final value of goods and services but on the basis of the domestic added value contained therein [Wei, Mattoo, Wang 2014; Koopman et al. 2010; Koopman, Wang, Wei 2014; Foster-McGregor, Stehrer 2013].

2. Literature review

To determine the comparative advantage in foreign trade, various measures are used (e.g. the coverage of exports by imports – EXIM, contribution to trade balance, Bowen's Net Trade Index, Michaely's index) [OECD 2011; Cieślik 2000; Michaely 1962; CEPII 2016; Iliopulos 2005; OECD 2005b; Bowen 1983].

The most common indicator, however, is the index showing the position of a given country in the export of certain goods/services compared to the reference group of countries, developed by H.H. Liesner in 1958, refined and popularized by B. Balassa, known as the Balassa index (RCA) [Liesner 1958; De Benedictis, Tamberi 2002].

In the classic approach, the Balassa index has the form [Balassa 1965; 1989]:

$$RCA = \frac{Ex_{ij}}{\sum_{i=1}^{n} EX_{ij}} : \frac{EX_{iw}}{\sum_{i=1}^{n} EX_{iw}},$$

where: RCA – Balassa revealed comparative advantage index; EX_{ij} – the country's export of the i product to the m market; EX_{iw} – the export of the i product to the m market by the reference group of countries; n – a number of sectors, products, industries.

The Balassa index was modified by many authors, who proposed different variants of the formula shown above [e.g.: Laursen 2015; Vollrath 1991; Hadzhiev 2014]. However, due to the fragmentation of production and its effects mentioned in the introduction, it was decided to use the Balassa index in a slightly modified form to determine the comparative advantage of the countries under study in terms of foreign trade. Measuring foreign trade with the final value of goods and services means that intermediate goods consumed for their production are doubled (or even counted multiple times) and do not reflect the actual contribution of a given country to their production. R. Koopman, Z. Wang and S.-J. Wei argued that the traditionally estimated RCA index might yield misleading results [Koopman, Wang, Wei 2012]. Therefore, they proposed that comparative advantage should be determined taking into account domestic value added in the export of particular goods and services. The corresponding formula is as follows [Koopman, Wang Z., Wei 2012; Ambroziak 2013]:

$$RCA_{DVA} = \frac{DVA_{EX_{ij}}}{\sum_i^n DVA_{EX_{ij}}} : \frac{DVA_{EX_{iw}}}{\sum_i^n DVA_{EX_{iw}}},$$

where: RCA_{DVA} – modified Balassa revealed comparative advantage index; DVA_{EXij} – domestic value added in the country's export of the *i* product to the *m* market; DVA_{EXiw} – domestic value added in the export of the *i* product to the *m* market by the reference group of countries; *n* – a number of sectors, products, industries.

The modified index takes values greater than 0 and their interpretation is the same as in the case of the classical index. The value above 1 indicates that a given country has comparative advantage in the foreign trade in a particular product. The value between 0 and 1 indicates that the country does not have comparative advantage in the trade of a given product.

The calculations were based on the data for the years 2000-2014, obtained from the WIOD database [WIOD Database 2016]. They covered 56 groups of goods and services classified by the ISIC divisions [UN 2015]. According to the modified formula, first it was necessary to estimate domestic value added in the exports of the USA, Germany and China. For this purpose, the method described by OECD and based on the Leontief matrix was used[1]. The results obtained were then used to determine the RCA_{DVA} index for the countries under study.

3. Results

The results showed that, similarly to the findings of other authors[2], the comparative position of the countries under study was different depending which RCA index formula was used (Figure 1). In the case of agricultural products, only the USA had

[1] The methodology was discussed in detail in literature [Cf.: OECD 2005a; Stehrer 2012; Stehrer 2013].

[2] [Cf.: Koopman, Wang, Wei 2012].

comparative advantage and the modified index indicated that it was actually lower than the one calculated with the classical RCA. The other two countries did not have any advantage in the trade in agricultural products and the differences between the classic index and the modified index were almost imperceptible. It is also notable that in the analyzed period the comparative position of China in this market deteriorated significantly.

