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Revealed comparative advantages and trade balance indicators of trade structure of V4 countries

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Abstract: The paper aims to inspect trade structure and changes in comparative advantages of the Czech Republic, Hungary, Poland, and Slovakia on the intra-EU28 market for the period 2009–2019. The categorisation of the products corresponds to the Statistical classification of products by activity (CPA). This paper exploits the modified index of revealed comparative advantages–the revealed symmetric comparative advantages (RSCA) and the trade balance index (TBI). Econometric models using the RSCA were applied for testing stability and specialisation trends of a country's trade. The results show that the Czech Republic and Hungary had the biggest changes in comparative advantages in 2009–2011, Poland and Slovakia in 2011–2015. The findings indicate space for increasing export performance and specialisation of these V4 countries on the intra-EU market in the short and long-run.

Keywords: specialisation; revealed comparative advantages; revealed symmetric comparative advantages; trade balance index; export performance.

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1 Introduction

The framework of regional cooperation between the Czech Republic, Hungary, Poland, and Slovakia, known as the Visegrad Group or V4 was launched in 1991. The formation of the Visegrad Group contributed to the enhanced stability in Central Europe and deepened cooperation among Central European states in the areas such as education, culture, science, environment, fight against organised crime, regional development, civil society development, transport; in addition, this cooperation facilitated the integration efforts of the V4 countries (Gyárfášová and Mesežnikov, 2016). The Czech Republic, Hungary, Poland, and Slovakia became EU members on 1 May 2004.

The V4 countries are open economies, amongst which Slovakia is the most open one, followed by Hungary, the Czech Republic and Poland.[1] In Slovakia, the ratio of total trade to GDP jumped from 136% in 2009 to 184% in 2019 (maximum 191% in 2018, minimum 136% in 2009) in Hungary it increased from 145% in 2009 to 161% in 2019 (maximum 168% in 2014, minimum 145% in 2009). In the Czech Republic, the value of the trade-to-GDP ratio reached 113% in 2009 and 143% in 2019 (maximum 158% in 2014 and minimum 113% in 2009) and in Poland the indicator expanded from 75% in 2009 to 106% in 2019 (maximum 107% in 2018 and minimum 75% in 2009). The whole V4 group contributes to the merchandise intra-EU28 export with 12% and to the import with 11% (on the average of 2009–2019). These values confirm the importance of foreign trade activities for all these economies. More data on their trade openness and exports/imports are provided in Appendix 2. Haddad et al. (2012) argued that countries with deeper integration into trading activities were more exposed to external shocks. Therefore, for a country to remain competitive in the long run, it is necessary to observe its engagement in foreign trade activities, inspect the changes in comparative advantages and the dynamics of specialisation changes.

This paper focuses on comparative advantages of selected CPA product categories of individual V4 countries, measures the stability of trade patterns and trends of export specialisation. Unfortunately, most papers dealing with comparative advantages of the V4 countries focus on agricultural products rather than manufacturing. Therefore, this paper attempts to fill in this gap and make a valuable contribution to the trade theory and praxis. The paper is organised as follows: after the introductory part there is an overview of corresponding literature and empirical papers. The following section focuses on methodology, followed by a discussion on achieved results and a conclusion with policy recommendations.

2 Literature review

The competitiveness of countries represents a key factor of the theory of international trade and economic growth. The traditional trade theories and international trade flows are explained from the supply-side variables, the comparative advantages (Zhang and Jensen, 2005). From the early nineteenth century until the late 1970s, international trade theory was dominated almost entirely by the concept of comparative advantage – countries trade to take advantage of their differences (Krugman, 1987). However, the new view of international trade considers trade driven by economies of scale rather than comparative advantage and international markets, which are typically imperfectly competitive (Krugman, 1987).

Theories of comparative advantages and competitiveness go back to absolute advantages (Smith, 1776), comparative advantages (Ricardo, 1817) and competitive advantages (Porter, 1990). According to Ricardo (1817), countries trade and gain from trade due to differences in technology. This principle of comparative advantage does not require higher absolute productivity but only higher relative productivity (a weaker assumption) in producing a commodity (Gupta, 2015). Eli Heckscher and Bertil Ohlin argued that trade could be beneficial even if two countries had the same production technology but different factor endowments (Clarke and Kulkarni, 2009). Heckscher (1919) and Ohlin (1933) introduced the concept of factor endowments, that countries will

export commodities that require for their production much of abundant production factors and few scarce factors in exchange for goods that demand factors in different proportions. This postulation became a subject of further analyses, e.g., Stolper and Samuelson (1941) and Samuelson (1949), and Leontief (1956).

Comparative advantages are a subject of many research papers dealing with specialisation and trade patterns of economies. Besides comparative advantages there is special attention paid to competitive advantages (Porter, 1990), sustained competitive advantages (Porter, 1990) and sustainable advantages (Hoffman, 2000). Comparative advantages are often related to the term of revealed comparative advantages (RCAs). The concept of RCAs was introduced by Liesner (1958), later in Balassa (1965, 1977, 1986). Porter (1990) focused on competitive advantages and sustained competitive advantages. He declared that national competitiveness was created and not inherited. Competitive vs. comparative advantages were investigated by Neary (2003).

Gupta (2015) proposed a link between comparative and competitive advantage concepts and outlined a synthesis between these two principles in international trade/ business. Hoffman (2000) focused on the sustainable advantages in the past, present and the future. If comparative advantages refer to the quantitative notion of factors of production and goods, competitive advantages are based mainly on the quality of these factors and goods. Comparative advantages are often used to evaluate trade patterns and investigate the specialisation of a country. Hence, it becomes a topic of many theoretical, empirical and policy debates.

