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CEE COUNTRIES IN EUROPE: TOWARD CENTER OR PERIPHERY IN GLOBAL VALUE CHAINS

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Preface

China-CEE Institute had announced “Call for Proposal” research programs in December 2018. One of the proposed research projects is “CEE countries in Europe: toward Center or Periphery”. What we are presenting here is the result of the research project, conducted by a consortium led by University of Ljubljana (Slovenia), together with scholars from University of Belgrade (Serbia), Victoria University of Wellington (New Zeland), Corvinus University of Budapest (Hungary), University of Warsaw (Poland), and Shanghai University of International Business & Economics (China). The project title is “CEE Countries in Europe: Toward Center or Periphery in Global Value Chains”.

This project, from the angle of global value chains (GVCs), analyzes embeddedness and impact of the CEECs in the European and global economy via position and dynamic within GVCs in terms of so-called core-periphery dynamics. Special attention has been paid to structural positions and changes of individual CEECs within the GVCs as networks. The research is developed based on two datasets. One is the TiVA database provided by the OECD and the WTO, which provides GVC indicators for eleven CEE countries (CEE-11) and at the same time also EU member states, namely Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The other dataset is the Eora MRIO database to cover the other 5 CEECs (hereafter referred to as CEE-5), which includes Serbia, Bosnia and Hercegovina, Montenegro, North Macedonia and Albania. The corresponding time for research is 2005-2015 period. According the overall findings, the extent of GVC participation is fairly high for most of the CEECs. Among the CEE-11, GVC participation is the highest in Slovakia and lowest in Croatia. Among the CEE-5 countries, the so-called supply chain trade represents the highest share in gross exports of Serbia and North Macedonia, while it is lowest in Albania. In line with the general global trend. The peak in

terms of the importance of supply chain trade in CEECs was reached in 2011 and 2012, while the stagnation in the GVC importance has been witnessed since the year 2012.

The China-CEE Institute, registered as a non-profit limited company in Budapest, was established by the Chinese Academy of Social Sciences (CASS) in April 2017. The Institute aims to build ties and strengthen partnerships with academic institutions and think tanks in Hungary, Central and Eastern European countries, as well as other parts of Europe. The China-CEE Institute encourages scholars and researchers to carry out joint researches and field studies, organizes seminars and lecture series, holds training programs for students and junior researchers and publishes publications, etc.

I hope this book will help enriching the research literature on CEE countries.

Prof. Dr. CHEN Xin
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Deputy Director General, Institute of European Studies, CASS

Executive summary with implications

Production and trade have been increasingly organised along so-called global value chains (hereinafter GVCs) in which firms fragment internationally their production processes in an increasing number of stages and source parts, components, and services from producers in several countries, and in turn sell their output to firms and consumers worldwide. The role of GVCs has also played an increasingly important part in China's reform and opening up process, particularly after China's accession to the World Trade Organization in 2001. In many ways, China's integration into the world economy has played a crucial role in its transformation into a moderately prosperous society. Nowadays, trade in intermediate goods accounts for more than 50% of world trade. Participation and the position in GVCs greatly affect the way economies are linked, specialize, and develop (Dollar et al., 2017). As China strengthens its cooperation with the 16 Central and Eastern European countries (hereinafter CEECs) within its 16+1 cooperation platform and the Belt and Road Initiative (BRI), more information is needed in terms of the CEECs' position and dynamic within GVCs in terms of so-called core-periphery dynamics, especially following the 15 years since the accession of 10 CEECs into the EU. Understanding the position, embeddedness and impact of the CEECs within the European and global economy, therefore, requires knowledge about the way value chains are put together in Europe. A comprehensive and detailed picture of the dynamic trade network structure of the European economy and the position and role of the CEECs has largely been missing in the literature, which also constitutes a challenge for policymakers. When it has been examined, it has tended to disregard the network nature of GVCs and relied mostly on simple gross trade flow data, disregarding trade in actual value added.

In this study, we aim to fill this gap. We adopt a GVC perspective and aim to provide answers whether the CEECs are heading towards the centre or periphery in European and global trade networks. We map the evolving

embeddedness of the CEECs' economies in European and global trade according to their participation and position in GVCs. In doing so, we pay special attention to structural positions and changes of individual CEECs within the GVCs as networks. First, we calculated several types of network centrality measures, which refer to different structural features of actors within networks (Borgatti, 2005). Given that we are analysing trade data, which is a value (weighted) network-type data, we have employed so-called valued (weighted) network centrality measures, fairly new in the field of social network analysis (Opsahl, Agneessens & Skvoretz, 2010). Social network analysis had evolved into a distinct methodological area, originating from graph theory and sociometric analysis (Wasserman & Faust, 1994). Second, and more relevant to the underlying theme of this project (e.g. core-periphery analysis), we calculated so-called coreness coefficients (Borgatti & Everett, 2000) for each the CEECs in the examined European and global trade network in terms of value added trade. Our key research questions have been: (i) How integrated are CEECs in European and global value chains?, (ii) What are their positions along the GVCs?, (iii) How has their trade coreness in Europe changed over time in terms of core-periphery dynamics?, and (iv) How are positions in the GVC (upstreamness/ downstreamness) and network centrality related?

Our methodological approach involves, first, a comparative analysis based on relevant GVC indices capturing both the extent of participation in and the position along GVCs. Second, we employ network analysis methodology and exemplify the centre-periphery structure of the CEECs within both European and global trade network. Complex production networks with multiple participants and numerous cross-border flows are mostly invisible when the focus is on gross export-import trade flows. Hence, GVCs cannot be effectively studied based on gross export-import trade data. Therefore, we complement traditional gross trade data with the value added trade data at aggregated and selected industry levels. In our analysis, we combine two datasets for trade in value added data. First is the TiVA database provided by the OECD and the WTO which provides GVC indicators for eleven CEE countries, namely Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania,

Slovakia and Slovenia. In the remainder of the study, we refer to these eleven CEECs as CEE-11. To cover the other 5 CEECs (hereafter referred to as CEE-5), which include Serbia, Bosnia and Hercegovina, Montenegro, North Macedonia and Albania, we additionally use the Eora MRIO database. Since the methodology for calculation of trade in value added differs between the Eora and TiVA databases, in turn not allowing direct comparison, we carry out the comparative analysis separately for CEE-11 and CEE-5.

Our analysis corresponds to the 2005-2015 period. This period coincides with the biggest EU enlargement in its history; i.e. the first eight CEECs became full EU members in May 2004, Bulgaria and Romania in January 2007, and, finally, Croatia in July 2013. The period of our analysis also covers the time of 2008-2009 global economic and financial crisis when all CEECs experienced significant erosion of participation in GVCs, and the adoption of the Euro in Slovenia (2007), Slovakia (2009), Estonia (2011), Latvia (2014), and Lithuania (2015). The 2005-2015 period coincides also with the process of enforcement of Stabilisation and Association Agreements between the EU and CEE-5 countries (i.e. North Macedonia in 2004, Albania in 2009, Montenegro in 2010, Serbia in 2013, and Bosnia and Herzegovina in 2015).

This study is structured into two parts. In the first part, we present our comparative analysis of the CEECs in terms of their GVC participation, GVC position and network centrality – all in the context of the CEECs' embeddedness in the European and global trade network. In the second part, we further analyse involvement in the GVCs and network centrality developments for four countries in focus, namely: Slovenia, Hungary, Poland and Serbia. The four countries in focus have been chosen as they correspond to different GVC profiles and have experienced divergent paths in terms of GVC integration and trade network embeddedness throughout the 2005-2015 period. For example, Serbia witnessed a significant increase in backward participation coupled with downstream movement along the GVCs. Slovenia increased its involvement in the GVCs on account of forward linkages. Hence, it progressed upstream along the GVCs. It moved

towards global centre whilst headed towards European periphery, suggesting its increased global diversification. Poland increased its GVC participation, whilst it moved slightly more downstream. Poland is also the most "central" country in our trade network and gained the most among the CEE-11 in terms of European and global coreness during the 2005-2015 period. Hungary is the most downstream positioned economy among the CEE-11 and has the second highest GVC participation. Similarly, to Slovenia, Hungary moved towards the global centre, whereas it shifted towards the European periphery during the 2005-2015 period.