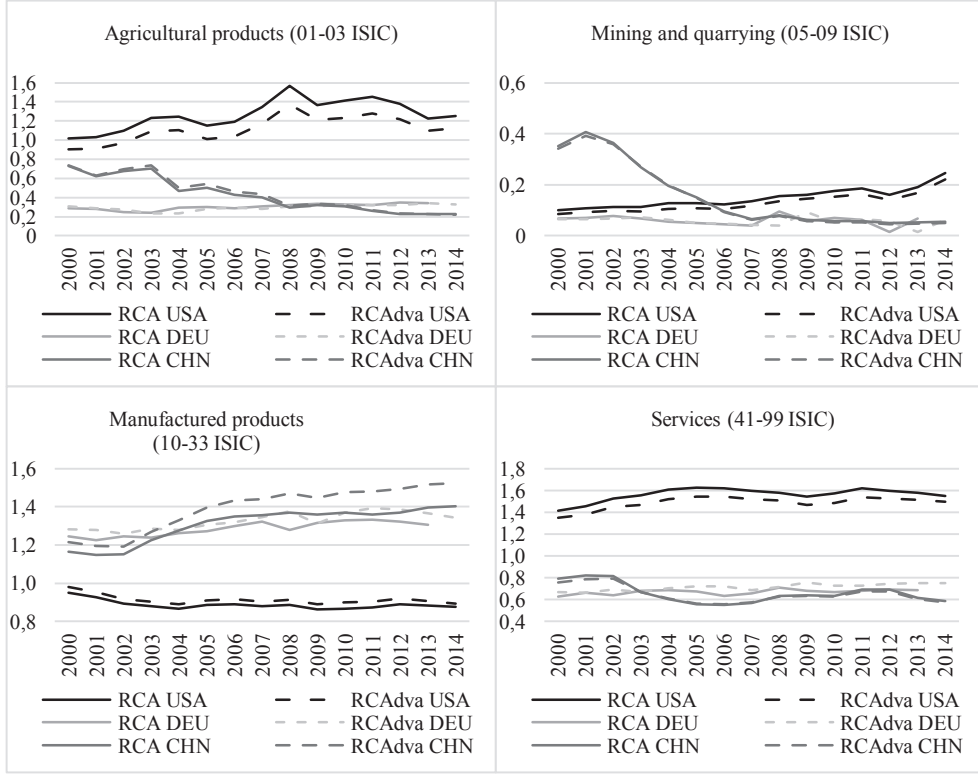

Figure 1. The comparative advantage index for the trade of the USA, Germany and China in the years 2000-2014 according to the main ISIC divisions of goods and services

Source: own elaboration based on WIOD [WIOD Database 2016].

None of the countries had comparative advantage in the trade in mining products. The classic index generally pointed to a slightly higher or similar position than the modified index. Nevertheless, the index for the USA followed an upward trend, while China's index declined considerably.

The situation in the area of manufactured products was completely different. The comparative position of the USA was clearly the worst. Although the modified index was slightly higher than the classic index, in none of the analyzed years the

country had comparative advantage in the trade of manufactured products. However, the other two countries had comparative advantage in the trade of those products. Moreover, between 2000 and 2014, the advantage increased significantly and the modified index assumed considerably higher values than the classic index. This was particularly evident in the case of China.

The USA gained comparative advantage in the trade in services, with the modified index being slightly lower than the classic one. China and Germany did not have comparative advantage. In the case of Germany, the modified index was a little higher than the classic one, while in China the two indices were at a similar level. Based on the data from the years 2000-2014, however, it is difficult to determine the trend concerning changes in the comparative position in the trade in services for the countries under study.

The analysis of the data presented in Table 1 led to the conclusion that, in the years under study, the US had comparative advantage in the trade in about half of all types of goods and services, and their exports accounted for about 70% of total exports.

Table 1. The number of the ISIC divisions in which the country has comparative advantage in foreign trade (RCADVA>1)

Yrs	USA		Germany		China	
	Number of divisions where $RCA_{DVA}>1$	Share in exports (in %)	Number of divisions where $RCA_{DVA}>1$	Share in exports (in %)	Number of divisions where $RCA_{DVA}>1$	Share in exports (in %)
2000	23	66.9	21	67.3	14	74.5
2001	24	68.2	22	68.1	14	74.2
2002	25	70.0	23	68.9	14	74.4
2003	25	69.7	21	69.0	16	77.6
2004	26	71.1	21	69.1	16	74.4
2005	27	70.7	21	68.9	13	71.0
2006	26	70.3	20	68.0	16	81.2
2007	26	70.5	19	66.0	14	76.0
2008	27	74.2	24	72.7	16	78.5
2009	26	68.2	27	75.0	17	83.4
2010	26	67.6	26	73.7	16	76.2
2011	26	68.4	25	71.0	17	80.5
2012	26	68.6	27	75.3	17	81.0
2013	27	70.7	27	76.1	16	77.6
2014	25	62.2	27	75.9	15	77.3

Goods and services grouped in 56 ISIC divisions.