The indexes of the revealed comparative advantages (RCAs) can be divided into two groups. The first one involves the traditional RCA index proposed by Balassa (1965, 1977, 1986), the second group comprises modified RCA indexes. The initial (traditional) Balassa index was based on export data but ignored the imports. The index was later modified with both the exports and imports (Gnidchenko and Salnikov, 2015). Laursen (2015) argues that if the RCA is used in the econometric analysis, there is a need to adjust the RCA to become symmetric. Due to these shortcomings of the traditional RCA index, several attempts were made to modify the indicator. As a result, there are various modified RCA indexes using either export or both export and import data see e.g., Vollrath (1987, 1991), Dalum et al. (1998), Hoen and Oosterhaven (2006) and Lafay (1992).

Vollrath (1987, 1991) suggested three alternatives. The first option is the Index of the revealed competitive advantages (RCoA). The second is the log transformation of the traditional RCA and the third measure is the indicator of the Revealed competitiveness. Another modified index of comparative advantage was presented by Lafay (1992) considering both exports and imports. The International Trade Centre uses this index for computing trade performance indicators of observed countries. Dalum et al. (1998) suggested another alternation to the Balassa RCA index. The modified index refers to the Revealed symmetric comparative advantage (RSCA). Hoen and Oosterhaven (2006) proposed additive RCA (ARCA) computed as the difference between the export shares instead of the quotient as in the standard index. Another indicator of comparative advantages is the Net trade to total trade ratio. Azzam et al. (2010) suggested adjusting the RCA for export and re-exports in cases when merchandise exports are the country's mainstay and most of them are in the form of re-exports (e.g., Dubai). Data on imports and exports as percentages of GDP were used as indicator of globalisation trends and

patterns by Naghshpour and Sergi (2009). Balassa and others have used production, consumption, import and export data to construct various trade performance indicators. However, there is little argument for selecting one measure over another (Leishman et al., 1999; Ufuk, 2011).

Sari and Divinagracia (2021) analysed the revealed comparative advantage and constant market share of Indonesian cinnamon in the world market. The outcomes showed that Indonesian cinnamon had a comparative advantage in either the world or US market. D'Aleo and Sergi (2017) focused their research on competitive advantage in the EU's logistics sector. The findings showed that investment in the human factor was appropriate means of stimulating innovation and economic outlook. The trade and industry developments in Central and Eastern Europe were analysed by Sergi et al. (2007). Mishra et al. (2016) focused on inspecting the competitiveness of emerging Asian economies with special reference to India. Factors such as GDP, outward FDI flows, and export of goods and services were identified as determinants for a nation's competitiveness. Hsing and Sergi (2010) tested the bilateral trade J-curve for Australia, Canada, New Zealand, and the UK. According to their results, there was a lack of support for a J-curve for Australia, Canada, and the UK.

The patterns of international trade and the RCA indexes of V4 became a subject of research in most empirical papers (mainly dealing with the agricultural sector). The research involves analysing the trade of an individual country (the Czech Republic, Hungary, Poland, and Slovakia) or within a set of countries. For example, Bojnec and Fertő (2014a) inspected the agri-food export competitiveness in European Union Countries. Their findings indicated that Netherlands, France, and Spain belonged to the most competitive states in agri-food export. A study elaborated by Sankot (2015) analysed comparative advantages of the Visegrad 4 countries and Germany and sectors were compared according to the labour qualification and intensity of technology. The study identified a gradual shift towards export of higher value-added in the Czech Republic, Hungary, and Slovakia, but a slow export change in Poland.

Bojnec and Fertő (2017) used the RCA index on panel data to assess the pattern, duration, and country-level determinants of global agri-food export competitiveness. According to their outcomes, the long-term survival rates revealed by the comparative advantage indices were among the highest for the Netherlands, France, Belgium, the USA, Argentina, and New Zealand. Torok and Jambor (2016) focused on determinants of revealed comparative advantages of the European ham trade. The results showed that the competitiveness of the European ham trade was affected by the quality linked to the production area. The study presented by Rytko (2014) analysed Polish and Slovak agri-food products' competitiveness in the European market with the following findings: membership of these countries in the EU supported the growth of the foreign agro-food trade in both of these countries in the European market, but the trade on the third countries market increased only for Poland. Bojnec and Fertő (2007) studied revealed comparative advantages and competitiveness of Hungarian and Slovenian agro-food trade in the European Union markets between 1993 and 2003. According to the Balassa index, the study showed that both countries had lost comparative advantage for a number of product groups over time.

Qineti et al. (2009) examined the competitiveness and comparative advantages of the Slovak and the EU agri-food trade with Russia and Ukraine. The presented results

indicated a declining trade specialisation. Hambalková (2006) analysed factors of competitiveness and their impact on export efficiency of grape and wine in the Slovak Republic. The findings indicated that for Slovakia, it was important to diversify the export market. Finally, Fertő and Hubbard (2003) exploited four revealed comparative indexes to inspect the competitive ability of Hungarian agriculture and food processing. According to their results Hungary achieved a comparative advantage in various agri-food products, including animals and meat. Bojnec and Fertő (2014b) focused on the export competitiveness of dairy products of EU countries on intra-EU, extra-EU, and global markets. Applying the RCA index over the 2000–2011 period, the results revealed that it was difficult for most of the new EU-12 countries to keep the level of their export competitiveness in some dairy products. Juchniewicz and Łukiewska (2014) studied the international competitiveness of the food industry in the EU member states on the world market and its changes in the years 2005–2012. The outcomes suggested that the highest places in the competitiveness ranking were occupied by states of the old EU, such as the Netherlands, France, Spain, and Denmark. Fertő and Soós (2008) paid attention to trade specialisation in the EU and Postcommunist European Countries. European countries suffered a decline of comparative advantages in a few product groups over time. The specialisation indices appeared to be stable for product groups with comparative disadvantage, but product groups with weak-to-strong comparative advantage showed significant variation. Zámborský (2012) inspected the competitiveness gap and host country effects of FDI in the New OECD. The findings suggested that industries with a low competitiveness gap benefited most from the FDI in Central Europe in the medium run. According to Pavličková (2013), between 1999–2011, Slovakia achieved product competitiveness on the EU market mainly with prices. Haluška and Dolinič (2018) analysed the economic performance and export of Slovakia, showing gradual shifts from heavy industry towards the automobile sector. Hsing (2009) examined the J-curve for the bilateral trade between Croatia, the Czech Republic, Hungary, Poland, Slovakia, Slovenia, and the USA. Results showed that the J-curve was not empirically confirmed for any of these six countries. Finally, Pitoňáková (2020) focused on measuring Slovakia's trade specialisation on the extra-EU market. The results indicated the stability of trade patterns and an increase in the level of specialisation between 2013–2017. The machinery and transport equipment sector were identified as the most competitive.