The comparative analysis showed that, overall, the extent of GVC participation is fairly high for most of the CEECs. Among the CEE-11, GVC participation is the highest in Slovakia and lowest in Croatia. Among the CEE-5 countries, the so-called supply chain trade represents the highest share in gross exports of Serbia and North Macedonia, while it is lowest in Albania. In line with the general global trend, the peak in the importance of supply chain trade in CEECs was reached in 2011 and 2012, while we have been currently witnessing the stagnation in the GVC importance since the year 2012.

GVC participation of the CEE-11 is strongly driven by backward linkages resulting in downstream position of all CEE-11 counties throughout the 2005-2015 period. Thus, compared to the old EU member states, the CEE-11 are in general positioned in more downstream stages of value chains. However, the gap has been narrowing throughout the considered period. For the CEE-5 group, the predominance of backward participation over forward linkages hold for Serbia and Montenegro since the global economic and financial crisis, but not for Albania and Bosnia and Herzegovina. In the latter, GVC involvement appears to be strongly driven by forward linkages, while backward and forward linkages tend to have balanced importance in driving GVC participation of North Macedonia.

The CEECs with a higher extent of GVC participation tend on average to be located more downstream. In 2015, Romania, Latvia and Poland held the most upstream position among the CEE-11 but also exhibited a below-

average degree of participation in GVCs. On the other hand, the three countries with the highest share of supply-chain trade among the CEE-11, namely Slovakia, Hungary, and the Czech Republic, were also positioned most downstream together with Bulgaria. Towards the end of a 2005-2015 period, a similar regularity may be observed for Western Balkan (hereinafter WB) or CEE-5 countries. For example, in 2015, Serbia and Montenegro on average exhibited the highest degree of GVC participation and were integrated in most downstream stages while Albania and Bosnia and Herzegovina were least integrated in GVCs but occupied most upstream positions.

The development path in GVC integration across the CEECs was divergent in terms of the degree of involvement and even more so with respect to shifts in the upstreamness/downstreamness position. Most of the CEECs, with the exception of Croatia, Romania and Latvia among the CEE-11 and Bosnia and Herzegovina in the CEE-5 group, increased their participation in GVCs during the 2005-2015 period. Hungary, Slovenia, Romania, Croatia, Bosnia and Herzegovina and Albania have moved more upstream by 2015. Compared to the initial year of 2005, the position of Lithuania, Slovakia and North Macedonia remained relatively stable, while the rest of the CEECs (i.e. Bulgaria, the Czech Republic, Estonia, Poland, Serbia and Montenegro) moved downstream.

Aggregate trends hide relatively large variability in terms of specific GVC involvement for the CEECs across different sectors and industries. The CEE-11 group displays higher GVC participation in most industries than EU-28 region (excluding intra-EU trade) but occupies more downstream location, with notable exceptions in *Machinery and equipment* (D28), *Transport equipment* (D29T30) and *Food products, beverages and tobacco* (D10T12); where CEE-11 gains dominance of the forward integration over the backward participation. The difference in GVC position between the average CEE-11 and the EU-28 region is most pronounced in *Textiles, wearing apparel, leather and related products* (D13T15) and *Computers, electronic and electrical equipment* (D26T27); where the CEE-11 are integrated in GVCs in downstream stages with the

predominance of foreign value added in their gross exports. On the other hand, the old EU members tend to participate in more upstream activates with high values of domestic value added embodied in third countries' exports. In contrast to CEE-11, the WB (CEE-5) countries tend to participate in GVCs in more upstream stages in the industries of *Wood and paper products, printing* (D16T18) and *Chemicals and non-metallic mineral products* (D19T23) and *Basic metals and fabricated metal products* (D24T25) suggesting the reliance of WB countries on their natural resources in these industries, while in *Transport equipment* (D29T30) backward linkages were relatively stronger compared to forward ones in contrast to CEE-11. Tables 1 and 2 within this executive summary further categorise the GVC profiles across industries in the CEE-11 and CEE-5 countries respectively. This is done according to the GVC position (upstream vs downstream) and contribution of a particular industry to the share of GVC-related trade in total gross exports (high and moderate according to above or below average GVC participation, respectively, based on calculations from Fig. 1.11b and 1.15b).

Dynamic panel data analysis revealed strong persistence in the extent of GVC participation and position for CEE-11 group. The persistence of the forward participation is weaker than for the backward involvement, but it lasts for longer. After controlling for the persistence in GVC involvement, the results confirmed the important role of economic health of Germany in general for the extent of the participation and position of CEE-11 in GVCs within considered industries. The results, hence, suggest that an industry-level shock in Germany would put downward pressure on both forward and backward participation of CEE-11 even after controlling for the fixed year effects, but the impact is more prompt and stronger for forward than for the backward participation where we found considerable lag in the influence. As a result, the GVC position of CEE-11 group on average tends to move downstream as a response to an industry-level negative shock in Germany within the two-year time window.

Table 1: GVC profiles of CEE-11 by industries in 2015

Industry	Contribution to GVC participation	Upstream (GVC position > 0)	Downstream (GVC position < 0)
FOOD PRODUCTS, BEVERAGES AND TOBACCO	High		BGR, EST, HRV, LTU, LVA, POL
	Moderate	ROU, SVK, SVN	CZE, HUN,
TEXTILES, WEARING APPAREL, LEATHER	High		BGR, EST, HRV, ROU, SVN
	Moderate		CZE, HUN, LTU, LVA, POL, SVK
WOOD AND PAPER PRODUCTS	High		EST, LVA, SVN
	Moderate		BGR, CZE, HRV, HUN, LTU, POL, ROU, SVK
CHEMICALS, NON-METALLIC MINERAL PRODUCTS AND METALS	High		BGR, LTU, SVK, SVN
	Moderate	LVA	CZE, EST, HTV, HUN , POL, ROU
COMPUTERS, ELECTRONIC AND ELECTRICAL EQUIPMENT	High		CZE, EST, HUN, SVK
	Moderate	LTU, LVA	BGR, HRV, POL, ROU, SVN
MACHINERY AND EQUIPMENT	High	POL, ROU, SVN	BGR, CZE, HUN, SVK
	Moderate	EST, HRV, LTU, LVA,	
TRANSPORT EQUIPMENT	High	POL	CZE, HUN, SVK
	Moderate	BGR, EST, LTU, LVA, HRV, ROU	SVN
TOTAL SERVICES	High		BGR, EST, HRV, LTU, LVA, ROU
	Moderate		CZE, HUN, POL, SVK, SVN

Note: Distinction between high and moderate according to above or below average GVC participation index among the countries considered based on calculation from Figure 1.11b in Chapter 1.

Source: Authors' calculations based on TiVA database.

Table 2: GVC profiles of CEE-5 by industries in 2015

Industry	Contribution to GVC participation	Upstream (GVC position > 0)	Downstream (GVC position < 0)
FOOD PRODUCTS, BEVERAGES AND TOBACCO	High		SRB, MKD
	Moderate		ALB, BIH, MNE
TEXTILES, WEARING APPAREL, LEATHER	High		ALB, MKD
	Moderate		BIH, MNE, SRB
WOOD AND PAPER PRODUCTS	High	BIH	ALB
	Moderate	MKD, SRB	MNE
CHEMICALS, NON-METALLIC MINERAL PRODUCTS	High	BIH, MKD	ALB
	Moderate	SRB	MNE
BASIC METALS AND FABRICATED METAL PRODUCTS	High		MKD
	Moderate	BIH	ALB, MNE, SRB
COMPUTERS, ELECTRONIC AND ELECTRICAL EQUIP. & MACHINERY AND EQUIPMENT	High		ALB, BIH
	Moderate	SRB	MKD, MNE
TRANSPORT EQUIPMENT	High		MKD, MNE
	Moderate		ALB, SRB, BIH

Note: Distinction between high and moderate according to above or below average GVC participation index among the countries considered based on calculation from Figure 1.15b in Chapter 1.

Source: Authors' calculations based on Eora database.