Source: own elaboration based on WIOD [WIOD Database 2016].

Table 2. The list of the ten most important exports of the USA, Germany and China in 2000 and in 2014 according to the ISIC divisions

	2000		2014
	ISIC		ISIC
USA	**1. Computer, electronic, optical products (15.6)** **2. Wholesale trade (9.7)** **3. Machinery and equipment n.e.c. (7.6)** 4. Motor vehicles (6.8) **5. Other transport equipment (6.0)** **6. Chemicals (5.5)** 7. Food products, beverages, tobacco products (3.2) **8. Administrative and support service activities (2.7)** **9. Publishing activities (2.5)** **10. Air transport (2.4)**		**1. Wholesale trade (10.3)** **2. Coke and refined petroleum products (6.6)** **3. Other transport equipment (6.6)** **4. Chemicals (6.2)** 5. Computer, electronic, optical products (5.8) 6. Machinery and equipment n.e.c. (5.6) 7. Motor vehicles (5.4) 8. Food products, beverages, tobacco products (3.9) **9. Administrative and support service activities (3.2)** **10. Financial service activities (2.9)**
Total share in the exports of the country (in %)		62.0	56.5
The share of divisions where $RCA_{DVA}>1$ in the country's exports (in %)		52.0	35.8
Germany	1. Motor vehicles (16.4) 2. Machinery and equipment n.e.c. (11.6) 3. Computer, electronic, optical products (9.5) **4. Chemicals (8.1)** **5. Electrical equipment (5.5)** 6. Wholesale trade (4.8) **7. Basic metals (4.2)** **8. Other transport equipment (3.2)** 9. Food products, beverages, tobacco products (3.2) 10. Textiles, wearing apparel and leather products (3.1)		**1. Motor vehicles (17.1)** **2. Machinery and equipment n.e.c. (12.6)** **3. Chemicals (8.2)** **4. Electrical equipment (5.4)** 5. Computer, electronic, optical products (5.0) 6. Wholesale trade (4.8) **7. Food products, beverages, tobacco products (4.5)** 8. Basic metals (3.7) **9. Rubber and plastic products (3.2)** **10. Fabricated metal products, except machinery and equipment (3.2)**
Total share in the exports of the country (in %)		69.6	67.7
The share of divisions where $RCA_{DVA}>1$ in the country's exports (in %)		58.5	54.2
China	**1. Textiles, wearing apparel and leather products (19.4)** **2. Computer, electronic, optical products (18.1)** **3. Electrical equipment (6.8)** **4. Furniture; other manufacturing (5.9)** **5. Wholesale trade (5.8)** **6. Rubber and plastic products (3.4)** 7. Basic metals (3.4) 8. Machinery and equipment n.e.c (3.4) 9. Chemicals (3.2) 10. Food products, beverages, tobacco products (3.1)		**1. Computer, electronic, optical products (23.1)** **2. Textiles, wearing apparel and leather products (12.3)** **3. Electrical equipment (9.1)** **4. Machinery and equipment n.e.c. (7.8)** **5. Wholesale trade (6.4)** 6. Chemicals (4.0) **7. Furniture; other manufacturing (3.9)** 8. Basic metals (3.6) **9. Fabricated metal products, except machinery and equipment (3.5)** 10. Legal and accounting activities; activities of head offices; management consultancy activities (2.6)
Total share in the exports of the country (in %)		72.5	76.3
The share of divisions where $RCA_{DVA}>1$ in the country's exports (in %)		59.4	68.7

Divisions where RCADVA>1 are marked in bold.

Source: own elaboration based on WIOD [WIOD Database 2016].

In Germany the situation was different. In the years 2000-2007, the country had comparative advantage in the 19-23 ISIC divisions and their share in total German exports accounted for about 66-69%. However, in the years 2008-2014 the number of divisions in which Germany reported comparative advantage in foreign trade increased to 25-27 and their share in total exports grew to 71-76%.

In contrast, China was in a completely different situation. The country had comparative advantage in the trade in goods and services classified in only 13-17 divisions, but they accounted for as much as 71-84% of total Chinese exports.

In 2000, eight items on the list of the ten most important products exported by the USA had comparative advantage. This accounted for 52% of total US exports. In 2014, it was six divisions whose share in exports did not exceed 40%. Detailed data are presented in Table 2.