Ignjatijevic et al. (2013) analysed comparative advantage and specialisation level in international trade of countries' primary and industrial products from the Danube region. Comparative advantages were achieved in exporting agricultural products and food in Hungary, Serbia, Moldova, Ukraine, Bulgaria, and Romania. Beblavý and Kureková (2014) focused on the antivirus industry's competitive advantage in the Czech Republic and Slovakia stressing the role of highly skilled and technical human capital. Stefaniak-Kopoboru and Kuczewska (2016) dealt with export specialisation in services of the Visegrad countries. The findings indicated that the accession to the EU had some positive effects on the total exports of services for the whole Visegrad group with different influences on countries and types of services.

3 Trade performance of the Czech Republic, Hungary, Poland, and Slovakia

In this paper, the analysis of trade performance of the Visegrád Group is based on the export and import of goods towards the EU within 2009–2019. The observation time span was selected to catch up with the point of recession but excludes the turbulence in 2020.

The measures based on data of exporting of goods will in the next sections form a basis for calculating the traditional revealed comparative advantages (RCAs), proposed by Balassa (1965, 1977, 1986), which, for econometric analysis of the trade specialisation, will be transformed into the modified version of the RCAs – the revealed symmetric comparative advantages (RSCAs) presented by Dalum et al. (1998).

Figure 1 plots the exporting and importing of goods to/from the EU28 (% of total exports/imports of goods of the Czech Republic, Hungary, Poland, and Slovakia[2]). The figures reveal rising exports of Hungary in 2019 contrary to the Czech Republic, Poland, and Slovakia, whereas only in Slovakia the import values indicated a rise in 2019.

The figures show all countries as net exporters to the EU28. Their export orientation to the EU market is very broad. We can expect that the number of product categories with comparative advantages is high and that these manufacturers are important for the total merchandise export.

4 Data and methodology

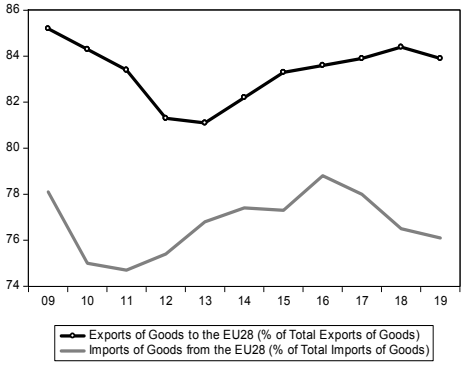
There are different indicators for inspecting the specialisation of a country using either export or import data or both. In this paper, the trade specialisation of V4 countries is separately analysed using two indicators of comparative advantages which were calculated from the annual data 2009–2019. The first indicator is expressed in the form of revealed comparative advantages (RCAs) using only export data. The second refers to both exports and imports – the trade balance index (TBI). Trade data were obtained from Eurostat for manufactured products of the Statistical classification of products by activity (CPA). Table 1 presents products (goods and services) in the section Manufactured products. Those sections which are coloured in grey were excluded from the analysis either due to data shortage/incompleteness or because these sections primarily refer to services. The products section 32 other manufactured goods were not included in the analysis.

As this paper aims to examine the competitiveness of the Czech Republic, Hungary, Poland, and Slovakia on the intra-EU28 market, it is of interest both for experts and the wide public to understand if and how stable are revealed comparative advantages (specialisation/competitiveness) and export/import performance of the V4 countries, and which manufactures enhance their competitiveness. To identify the structural changes in comparative advantages and specialisation, we follow the procedure of Product Mapping presented by Widodo (2008). Figure 2 depicts the Product Mapping framework later used in our analysis (RSCA stands for Revealed Symmetric Comparative Advantages, TBI for Trade Balance Index).

Figure 1 Exports/Imports of goods to/from the EU28

CZ

Exports/Imports of Goods to/from the EU (2009–2019)

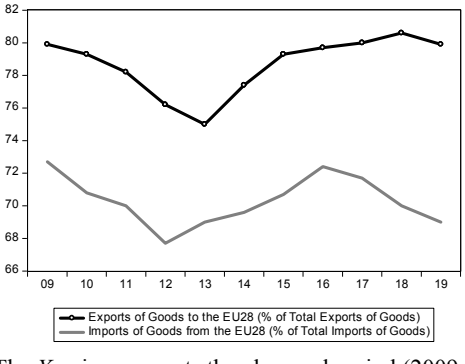


HU

Exports/Imports of Goods to/from the EU (2009-2019)

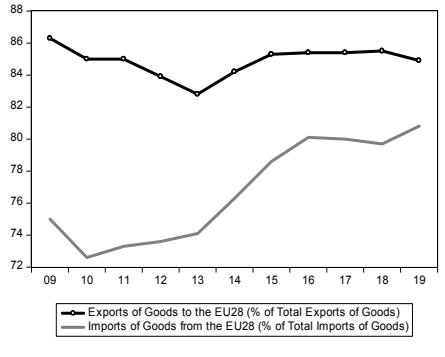
PL

Exports/Imports of Goods to/from the EU (2009-2019)



SK

Exports/Imports of Goods to/from the EU (2009-2019)



The *X*-axis represents the observed period (2009–2019), *Y*-axis denotes the Exports/Imports (%).