Network analysis carried out on the trade in value added data measuring domestic value added embodied in foreign final demand shows that in general, the CEE-11 countries became more central in terms of closeness and eigenvector centrality but not in terms of betweenness centrality throughout the 2005-2015 period. Given the nature of the analysed added-value network data, this implies that while the CEECs better integrated into the trade networks (as seen from improvements in their network centrality measures, particularly eigenvector centrality), their declining betweenness network centrality shows a decline in their unique position (control) within those networks. We believe this may be a direct result of other countries replacing the unique "betweenness" position of the CEECs within GVCs. Interestingly, the industries with the highest GVC participation and most upstream position, i.e. *Machinery and equipment* and *Transport equipment,* tend to be least central in terms of closeness centrality, but most central in terms of betweenness and eigenvector centralities. This suggests that the path from the CEE-11 to other nodes in the network is not the shortest one, but it seems to be relatively important (bottleneck) for the trade flows through the network in these two industries.

Furthermore, our core-periphery network analysis shows Poland, the Czech Republic, Hungary and Romania represent the so-called CEEC core (both in the European and global trade networks considering value added trade), while the rest of the CEE-11 countries are and have become much more peripheral. However, they differ to some extent with respect to the relative network coreness in European versus global trade networks. For example, the Czech Republic, Romania, Slovakia and Slovenia are among the CEE countries displaying the highest European orientation in the sense that their ratio between European and global coreness is amongst the highest at the end of the period considered. At the industry level, relatively strong European orientation is detected in *Textiles, wearing apparel, leather and related products* (D13T15), *Wood and paper* products (D16T18) and *Computers, electronic and electrical equipment* (D26T27).

From a dynamic perspective, the group of the CEE-11 countries elevated its network coreness from 2005 to 2015, both globally and Europe-wise.

Concerning individual countries, Poland gained the most among the CEE-11; both in terms of European and global coreness during the 2005-2015 period. The shift towards network centre in global and European trade networks could be observed also for Bulgaria, Lithuania and Romania. In contrast, Latvia was the only CEE-11 country which moved towards periphery; both in European and global networks between 2005 and 2015. The remaining CEECs either increased their European or global network coreness. On the one hand, Estonia, Croatia, Hungary and Slovenia moved towards the global network centre, whilst headed towards the European periphery. This suggests their increased global diversification. The opposite was the case for the Czech Republic and Slovakia which, as it seems, further increased their reliance on the European trade network.

For the CEE-11 countries, our study provides industry-level evidence in support of the theoretical expectation from Antràs & De Gortari (2017) that the more central a particular country is in terms of geographical proximity to other countries with large production, the more downstream it tends to be in terms of its position within the value chains. Moreover, the centrality-downstreamness nexus is detected also in relation to the position in the trade network. The results suggest that those CEE-11 countries occupying a more downstream position in the GVCs tend to have (i) a shorter path to every other country in the network (higher closeness centrality), (ii) more influence in the network (higher eigenvector centrality), (iii) greater control (betweenness centrality), as they have the most unique patterns of shortest paths going through them. They also tend to be closer to the core of the European network; although it must be noted all of them are quite far in terms of the core-periphery dichotomy or even the core-semi-periphery-periphery.

To sum up, CEECs as a region increased the extent of their integration in the GVCs and increased their European and global network coreness throughout the 2005-2015 period across the industries considered in our study. These trends indicate that the CEE region overall enhanced its GVC competitiveness and became a more attractive location for investments in globally dispersed production networks. The significant differences in the

way how the extent of participation and position in GVCs changed across industries and the CEECs suggest rather heterogeneous investment opportunities; depending on the industry of activity, stage in the production process and the trade orientation. Therefore, potential investors that are considering organising production networks in the CEE region need to take into account not just the industry but also the industry-stage specifics across the CEECs.

However, the strengthening of GVC integration in most of the CEECs amplifies the exposure to potential disruptions in the global production and trade networks which may arise as a result of: (i) a recent weakening of the fundamentals of the multilateral trade system, (ii) increased global tendency towards protectionist measures; (iii) escalation and spread of US-China trade war; (iv) more intense and faster transmission of demand and supply shocks through intense vertical production links and increased interdependence within the constellation of the GVCs. Our study suggests that on average, backward participation was relatively more hurt during the crisis period, which is in line with the theoretical prediction of trade barriers being more detrimental to trade in downstream stages than in more upstream ones. This observation bears important policy and managerial implications. In today's global environment, geographical diversification and smart and agile supply chain risk management practices are of vital importance for successful internationalization of firms and sustainable long-term development of the small open economies of CEE; especially given their downstream embeddedness in global and regional value chains. This is of particular importance in those CEECs specialised in relatively more downstream stages within GVCs and being less diversified with respect to range of the industries and the positions in GVCs, since according to theoretical and empirical indications the exposure to risk of increased trade barriers or other GVC related risks tend to be higher in such cases. To illustrate this point, for example, supply chain trade in transport equipment in Hungary, Slovakia and the Czech Republic contributes around 20% to their total gross exports coupled with their very downstream position in transport equipment value chains, or similarly in Bulgaria and Lithuania the chemical and metal industry accounts for around one fifth of

supply chain trade with both being positioned in very downstream stages in this sector. Further, CEECs seem to be vulnerable to industry-specific business cycles in Germany. Hence, related policy measures should aim:

- to facilitate geographical diversification of trade and production relations, for example through increasing the awareness of the firms how to leverage the wide network of EU's deep and comprehensive free trade and investment agreements;
- promote multilateral trade rules for improving the predictability of the global economic environment; and
- help firms, especially small and medium-sized ones, to adopt smart and agile supply chain risk management practices complementing "just-in-time" approaches with "just-in-case" strategies.

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PART I
Comparative Analysis

Chapter 1
Comparative analysis of CEE countries' involvement and network centrality in GVCs

Katja Zajc Kejžar[1], Matevž Rašković[2], Yang Chencheng[3], Peter Vakhal[4], Alan Velić[5], Shang Yuhong[6] and Zhang Lin[7]

1.1. Introduction – Participation, position and network centrality in GVCs

In recent years, we have witnessed both the rise of the importance of GVCs, as well as significant changes in their structure (evolving into increasingly complex networks). Several papers have addressed the measurement of countries' involvement in GVCs. The most common way

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of characterising the countries' GVC profile is by studying both the **GVC participation** and the **GVC position**. The GVC participation indices measure to what extent are countries involved in a vertically fragmented production and resulting supply chain trade flows. Historically, the first indicator proposed in the literature was the so-called vertical specialization share (VS), which can be understood as the import content of exports reflecting the importance of upstream foreign suppliers in the value chain for the exports of a particular country. Later, the so-called "VS1" share was introduced and defined as a percentage of exported goods and services used by other countries, as imported inputs in the production of their exports – in order to capture forward GVC participation by being a supplier of inputs used in third countries for further exports (Hummels, Ishii and Yi, 2001). Koopman et al. (2010) proposed an indicator combining both VS and VS1 shares to obtain a comprehensive assessment of the participation of a country in GVCs. The participation of being a user of foreign inputs was defined as upstream links or **backward participation**, and a supplier of intermediate goods and services used in other countries' exports are referred to as downstream links or **forward participation**.

With regards to the GVC position, Fally (2012) and Antràs et al. (2012) introduced a measure of "upstreamness", which may be referred to as the "distance to final demand". It measures how many stages of production are left before the goods or services produced by an industry reach their final consumers. An increase in "upstreamness" means that an economy is becoming more specialised in the production of inputs at the beginning of the value chain. The fact that, on average, most countries move upstream is consistent with the overall increase in the length of the GVCs and outsourcing trends globally. Alternatively, Koopman et al. (2014) defined a position index which characterises the relative upstreamness of a country by comparing the importance of forward and backward participation. They proposed measuring upstreamness as the log ratio of a country's supply of intermediates used in other countries' exports to the use of imported intermediates in its own production. Combining the GVC participation and position indices, De Backer and Miroudot (2013) confirmed that all OECD regions, not only Asia, show a comparable level of participation in the

GVCs. Further, successful emerging economies have become more specialised in intermediate inputs and generally increased their "upstreamness". For the EU member states, Kersan-Škabić (2017) found a high level of participation of EU member states in the GVCs with a predominance of backward linkages and a very integrated, intra-regional European production network where about 80% of value added in their gross export or final demand originates from within the EU.