Both in 2000 and 2014, Germany had seven divisions on the list, in which the country had comparative advantage, but their share in the country's total exports fell from 58.5% to 54.2%. In turn, China had only six divisions on the list of the most important exports at the beginning of the period under study, in which they reported comparative advantage, while in 2014 the number of the divisions increased to eight. Their share in the total Chinese exports increased from 59.4% to 68.7%.

The results also verified the calculation of the correlation coefficient between the share of particular goods and services in total exports and the RCA_{DVA} index of the countries under study (Table 3).

Table 3. Correlation between the share of particular goods and services in exports and the RCADVA index

Years	Correlation coefficient R_S			Determination coefficient R_S^2 (in %)		
	USA	Germany	China	USA	Germany	China
2000	0.607	0.658	0.889	36.8	43.3	79.0
2001	0.594	0.654	0.886	35.3	42.8	78.5
2002	0.601	0.626	0.881	36.1	39.2	77.6
2003	0.588	0.644	0.893	34.6	41.5	79.7
2004	0.567	0.640	0.887	32.1	41.0	78.7
2005	0.556	0.655	0.890	30.9	42.9	79.2
2006	0.562	0.651	0.899	31.6	42.4	80.8
2007	0.578	0.686	0.886	33.4	47.1	78.5
2008	0.567	0.646	0.895	32.1	41.7	80.1
2009	0.570	0.560	0.920	32.5	31.4	84.6
2010	0.556	0.567	0.913	30.9	32.1	83.4
2011	0.550	0.532	0.919	30.3	28.3	84.5
2012	0.559	0.547	0.908	31.2	29.9	82.4
2013	0.586	0.575	0.913	34.3	33.1	83.4
2014	0.582	0.531	0.914	33.9	28.2	83.5

Correlation was measured with Spearman's Rs rank correlation coefficient. All the results are statistically significant at $p<0.05$.

Source: own elaboration based on WIOD [WIOD Database 2016].

The relationship between these two variables turned out to be positive, which means that the higher value of the RCA_{DVA} index for particular goods and services was linked with their higher share in exports. For the USA, it was moderate and amounted to approx. 0.55-0.60, which means that the export structure was related to the value of the comparative advantage index by approx. 30%. For Germany, the correlation coefficient of 0.63-0.69 in the years 2000-2008 fell to 0.53-0.57 in the next period (2009-2014). It means that in the former period the share of particular goods and services in exports was dependent on the value of the RCA_{DVA} index in approx. 40%, while in the latter period the importance of this factor dropped to approx. 30%. The strongest correlation between the analyzed variables concerned China. The R_S coefficient was about 0.9 and followed an upward trend. The determination coefficient showed that the share of goods and services in the exports of China could be explained in more than 80% by the value of the comparative advantage index.

4. Conclusions

The analysis led to the conclusion that the level of comparative advantage of the USA, Germany and China adopts slightly different values depending on the measure used.

First of all, it turned out that the value of the modified index is higher than the value of the classic index in the case of manufactured products. Interestingly, the US index (regardless of the measurement method) indicated that the country did not have comparative advantage in foreign trade in those products, while China had the highest and growing advantage.

In the case of other types of goods, the modified index was either slightly lower or very similar to the classic index. In the foreign trade of other goods and services, the USA clearly had the best position. The country enjoyed comparative advantage in the trade in agricultural products and services (China and Germany did not have such advantage). However, none of the countries under study had comparative advantage in the trade in mining products.

It turned out, therefore, that the USA had comparative advantage in the trade in agricultural products and services, while Germany and China in the trade in manufactured products.

Another issue is whether the countries under study used this advantage in foreign trade. The results obtained lead to the conclusion that the country that exploited it to the largest extent was China. The structure of its exports was positively and strongly related to the value of the RCA_{DVA} index, and the export of those products in which the country had comparative advantage accounted for 71% to 84% of its exports.

The USA and Germany exploited their advantage to a lesser extent. The structure of their exports was positively but moderately related to the values of the RCA_{DVA} index. The US value of exports in which they had comparative advantage consti-

tuted approx. 70% of all the country's foreign trade. In Germany, the share of such goods and services in total exports increased from less than 70% to around 75%. Therefore, taking into account the results presented earlier, the structure of the exports of China was the most consistent with the index of its comparative advantage, while the structure of US exports was the least consistent with it.

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