Source: Own calculations based on data from Eurostat

Table 1 Classification of manufactured products according to the CPA

Division	*Label*
10	*Food products*
11	*Beverages*
12	*Tobacco products*
13	*Textiles*
14	*Wearing apparel*
15	*Leather and related products*
16	*Wood and of products of wood and cork, except furniture; papers of straw and plaiting materials*
17	*Paper and paper products*
18	*Printing and recording services*
19	*Coke and refined petroleum products*
20	*Chemicals and chemical products*
21	*Basic pharmaceutical products and pharmaceutical preparations*
22	*Rubber and plastics products*
23	*Other non-metallic mineral products*
24	*Basic metals*
25	*Fabricated metal products, except machinery and equipment*
26	*Computer, electronic and optical products*
27	*Electrical equipment*
28	*Machinery and equipment n.e.c*
29	*Motor vehicles, trailers and semi-trailers*
30	*Other transport equipment*
31	*Furniture*
32	*Other manufactured goods*
33	*Repair and installation services of machinery and equipment*

Source: Eurostat (CPA, 2008)

Class A involves products that have both comparative advantage and export specialisation, while category B consists of products with comparative advantages but no export specialisation. Section C includes products with export specialisation but without comparative advantages and category D represents products without comparative advantages and without export specialisation.

Using the values of both the RSCAs and TBI, the product mapping of the V4 countries is elaborated and presented in Section 5.1 (Table 3).

The original formula of the RCA suggested by Balassa (1965) is the following

$$RCA_{ij} = \frac{X_{ij} \Big/ \sum_i X_{ij}}{\sum_j X_{ij} \Big/ \sum_i \sum_j X_{ij}} \tag{1}$$

where X_{ij} denotes the volume of exports of product/sector i from country j, the numerator represents the percentage share of a given product/sector in national exports,

and the denominator represents the percentage share of a given product/sector in the export of the EU28. The RCA > 1 indicates revealed comparative advantage and RCA < 1 denotes a comparative disadvantage. When RCA is used in econometric analysis it should always be made symmetric because the RCA is not comparable on both sides of unity (Laursen, 1998). The adjusted RCA–the revealed symmetric comparative advantage (RSCA) has the following form (Laursen and Drejer, 1997).

$$RSCA = \frac{(RCA - 1)}{(RCA + 1)} \tag{2}$$

RSCA values range from –1 to + 1. Positive values indicate comparative advantage, negative values show comparative disadvantage.

Figure 2 Products mapping

	TBI<0	TBI>0
RSCA>0	**Group B** Have Comparative Advantage No Export-Specialisation (net importer) (RSCA > 0 and TBI <0)	**Group A** Have Comparative Advantage Have Export-Specialisation (net exporter) (RSCA > 0 and TBI >0)
RSCA<0	**Group D** No Comparative Advantage No Export-Specialisation (net importer) (RSCA < 0 and TBI <0)	**Group C** No Comparative Advantage Have Export-Specialisation (net exporter) (RSCA < 0 and TBI >0)

Source: Widodo (2008)

The TBI is applied to analyse whether a country has specialisation in export (as net-exporter) or import (as net-importer) for a specific group of products (Widodo, 2008).

The TBI is formulated as follows (Lafay, 1992; Widodo, 2008)

$$TBI_{ij} = \frac{(X_{ij} - M_{ij})}{(X_{ij} + M_{ij})} \tag{3}$$

where TBI_{ij} denotes trade balance index of country j for group of products i; X_{ij} and M_{ij} represents exports and imports of group of products i by country j, respectively. This index ranges from –1 to +1 (or $-1 \leq TBI_{ij} \leq 1$). Two extremes may appear: the value of the TBI index be –1 (if a country only imports), or the TBI can have a value of 1 if a country only exports. In case when a country neither exports nor imports, the TBI is not defined. Any values between –1 and + 1 imply that the country exports and imports product i simultaneously. The country is a 'net-importer' if the TBI < 0 or a country is in a position of 'net-exporter' if the TBI > 0 (Lafay, 1992; Widodo, 2008).

For testing stability and specialisation trends of country's trade, Dalum et al. (1998) suggested using the following regression equation:

$$RSCA_{ij}^{t_2} = \alpha_i + \beta_i RSCA_{ij}^{t_1} + \varepsilon_{ij} \quad (4)$$

where the superscripts t_1 and t_2 refer to the initial and the final year, respectively. The dependent variable, *RSCA* at time t_2 for product i in country j is tested against the corresponding variable at time t_1 (initial year), α and β are standard linear regression parameters and ε is a residual term. The size of β measures the stability of the specialisation pattern of a given country between two periods. If coefficient $\beta = 1$, the trade pattern does not change from t_1 to t_2. If $\beta > 1$, the country tends to be more specialised in sectors where it is already specialised and less specialised in sectors where initial specialisation is low. If $0 < \beta < 1$, then there is despecialisation, meaning that sectors with initial low RSCAs increase over time, whereas sectors with initial high RSCAs decrease their values. If $\beta < 0$, the ranking of sectors is reversed; this seldom occurs in the real world, considering the path dependency of technology or trade specialisation (Dalum et al., 1998; Sanidas and Shin, 2011).

It is to note, that in our analysis, the revealed comparative advantages (RCAs) were calculated according to (1), later transformed into revealed symmetric comparative advantages (RSCAs) according to (2) and the trade balance index was computed according to (3). For testing the stability of specialisation, equation (4) was used. Descriptive statistics of the RSCAs for each country in 2009, 2011, 2015 and 2019 are presented in Appendix 1.

5 Results and discussion

For following calculations, we applied the extraction of the Eurostat data by CPA (version 2008).

The results from examining the competitive manufactured products based on the revealed comparative advantages (RCA) in V4 economies are presented in Table 2. This table deploys the ranking of the three most competitive product groups for each country in 2009, 2011, 2015, and 2019. These selected years correspond to the initial and final years, which form a time boundary in our econometric models for each country (for more details see Tables 4–7).

5.1 Identification of the most competitive sectors

Table 2 presents results from identifying the three most competitive manufactured products within 2009–2019 in corresponding countries. The results are based on the RCAs values computed according to equation (1).