The so-called **network centrality** measures present another concept used to explain the importance and position of countries in trade networks by focusing on the specific structural positions and corresponding roles played by a given country in a network. As a key aspect of network analysis (Freeman, 1978), the concept of network centrality relates to how central or "in the thick of things" a given actor is within a network (Opsahl, Agneessens & Skvoretz, 2010, p. 245). An increasing number of empirical studies have applied the well-established network analysis methodology to the area of the GVCs. This has been most often used to reflect the central "hubs" and peripheral relationships between economies in the global production networks, as well as to assess the accompanying impacts on their economies. However, the relation between GVC involvement and network centrality positions has been neither well studied nor documented in the economic and trade literature. In their recent paper, Antràs & De Gortari (2017) show that a country's centrality position in geographical terms, i.e. where centrality is related to the magnitude of the trade costs of shifting goods to other countries, and its position along the GVC are interrelated. The key mechanism in their model relates to the premise that trade elasticity is larger at downstream stages than at upstream ones within the GVCs. This is because trade barriers tend to impede trade more severely in downstream stages than in upstream stages. They demonstrated that relatively more central countries will tend to gain comparative advantage and specialise in relatively downstream stages, ceteris paribus.

Employing a network analysis approach to inter-country export patterns of EU member states, Rašković, Udovič and Žnidaršič (2011) showed that there is a clear core-periphery structure within the EU production network.

Their study was, however, based on gross trade flow data, not trade in value added. By computing a range of network centrality metrics using WIOD input-output (IO) data, Cerina et al. (2015) found that industries are highly asymmetrically connected and that the GVCs are regionally clustered. Pascariu and Frunză (2011) applied a centre-periphery model to study development disparities within the EU, but from the perspective of spatial (geographic) position, not GVC position. Criscuolo and Timmis (2018) have recently found that there have been large changes in the organisation of some GVCs. They highlighted how several emerging economies and their industries have become more central in general to global production networks and that the growing importance of Eastern European economies coincides with the timing of their EU accession. Thus, EU accession has had an important influence on the GVCs, at least for European countries and the EU value chains.

At the same time, recent studies have also begun to uncover that the network of linkages between firms, industries and economies matters for the economic outcomes (when it comes to their structural and relational aspects of networks). The more central position a country has, the more advantages it seems to have and reap, while being potentially exposed to higher risks. Central firms and industries facilitate shock transmission domestically (Acemoglu et al, 2012; Carvalho, 2014), while the international transmission of inflation is strongly influenced by cross-country input-output linkages; with such linkages doubling the cross-country impact of common global shocks (Auer et al., 2019). Imbs and Pauwels (2019) found that centrality is strongly correlated with GDP volatility, particularly for high-income economies. Besides, the centre, a hub is also useful for knowledge and information diffusion (Alatas et al., 2016; Banerjee et al, 2016). Further, Criscuolo and Timmis (2018) studied the effects of the structure of the GVC network on the diffusion of productivity and found that changing structure of the GVCs can play a role in the catch up of firms. Becoming more central as a customer (but not a supplier) is associated with faster productivity growth of smaller or non-frontier firms, as well as firms in post-2004 EU members or other smaller countries.

In this chapter, we aim to analyse the GVC participation, the GVC position and the network centrality nexus in the context of the CEECs' embeddedness in European and global trade networks. We first present the two key datasets employed in the study and illustrate the trade in value added network for the CEE region. We continue with a comparative analysis of the GVC characteristics of CEECs based on several established indices. Then, we employ a network analysis approach and present findings from our centre-periphery analysis employing social network analysis methodology based on calculating continuous corenness indices for each country in the network. We explore the changes in the centre-periphery structure of CEECs within European and global trade in a value added network context between 2005 and 2015. Finally, we draw some conclusions on the GVC network position-centrality nexus in the context of CEECs.

1.2. The data on trade in value added

It is well established (e.g. in Maurer and Degain (2010), De Backer and Miroudot (2013)), that conventional gross trade data doesn't allow us to fully grasp and understand the complexity of contemporary trade networks with multiple participants and numerous cross-border flows. Therefore, we base our analysis on the trade in value added data which allows us to trace where the value is added and consumed; not just counted (booked).

1.2.1. Datasets

We draw on to two datasets for trade in value added data in our analysis. First is the TiVA database provided by OECD and WTO. This database, however, does not include all of the CEECs. It provides the GVC indicators for eleven CEE countries that are already the EU members; namely Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. In the remainder of the study, we refer to these eleven CEECs as the CEE-11 group. To cover

the remaining 5 CEE countries (hereafter referred to as CEE-5), which include Serbia, Bosnia and Hercegovina, Montenegro, North Macedonia and Albania, we additionally used the Eora MRIO Database. Since the calculation of trade in value added based on the Eora Input-Ouput database differs from the source of TiVA database, the two databases described below are not actually directly comparable. Thus, we had to carry our comparative analysis separately for the CEE-11 and CEE-5 groups.

TiVA database

The TiVA database provides a wide set of trade in value added indicators for 64 economies, including all OECD countries and covers the period between 2005 to 2015. Its 36 unique industrial sectors are represented within a hierarchy and include aggregates for all manufacturing and total services. The database is originally derived from the Inter-Country Input-Output (ICIO) tables based on statistics compiled according to the 2008 System of National Accounts (SNA 2008) from national, regional and international sources. It uses an industry list based on the International Standard Industrial Classification (ISIC) Revision 4.

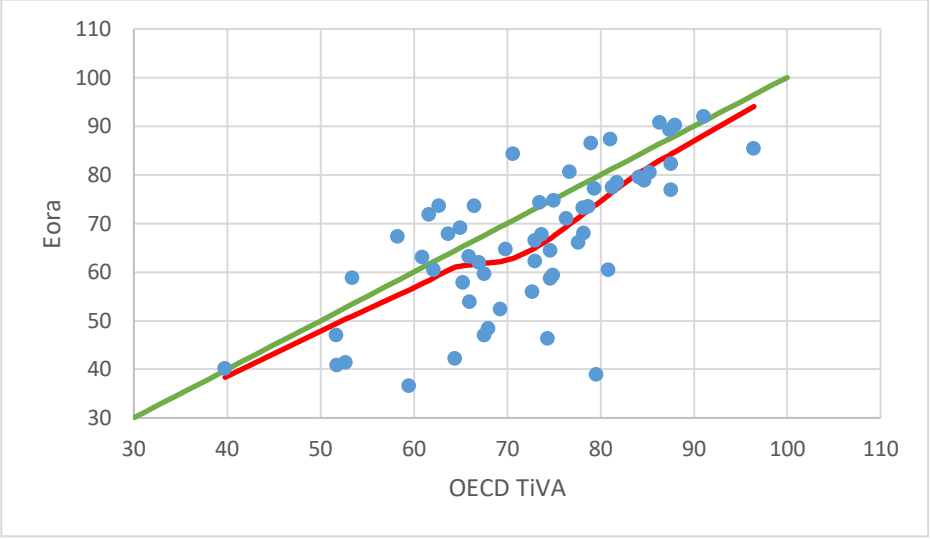
Eora MRIO database

The Eora Multi-Region Input-Output (MRIO) database (henceforth referred to as Eora (see Lenzen et al (2012) and Lenzen et al. (2013)), has a considerably broader geographic coverage than the TiVA database. It includes virtually all countries in the world and starts in 1990. Thus, it also provides information on countries without I-O tables. Eora uses highly sophisticated optimisation algorithms to estimate intra- and interregional transaction matrices for all countries worldwide. The idea behind this is that all economies report their national accounts and bilateral foreign trade data. Hence, all output, export and domestic value-added data are available, and these types of data constitute the so-called edges of the I-O matrices. Sectoral classification in Eora includes 26 sectors which are consistent across all countries covered. An even more detailed classification is obtainable for certain countries, with more detailed I-O tables available.

The main difference between Eora and OECD TiVA indicators arises from the fact that the OECD relies completely on the national I-O tables, while Eora doesn't (since only about 20% of the countries have national I-O matrices). Therefore, the amount of bias is unknown. That's why Eora also provides the variance of the estimations. The OECD data is also based on algorithmic optimisations, but the base tables for which the connections should be estimated are known. Thus, there are significantly less unknown parameters in the model than in the Eora's model, which means the bias tends to be smaller (though its extent/severity is still unknown).