In the Czech Republic, the *Computer, electronic and optical products* (CPA 26) was identified as the most competitive (the highest RCAs) in 2009, 2011 and 2019. However, in 2015 this product group dropped down to fourth place being replaced by *Electrical equipment* (CPA 27). *Computer, electronic and optical products* category meets with strong competition from other V4 economies namely Hungary and Slovakia. The division *Fabricated metal products* (CPA 25) was ranked in the second position in 2009, 2011, 2015 but in 2019 it was replaced by *Electrical equipment* (CPA 27) which jumped from the third position in 2009 and 2011 to the second rank in 2019.

Table 2 Ranking of the top three sectors (2009–2019)

CZ Ranking (1–3)				*HU Ranking (1–3)*			
CPA Division	*1*	*2*	*3*	*CPA Division*	*1*	*2*	*3*
2009	26	25	27	2009	26	27	29
2011	26	25	27	2011	26	27	29
2015	27	25	29	2015	27	29	26
2019	26	27	29	2019	27	29	26

PL Ranking (1–3)				*SK Ranking (1–3)*			
CPA Division	*1*	*2*	*3*	*CPA Division*	*1*	*2*	*3*
2009	31	16	29	2009	26	16	29
2011	31	16	22	2011	26	15	29
2015	31	16	22	2015	26	29	25
2019	31	16	22	2019	29	26	25

The author's calculations are based on Eurostat data (Eurostat for manufactured products of the Statistical classification of products by activity (CPA)).

The big change in the competitive products categories happened in 2015 when *Electrical equipment* (CPA 27) became a leader among the products. Surprisingly, *Motor vehicles, trailers, and semi-trailers* (CPA 29) was ranked as the third category in the Czech Republic. This country is famous for the automotive industry and its long-term tradition (Škoda Auto**,** a traditional Czech producer of passenger cars).

In Hungary, *Computer, electronic and optical products, Electrical equipment* and *Motor vehicles, trailers, and semi-trailers* (CPA 26, 27, 29) assumed the first, second and third position in 2009 and 2011. The table shows that there was a shift of ranking among sections 26, 27 and 29. The most competitive product category in 2009 and 2011, the *Computer, electronic and optical products* (CPA 26), achieved the third position in 2019. These products belong not only in Hungary, but also in the Czech Republic and Slovakia to their export priorities (connected to tradition in these countries e.g., on the Slovak territory Helios, was the first electronics company established in Žilina in 1893 (SARIO, September 2020), in former Czechoslovakia it was TESLA company in 1946 (https//www.tesla.cz/en/history/), and the Orion company in Hungary in 1913 (https//orion.hu/).

In Poland, *Furniture* (CPA 31), *Wood and of products of wood and cork, except furniture; papers of straw and plaiting material* (CPA 16), along with *Motor vehicles, trailers, and semi-trailers* (CPA 29) created a competitive cluster in 2009. The change happened only in the third position, where the manufacture of motor vehicle trailers and semi-trailers (CPA 29) was replaced by the manufacture of rubber and plastic products (CPA 22). Poland is famous for its manufacture of furniture and this sector drives the export performance of this country.

In Slovakia, export performance and competitiveness are powered by products belonging to the division *Computer, electronic and optical products* (CPA 26) keeping its first position in 2009, 2011, and 2015. In 2019, however, this sector dropped to the second position. A gradual shift of *Motor vehicles, trailers, and semi-trailers* (CPA 29)

from third place to first rank confirmed the strong position of Slovakia in the automobile industry.

To analyse the trade structure of the V4 economies, we started comparing competitiveness (comparative advantages) of selected product categories listed in Table 1 and expressed in the form of the RSCAs with the trade balance index (TBI). Using the values of the RSCA and those of the TBI we constructed the products mapping (see Figure 2). Table 3 deploys the percentages of product categories in the four groups (A, B, C, and D) on the total (20 categories).

Table 3 Products mapping percentage of the CPA divisions, 2009, 2011, 2015, 2019

Country	*The Czech Republic*		*Hungary*		*Poland*		*Slovakia*	
Year	*Group B*	*Group A*	*Group B*	*Group A*	*Group B*	*Group A*	*Group B*	*Group A*
2009	5%	45%	0%	20%	10%	40%	10%	45%
2011	0%	50%	0%	30%	15%	40%	10%	45%
2015	0%	50%	0%	30%	15%	50%	5%	45%
2019	0%	50%	0%	25%	10%	50%	5%	45%
	Group D	*Group C*	*Group D*	*Group C*	*Group D*	*Group C*	*Group D*	*Group C*
2009	40%	10%	60%	20%	40%	10%	30%	15%
2011	45%	5%	50%	20%	30%	15%	30%	15%
2015	40%	10%	50%	20%	25%	10%	30%	20%
2019	45%	5%	45%	30%	30%	10%	35%	15%

The products matrix was elaborated according to Widodo (2008). Compiled by the author from the Eurostat for manufactured products of the Statistical classification of products by activity (CPA).

The results in Table 3 show that the Czech Republic, Poland, and Slovakia have the majority of the products concentrated in groups A and D. Group A shows both comparative advantage and export specialisation, whereas those of the category D indicate neither comparative advantage nor export specialisation. In Hungary however, the categories A and C involve similar percentages of manufactures.

In the case of the Czech Republic, the number of products reported in groups A and D increased from 45% respectively 40% in 2009 to 50% respectively 45% in 2011. On the contrary, the number of manufactures in categories B and C declined within the same period. The biggest changes in category A were captured in 2009–2011 (comparative advantages and export specialisation increased by 5% points -pp) and remained constant later. Section B showed a decline from 5% to 0%. There was a slight increase/decrease in the number of product categories in sections D and C (5 pp).

In Hungary, the number of manufactured products involved in category A increased from 20% in 2009 to 30% in 2011. However, no changes happened in section B (comparative advantages and no export specialisation). A notable decrease by 10 pp was found in section D (no comparative advantage, no export specialisation) in 2009–2011.

In Poland, category A realised an increased number of manufactures from 40% in 2011 to 50% in 2015 and constant onwards. A decline in category D from 40% in 2009 to 30% in 2011 was saturated by an increased number in category B and category C.

The situation in the Slovak trade structure differs from the previous countries because only small changes in comparative advantages were identified within the selected period

of observation. Category A was constant (45%) through the entire time of observation; the highest change in the number of product groups involved in category B happened in 2011 and 2015. This decline was compensated by an increase in group C from 15% in 2011 to 20% in 2015.

5.2 Testing stability of comparative advantages

To test for stability of specialisation, we transformed the calculated RCAs for selected product categories listed in Table 1 into revealed symmetric comparative advantages (RSCAs) according to equation (2). Then these RSCA values were used in our econometric models to identify the changes in the specialisation. Models cover the following periods: 2011 against 2009 (Model 1); 2015 against 2011 (Model 2); 2019 against 2015 (Model 3), and 2019 against 2009 (Model 4). Four models were obtained for each country (CZ, HU, PL, and SK). Tables 4–7 present results from equation (4).[3]

Table 4 Results from testing specialisation stability (CZ)

Model 1 $2011(t_2) \leftarrow 2009\ (t_1)$	*Model 2* $2015(t_2) \leftarrow 2011\ (t_1)$	*Model 3* $2019(t_2) \leftarrow 2015\ (t_1)$	*Model 4* $2019(t_2) \leftarrow 2009\ (t_1)$
Coefficient β	*Coefficient β*	*Coefficient β*	*Coefficient β*
0.989*	0.926*#	0.986*	0.914*#
No change	D	No change	D

*denotes statistical significance at the 10% significance level; # denotes that the coefficient (β) is statistically different from one at the 10% significance level (the Wald coefficient test conducted to test H_0: $\beta = 1$ and alternative H_1: $\beta \neq 1$). D stands for Decline in specialisation.

Source: Compiled by the author from the Eurostat for manufactured products of the Statistical classification of products by activity (CPA).

The results show that all countries have become less specialised for the period 2009–2019 because the estimated coefficient β lies between 0 and 1. Slovakia has the smallest estimated coefficient ($\beta = 0.754$) compared to Poland ($\beta = 0.826$), Hungary ($\beta = 0.836$), and the Czech Republic ($\beta = 0.914$). It means that the most dynamic changes in comparative advantages happened in Slovakia.

Table 5 Results from testing specialisation stability (HU)

Model 1 $2011(t_2) \leftarrow 2009\ (t_1)$	*Model 2* $2015(t_2) \leftarrow 2011\ (t_1)$	*Model 3* $2019(t_2) \leftarrow 2015\ t_1)$	*Model 4* $2019(t_2) \leftarrow 2009\ (t_1)$
Coefficient β	*Coefficient β*	*Coefficient β*	*Coefficient β*
0.922*	0.936*	0.959*	0.836*#
No change	No change	No change	D

*denotes statistical significance at the 10% significance level; # denotes that the coefficient (β) is statistically different from one at the 10% significance level (the Wald coefficient test conducted to test H_0: $\beta = 1$ and alternative H_1: $\beta \neq 1$). D stands for Decline in specialisation.

Source: Compiled by the author from the Eurostat for manufactured products of the Statistical classification of products by activity (CPA).

Table 6 Results from testing specialisation stability (PL)

Model 1 $2011(t_2) \leftarrow 2009\ (t_1)$	*Model 2* $2015(t_2) \leftarrow 2011\ (t_1)$	*Model 3* $2019(t_2) \leftarrow 2015\ (t_1)$	*Model 4* $2019(t_2) \leftarrow 2009\ (t_1)$
Coefficient β	*Coefficient β*	*Coefficient β*	*Coefficient β*
0.932*#	0.902*#	0.983*	0.826*#
D	D	No change	D

Table 7 Results from testing specialisation stability (SK)

Model 1 $2011(t_2) \leftarrow 2009\ (t_1)$	*Model 2* $2015(t_2) \leftarrow 2011\ (t_1)$	*Model 3* $2019(t_2) \leftarrow 2015\ (t_1)$	*Model 4* $2019(t_2) \leftarrow 2009\ (t_1)$
Coefficient β	*Coefficient β*	*Coefficient β*	*Coefficient β*
0.767*#	0.996*	0.959*	0.754*#
D	No change	No change	D

*denotes statistical significance at the 10% significance level; # denotes that the coefficient (β) is statistically different from one at the 10% significance level (the Wald coefficient test conducted to test H_0: $\beta = 1$ and alternative H_1: $\beta \neq 1$). D stands for Decline in specialisation.

Source: Compiled by the author from the Eurostat for manufactured products of the Statistical classification of products by activity (CPA).

In the case of the Czech Republic, two models imply no changes in comparative advantages (Model 1, Model 3) since the value of the coefficient $\beta = 1$. In Hungary, models for the periods 2009–2011, 2011–2015, and 2015–2019 indicate the stability of specialisation. No changes in the specialisation pattern were revealed from 2015 through 2019 ($\beta = 0.983$) in Poland. In Slovakia, two models indicate the stability of comparative advantages (Model 2 and Model 3).

The findings imply that the comparative advantages of all V4 economies were steady in the period of 2015–2019 (Model 3).

The results are to be taken concerning the data used for modelling. The calculated RCAs are sensitive to the size of the commodity group. Splitting the commodity group into a more detailed structure changes the values of the RCAs. Therefore, the analysis involving more detailed subcategories of products as well as the study of indicators β is recommended for future research in a deeper study of the revealed comparative advantage.

6 Concluding remarks and policy implications

The paper focused on the study of the comparative advantages of V4 countries on the intra-EU28 market. The analysis of the trade structure of these four economies included the products mapping based on the comparison of the values of the revealed symmetric comparative advantages (RSCAs) and the trade balance indicator (TBI). The econometric analysis involved testing the stability of trade patterns and specialisation trends. The time of observation covered 2009–2019 period. The whole period was split into four subcategories to get a detailed view of changes in comparative advantages of individual

countries. The classification of product categories followed the CPA standard (version 2008) – in section manufactured products. The Czech Republic, Hungary, Poland, and Slovakia kept their competitiveness in manufacture with a strong connection to its long-term tradition on the domestic and foreign market (e.g., Poland in the manufacture of furniture, Hungary, the Czech Republic, and Slovakia in the electronics, and former Czechoslovakia in the automobile industry). The outcomes show possible implications for governing bodies when deciding on export promotion in manufactures that presently have comparative advantage and exhibit future export specialisation and have a potential for a long-term competitiveness.