Figure 1.1 compares the two databases on the indicator of exported domestic value-added as a share of gross exports. The comparison suggests that data fit together with a moderately high correlation of 0.71. The green line represents a 45 degree angle, while the red line represents the so-called LOWESS curve (Locally Weighted Scatterplot Smooth). This one indicates a small downward bias of the Eora data on domestic value added in gross exports.

Figure 1.1: A comparison of domestic value added in gross exports values from the TiVA (OECD) and Eora databases



Source: Authors' calculations based on Eora and OECD TiVA databases.

Despite a relatively high correlation, analyses based on different sources may imply different estimations. These errors and biases cannot be avoided and there is no universally approved dataset concerning global I-O data. On top of this, there are two rather restrictive assumptions behind the standard I-O methodology, which also need to be considered: (i) producers have the same technological coefficients for domestic and for international markets, and (ii) technological coefficients are the same for intermediate and for final goods, if classified in the same highly aggregated industry. One needs to bear these limitations in mind when interpreting our results.

Comparative and network analyses were performed for the 2005-2015 period, which corresponds to the last decade of the available data on trade in value added. This period coincides with the EU enlargement, namely the first eight CEE countries became full EU members in May 2004, Bulgaria and Romania in 2007 and finally Croatia in July 2013. Certain aspects of the analysis have been made based on 5-year interval estimates for the following years: 2005, 2010, and 2015. This was done because of the tedious nature of network analysis, where each year-industry network is analysed separately and all corresponding network centrality measures and corenness indices are estimated.

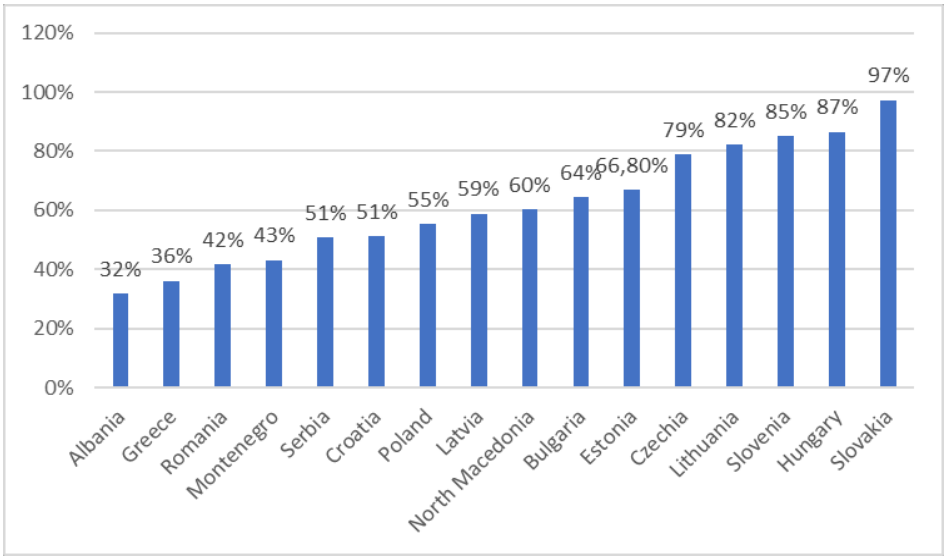
We complement the aggregate level analysis of the GVC integration and network centrality position with industry level investigation. Based on the International Standard Industrial Classification (ISIC) Revision 4, we consider the following 8 industry groups with corresponding TiVA industry codes:

- Food products, beverages and tobacco (D10T12);
- Textiles, wearing apparel, leather and related products (D13T15);
- Wood and paper products; printing (D16T18);
- Chemicals and non-metallic mineral products & Basic metals and fabricated metal products (D19T25);
- Computers, electronic and electrical equipment (D26T27);
- Machinery and equipment, not else classified (D28);
- Transport equipment (D29T30);
- Total services, including construction (D41T98).

1.2.2. Illustration of gross trade and value added trade networks in the CEE region

The CEE countries are highly open economies. Their export-to-GDP ratio (in goods and services) depicted in Figure 1.2 tends to be above 50% in most countries, though the distribution is quite unequal. Slovakia has the largest share (97%), followed by Hungary (87%) and Slovenia (85%), while the smallest ratio is for Albania (32%), Greece (36%) and Romania (42%).

Figure 1.2: Gross export-to-GDP ratio (goods and services) in the CEE region (2008)



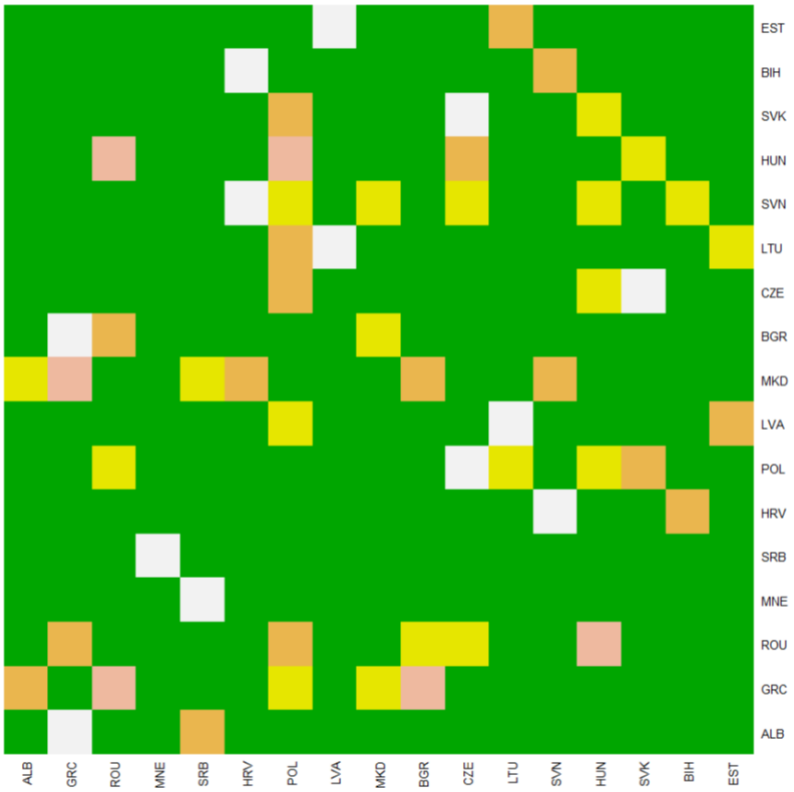
Source: European Commission's AMECO database.

Figure 1.3 presents bilateral export relations among the CEECs based on *gross* trade data. The green squares represent a zero or negligible market share of the partner country in the exporter's total outbound trade. For the remaining fields, the warmer the colour (redder), the stronger the relation between the two countries is. For example, Slovenia and North Macedonia are the most integrated countries in the region, as they both have six export

partners with more than a 1% share from the CEE region. The strongest tie is between Montenegro and Serbia, as Serbia represents more than a 15% share in Montenegro's exports. The so-called Visegrad countries (Poland, the Czech Republic, Slovakia and Hungary) and Romania form a separate group with strong export relations. The foreign trade of goods in the Visegrad region is organised along with the German automotive industry. Transport equipment parts and accessories, as well as capital goods (machinery) produced or assembled by local suppliers dominate trade within these countries.

Strong dependencies among the CEE countries suggest that the role of the GVCs in their economies is substantial. On the other hand, the role of CEECs in the GVCs is much less significant compared to the big global players. Therefore, we next wanted to demonstrate the importance of the intra- and inter regional trade based on network representation of the trade in value added data. First, we focused on the domestic value added traded within the value chain network. In other words, how much value added in terms of the national gross exports is being traded. In Figure 1.4, we show how trade in value added is organised in the CEE region. Large economies, such as Germany, China, Turkey and France are included, together with Nordic states, Russia and Ukraine. Several regional clusters are clearly identifiable based on Figure 1.4. They include: the Baltic countries with Nordic countries, the Visegrad countries supplemented by Austria, Slovenia, Croatia and Bosnia, the Balkan countries, like Bulgaria, Romania, and North-Macedonia. Serbia and Montenegro are two closely tied economies in terms of trade in value added, though they don't fit into any regional cluster. Germany is in the centre, with significant suppliers out of the CEE region, particularly China and France.