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Notes

[1]In this paper, the period of analysis covers 2009–2019. In 2008 (the beginning of the financial crisis) the openness of the Czech Republic achieved 124%, Hungary 158%, Poland 81%, and Slovakia 162%.

[2]The CZ stands for the Czech Republic, HU for Hungary, PL for Poland, and SK for Slovakia.

[3]All models were tested for the existence of autocorrelation and heteroskedasticity. Followed Widodo (2008), the OLS was applied and then the residuals were tested on heteroskedasticity and autocorrelation. If the test shows that there are no autocorrelation and heteroskedasticity simultaneously, then the results of the OLS are acceptable. If only heteroskedasticity exists, the White Heteroskedasticity Consistent Covariance is applied and, if the autocorrelation and heteroskedasticity exist, the HAC Consistent Covariances (Newey-West) is used.

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Appendix 1: Revealed symmetric comparative advantage indicators

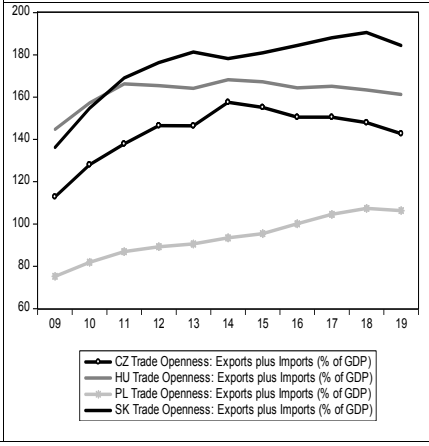
Revealed symmetric comparative advantage indicators for 2009-2011-2015-2019																				
CPA levels		10	11	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Descriptive statistics																					
MIN	Czechia	-0,435	-0,391	0,122	-0,432	-0,366	0,008	-0,226	-0,582	-0,428	-0,692	0,077	0,068	-0,246	0,235	0,224	0,246	0,101	0,230	-0,514	0,199
	Hungary	-0,216	-0,521	-0,419	-0,554	-0,283	-0,263	-0,305	-0,465	-0,398	-0,403	-0,007	0,007	-0,458	-0,185	0,232	0,320	-0,081	0,191	-0,676	-0,128
	Poland	0,095	-0,513	-0,003	-0,017	-0,388	0,382	-0,018	-0,303	-0,321	-0,670	0,189	0,139	-0,056	0,189	-0,014	0,216	-0,272	0,025	-0,325	0,605
	Slovakia	-0,899	-0,547	-0,274	-0,283	0,016	0,026	-0,143	-0,154	-0,468	-0,841	0,055	-0,059	0,077	0,161	0,269	0,041	-0,166	0,251	-0,742	0,120
MAX	Czechia	-0,359	-0,275	0,161	-0,329	-0,218	0,149	-0,163	-0,478	-0,341	-0,544	0,135	0,160	-0,107	0,288	0,337	0,311	0,129	0,257	-0,438	0,244
	Hungary	-0,080	-0,437	-0,261	-0,441	-0,192	-0,183	-0,233	-0,275	-0,238	-0,113	0,127	0,111	-0,360	-0,130	0,468	0,387	0,003	0,325	-0,485	0,076
	Poland	0,175	-0,400	0,049	0,059	-0,059	0,402	0,089	-0,075	-0,185	-0,573	0,251	0,203	0,119	0,217	0,087	0,235	-0,167	0,276	-0,197	0,647
	Slovakia	-0,283	-0,387	-0,199	-0,067	0,276	0,258	0,000	0,199	-0,372	-0,739	0,159	0,086	0,168	0,206	0,415	0,103	0,003	0,396	-0,532	0,194
AVG	Czechia	-0,399	-0,354	0,139	-0,383	-0,286	0,084	-0,205	-0,541	-0,383	-0,616	0,115	0,127	-0,166	0,274	0,289	0,281	0,112	0,248	-0,467	0,223
	Hungary	-0,151	-0,476	-0,298	-0,506	-0,233	-0,204	-0,270	-0,384	-0,287	-0,198	0,089	0,069	-0,415	-0,160	0,325	0,359	-0,027	0,254	-0,589	-0,003
	Poland	0,146	-0,459	0,023	0,022	-0,275	0,394	0,051	-0,160	-0,224	-0,614	0,235	0,184	0,018	0,205	0,023	0,221	-0,204	0,119	-0,263	0,629
	Slovakia	-0,475	-0,463	-0,243	-0,164	0,160	0,083	-0,109	0,042	-0,434	-0,793	0,119	0,008	0,128	0,179	0,348	0,084	-0,055	0,323	-0,637	0,142
MED	Czechia	-0,402	-0,367	0,137	-0,388	-0,268	0,091	-0,218	-0,549	-0,388	-0,615	0,123	0,133	-0,162	0,279	0,295	0,281	0,111	0,251	-0,459	0,219
	Hungary	-0,159	-0,479	-0,279	-0,521	-0,236	-0,197	-0,267	-0,424	-0,270	-0,166	0,105	0,081	-0,416	-0,158	0,304	0,362	-0,012	0,260	-0,593	0,008
	Poland	0,158	-0,465	0,023	0,018	-0,299	0,395	0,066	-0,129	-0,210	-0,614	0,243	0,191	0,014	0,208	0,012	0,217	-0,193	0,096	-0,264	0,627
	Slovakia	-0,436	-0,461	-0,256	-0,145	0,160	0,059	-0,129	0,046	-0,444	-0,803	0,123	0,003	0,134	0,176	0,352	0,086	-0,044	0,343	-0,655	0,136
KURT	Czechia	-2,569	1,820	0,602	-1,591	-1,924	-1,789	-0,585	2,123	-0,943	-3,005	-0,080	0,391	-0,802	4,956	-1,610	1,200	-1,117	1,423	0,480	-1,174
	Hungary	-0,034	-1,619	5,067	-2,453	0,860	4,869	-1,556	-1,825	2,479	3,758	3,208	-0,351	-0,977	-0,525	-1,701	2,044	0,394	-1,366	-2,816	2,130
	Poland	-0,877	-2,272	-1,649	-2,363	0,323	-1,565	2,182	-1,003	4,930	1,517	5,039	3,715	-0,163	-1,545	0,931	2,442	1,971	-0,874	-0,167	-0,340
	Slovakia	3,923	-2,776	-0,893	-1,794	0,395	5,156	5,605	-0,398	2,148	-1,871	1,870	-1,235	-1,841	2,002	2,626	3,627	4,145	-1,355	-0,892	4,457
SKEW	Czechia	0,147	1,427	0,723	0,269	-0,473	-0,280	1,128	1,166	0,060	-0,025	-1,047	-0,976	-0,449	-2,161	-0,389	-0,446	0,589	-1,288	-1,037	0,141
	Hungary	0,284	0,027	-2,208	0,383	-0,403	-2,136	-0,028	0,819	-1,560	-1,869	-1,751	-0,877	0,268	0,189	0,514	-0,945	-1,212	0,004	0,117	-1,215
	Poland	-0,873	0,169	-0,065	0,054	0,992	-0,475	-1,478	-0,838	-2,136	-0,849	-2,197	-1,845	0,568	-0,547	1,180	1,691	-1,395	0,716	0,161	-0,256
	Slovakia	-1,840	-0,065	0,858	-0,448	-0,469	2,219	2,343	-0,398	1,401	0,448	-1,178	0,293	-0,360	1,193	-0,618	-1,742	-1,816	-0,402	0,202	1,996