Figure 1.3: Heatmap of CEE trade relations based on gross export data (2015)



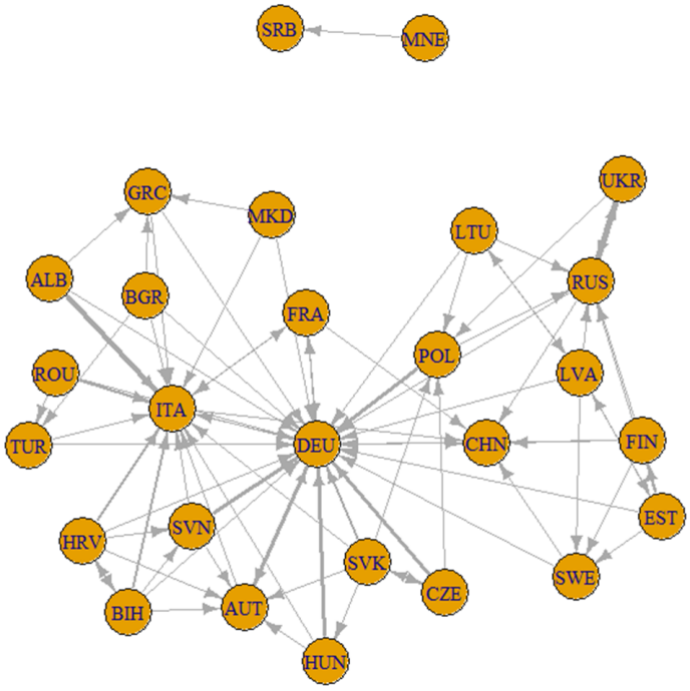
Note: Green fields represent negligible relative bilateral trade, for the rest of the fields, the warmer the colour (the redder) the higher is the relative export flow. Source: Authors' calculations based on Eora dataset.

Figure 1.4 indicates that the GVCs play a crucial part in the regional economies. Most countries have connections with 3-6 regional countries (that is, they trade in more than 5% of domestic value added in the partner country's export). This points to the importance of so-called local value chains. Most CEE countries have direct access to the world market, but via Germany and/or China as hubs. This relation is also true vice versa. German, Chinese and French domestic added value can be found in the exports of the CEE region in a significantly high amount.

Second, to consider the role of the CEE region in the GVCs, we further wanted to illustrate the embeddedness of CEECs in the trade network

based on domestic value added data in the partner's country final demand, which is shown in Figure 1.5. It presents the relationship among the CEECs and large players of the world economy in terms of value added in final demand. This indicator is valid here, as the ultimate destination of every domestic value added is consumption or investment as a final demand. The approach focuses on the demand side rather than on the production side. Of course, the share of a small country in the final demand of a large economy is usually small. At the same time, the number of partner countries in which the investigated countries can have a considerable share reflects their importance in the global economy.

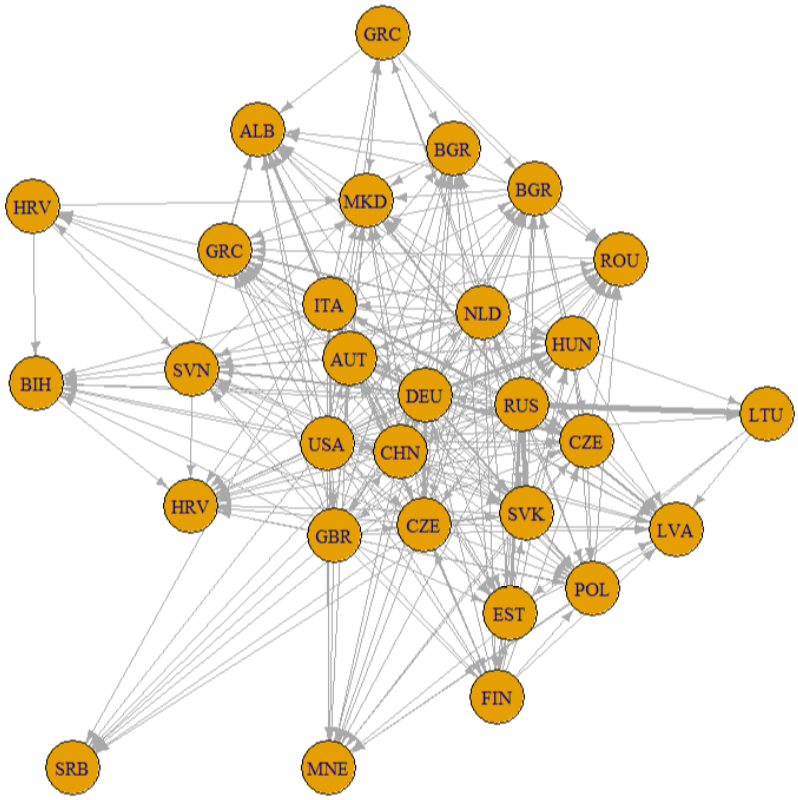
Figure 1.4: Domestic value added in terms of gross exports in the CEE region (2015)



Note: values below 5% are neglected due to the sake of clarity. Visualisation done in statistical software package R.
Source: Authors' calculations based on Eora dataset.

In contrary to Figure 1.4, one may hardly observe any clusters in Figure 1.5. This is mainly due to the fact that while domestic value-added in gross exports represents specialisation, domestic value-added in final demand represents trade relations, traditions and diversification. Germany, China and the Netherlands are in the centre of this network since most of the domestic value added in the CEE region is consumed in these countries. The relation is also true in the other way around; the domestic value added of these large economies can be found in almost all CEE country's final demand. Specialised value chains in two industries, transportation equipment and machinery, are of particular importance to the CEE region. It is through these industries, that most countries in the CEE region are connected to the GVCs. EU member states share good trade relationships, and some of them have diverse trade relations (especially the Visegrad countries). Thus, the interdependence in the region is strong, though it is rather relying on some industries and the production of certain key transnational companies. Therefore, in the remainder of this chapter, we continue first with the comparative analysis of the developments in the involvement in GVCs during the 2005-2015 period at the industry level. Again, this is done separately for the CEE-11 and CEE-5 groups, due to already explained reasons. Then, we proceed with network analysis based on the OECD TiVA database (corresponding on to the CEE-11 group).

Figure 1.5: Domestic value added in the partner country's final demand (2015)



Note: Values below 0.01% are neglected due to the sake of clarity. Visualisation was done in statistical software package R.
Source: Authors' calculations based on Eora dataset.

1.3. Comparative analysis of CEECs' integration in GVCs

1.3.1. Methodology

To reflect the degree of involvement of CEECs in GVC we calculate GVC participation index, which indicates the overall involvement of a country in GVC. This index is further decomposed in the two indices: forward

participation (FP) and backward participation (BP). Forward GVC participation refers to the type of participation where an economy joins the global production by exporting domestically produced inputs to partners who are in charge of downstream production stages, while backward GVC participation is the type of integration where the country participates by importing foreign inputs to produce the goods and services for its export[8]. Backward linkages are measured as foreign value-added (FVA) in domestic exports, while forward ones by the domestic value-added embodied in foreign exports (DVAFX). Hence, the FVA in the exports indicates the country's "downstreamness" in global production chains and the DVAFX indicates "upstreamness". Furthermore, to portray the position of CEECs along the GVCs we calculate GVC position index defined as the log ratio of a country's forward and backward participation as proposed by Koopman, Powers, Wang, & Wei, (2010). The higher the value of the ratio the more upstream position in the GVC a country holds. These measures and the data sources are further explained in Table 1.1.

Table 1.1: Explanation of the GVC indexes

	Definition	**Calculation method**	**Data source**
Forward participation (FP)	Domestic VA embodied in foreign exports [as % of total gross exports of a country]	**FP at aggregate level:** $$FP_i = \frac{DVAFX_i}{grossEX_i} \cdot 100$$ $DVAFX_i$ denotes country i's domestic VA embodied in foreign countries' exports, while $grossEX_i$ represents gross exports of country i.	**TiVA database** [$DVAFX_{ik}$ obtained based on EXGR_DVAFXS[9], $grossEX_{ik}$ from EXGR] **Eora database** [$DVAFX$ obtained based on DVX data, $grossEX$ as a sum of foreign value added (FVA) and

[8] More on the indices in "Trade in Value-Added and Global Value Chains" profiles Explanatory notes, https://www.wto.org/english/res_e/statis_e/miwi_e/explanatory_notes_e.pdf

[9] Domestic value added embodied in foreign exports (EXGR_DVAFXSH) is expressed as a share of total country's gross exports, hence we adjust it to reflect a share in industry level gross export.