Appendix 2: Graphical presentation of selected trade indicators

Trade Openness

CZ, HU, PL, SK

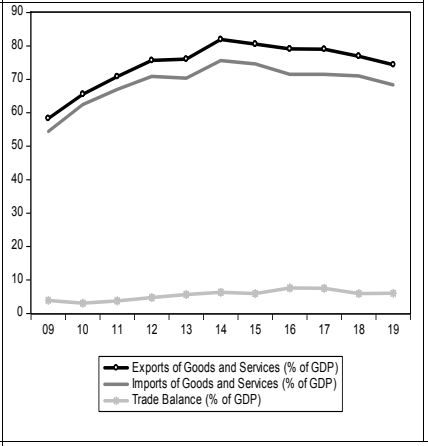
(2009-2019)



CZ

Exports/Imports/Trade Balance

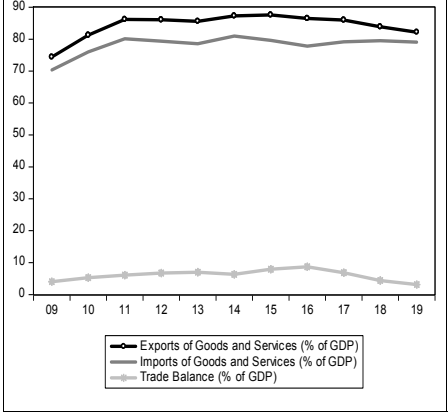
(2009-2019)



HU

Exports/Imports/Trade Balance

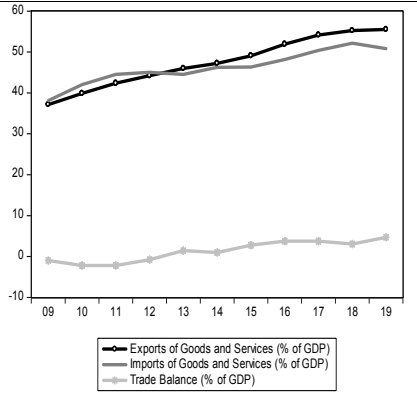
(2009-2019)

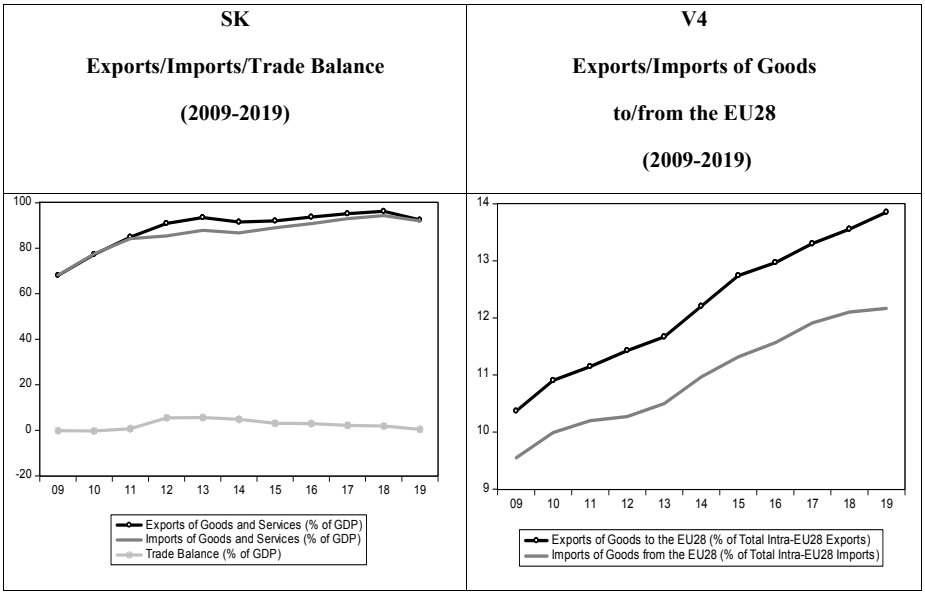


PL

Exports/Imports/Trade Balance

(2009-2019)





X-axis represents the observed period (2009–2019), *Y*-axis denotes the Exports/Imports/Trade Balance (%).