		FP at industry level: $$FP_{ik} = \frac{DVAFX_{ik}}{grossEX_{ik}} \cdot 100$$ $DVAFX_{ik}$ presents country i's domestic VA content of gross exports by industry k in partner countries, while $grossEX_{ik}$ represents gross exports of country i in industry k.	domestic value added (DVA) data]
Backward participation (BP)	Foreign VA in a country's export [as % of total gross exports of a country]	**BP at aggregate level:** $$BP_i = \frac{FVA_i}{grossEX_i} \cdot 100$$ FVA_i presents foreign value added content of country i's gross exports. **BP at industry level:** $$BP_{ik} = \frac{FVA_{ik}}{grossEX_{ik}} \cdot 100$$ FVA_{ik} presents foreign value added embodied in the exports by domestic industry k in country i.	**TiVA database** [FVA_{ik} defined based on EXGR_FVA data, $grossEX_{ik}$ from EXGR] **Eora database** [based on FVA data, $grossEX$ as a sum of FVA and DVA]
GVC participation	The sum of forward and backward participation	GVC participation = FP + BP	TiVA database, Eoro MRIO database

GVC position index	GVC position in terms of relative upstreamness of a country	GVC position = Ln(1 + FP/100) – ln(1 + BP/100) (Koopman, Powers, Wang, & Wei, 2010)	TiVA database, Eoro MRIO database

The above GVC indexes are calculated for all CEECs both at aggregate and industry level throughout the 2005-2015 period. Our comparative analysis is performed in two parts, first for the CEE-11 based on TiVA databases, and second for the CEE-5 employing the data from the Eora MRIO database.

1.3.2. Comparative analysis of the GVC involvement for CEE-11

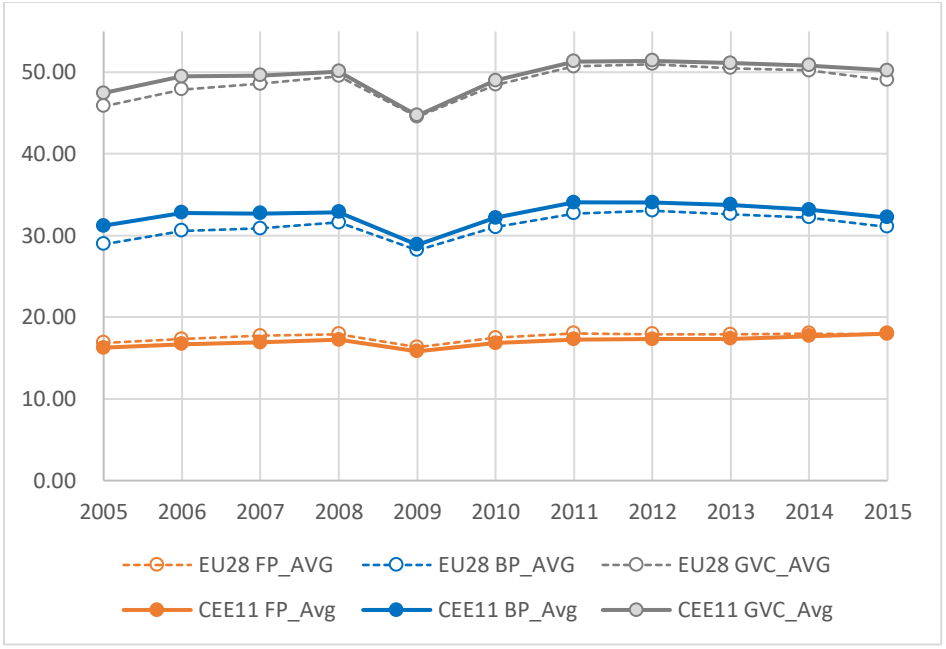
On one hand, GVC participation measures how intensively a country is involved in the GVCs, accounting for both backward and forward participation. On the other, the GVC position index indicates how upstream a country is positioned along the GVCs. GVC participation and position measures will be first analysed on an aggregate level for a group of CEE-11, followed by industry-level and country-industry level analysis.

1.3.2.1. Aggregated level

Figure 1.6 presents the development of average GVC participation for the CEE-11 and EU-28. It can be observed from Figure 1.6, that CEE-11 on average were slightly more involved in GVCs compared to the EU average throughout 2005-2015, however, the difference has been slightly more noticeable during the non-crisis period. The peak in the importance of supply chain trade for both EU-28 and CEE-11 was reached in years 2011 and 2012, while in line with the general global trend we are witnessing the stagnation in the GVC importance since the year 2012. Throughout the

observed period 2005-2015, CEE countries have maintained higher backward participation index compared to the EU-28 average. After the sharp drop upon the start of 2009's global financial crisis, the average share of foreign value added in CEE gross exports (BP index) reached a peak at around 34 % in 2011-2012 and started to decrease thereafter. On the contrarily, CEE-11 countries on average exhibited slightly lower forward participation than the EU average in the past decade but managed to catch up the average EU level in 2015. Forward participation of CEE-11 shows a sluggish upward tendency.

Figure 1.6: Average GVC participation (in %) of CEE-11 and EU-28 in 2005-2015 period

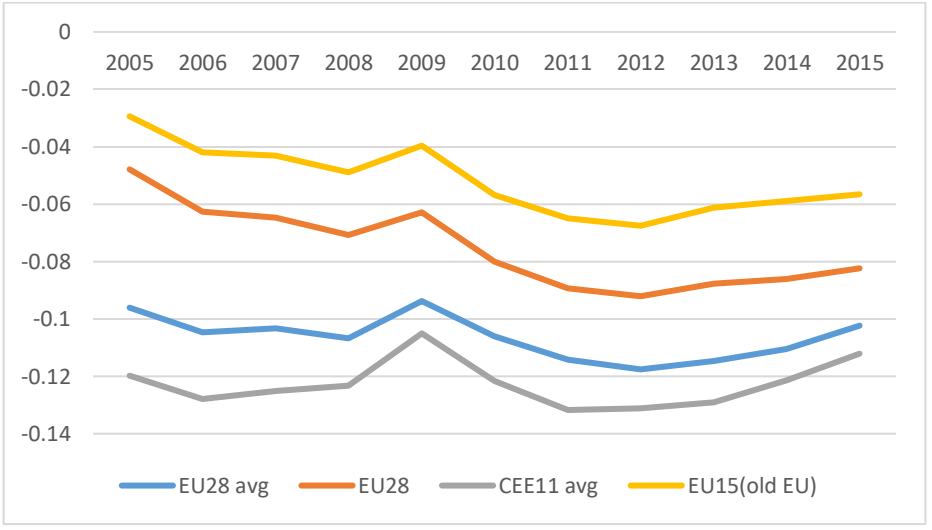


Source: Authors' calculations based on TiVA (OECD) database.

Developments in GVC position for the groups of CEE-11 and EU-28 are compared in Figure 1.7. In line with our expectations, the old EU members tend to be positioned more upstream in GVCs which is apparent from higher values of the position index for a group of old EU-15 member states

compared to CEE-11 average during the entire period observed. However, this gap has been narrowing throughout the period considered. Compared to the initial year 2005, the old EU MS moved downstream by the year 2015, while CEE-11 on average slightly increased their upstreamness. The diverged trend in the GVC position between the two groups was most obvious in a pre-crisis 2006-2008 period. In the crisis year 2009 both groups experienced a significant increase in their upstreamness since backward participation was relatively more hurt by the crisis. But already in the next year the downward trend in the upstream position was evident for both EU-15 and CEE-11, however it lasted for longer in the old MS, i.e till 2012. Moreover, climbing upstream the value chains since 2012 has been more significant in CEE-11. Since the average position across all the EU member states (EU-28 avg) is more downstream than for the "EU-28 region" that excludes intra-EU trade (EU-28), we may conclude that European countries hold on average more upstream position in global than European value chains.

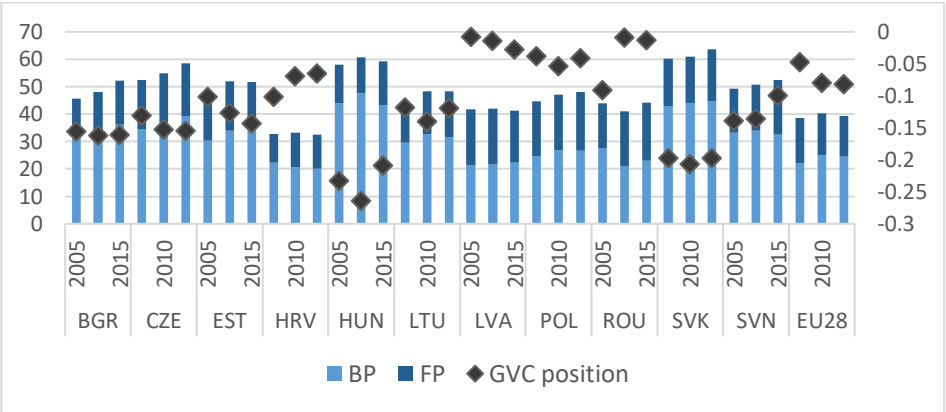
Figure 1.7: Average GVC position index for CEE-11 and EU-28 in 2005-2015 period



Source: Authors' calculations based on TiVA (OECD) database.

Considering individual CEE countries, we can conclude, based on Figure 1.8, that GVC participation index is relatively high for most of CEE-11, namely it is above 45% with the exception of Croatia where GVC participation has accounted throughout the period considered around one third of gross trade and Latvia and Romania with shares of GVC-linked trade around 40%. Hungary and Slovakia have the highest GVC participation among CEECs, which accounted for around 60% of their gross trade throughout the period. Meanwhile, CEECs show dominant backward linkages in GVC participation; namely, all CEECs have a negative GVC position index, indicating their downstream embeddedness in GVCs. Compared to EU average (which excludes the intra-EU trade), Poland and Latvia have been positioned relatively more upstream than the EU average throughout the entire period considered, while Croatia and Romania showed a more upstream position than EU average level only after the financial crisis. Moreover, we also observed that except for Romania, all other CEECs had higher involvement in GVC one year after the financial crisis (2010) compared to the year 2005. Furthermore, Bulgaria, the Czech Republic, Lithuania, Poland, Slovakia and Slovenia even continued to increase it during the 2010-2015 period, wherein Lithuania, Poland, Slovakia and Slovenia the increase was driven mostly by forward participation.

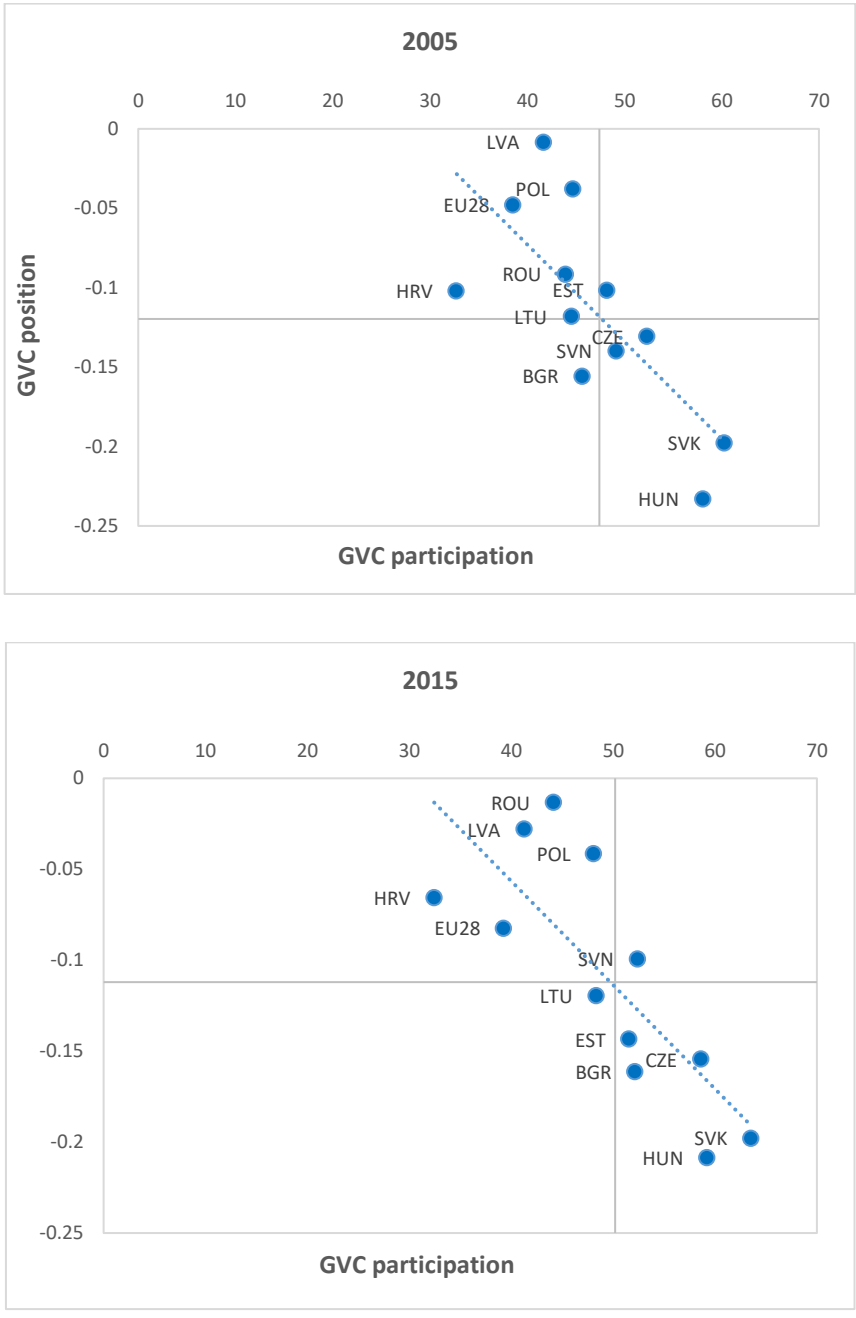
Figure 1.8: GVC participation and position for CEE-11 in 2005, 2010 and 2015



Source: Authors' calculations based on TiVA (OECD) database.

Some further notable changes in GVC profiles of CEE-11 in the last observed decade are evident from Figure 1.9 which plots GVC participation and position indices in the initial and final year of the period considered. First, CEE countries with higher participation in GVCs tend on average to be located more downstream as signalled by the negatively sloped trend line. In 2015, Romania, Latvia and Poland held the most upstream position among CEE-11 but exhibited a below-average degree of participation in GVC. On the other hand, the three countries with the highest share of supply-chain trade among the CEE-11, namely Slovakia, Hungary, and the Czech Republic, were also positioned most downstream together with Bulgaria. Second, most of the CEE-11 countries, with the exception of Croatia, Romania and Latvia, increased their participation in GVCs during the 2005-2015 period. Hungary, Slovenia, Romania and Croatia have moved more upstream by 2015 compared to the initial year 2005, concurrently Hungary and Slovenia also managed to increase their participation. The largest group of countries consisting of Bulgaria, the Czech Republic, Estonia and Poland, are those that moved downstream in the period observed but their involvement in GVCs has increased. Latvia, though it remained to be ranked as one of the most upstream countries among CEE-11, is the only country that underwent downstream movement without a growth in GVC participation. Finally, the GVC position of Lithuania and Slovakia has remained stable but their GVC participation share has elevated. To ease interpretation of the GVC dynamics, Table 1.2 groups 11 CEECs according to the direction of change in GVC participation and position through the 2005-2015 period.

Figure 1.9: Participation and position of CEE-11 countries in GVCs for 2005 and 2015



Note: position of axis in CEE-11 averages.
Source: Authors' calculations based on TiVA (OECD) database.

Table 1.2: GVC profile dynamics for CEE-11 between 2005 and 2015

POSITION / PARTICIPATION	Upstream movers	Downstream movers	Stable position
Increasing	HUN, SVN	BGR, CZE, EST, POL	LTU, SVK
Stagnating	HRV, ROU	LVA	

Source: Authors' calculations based on TiVA (OECD) database.

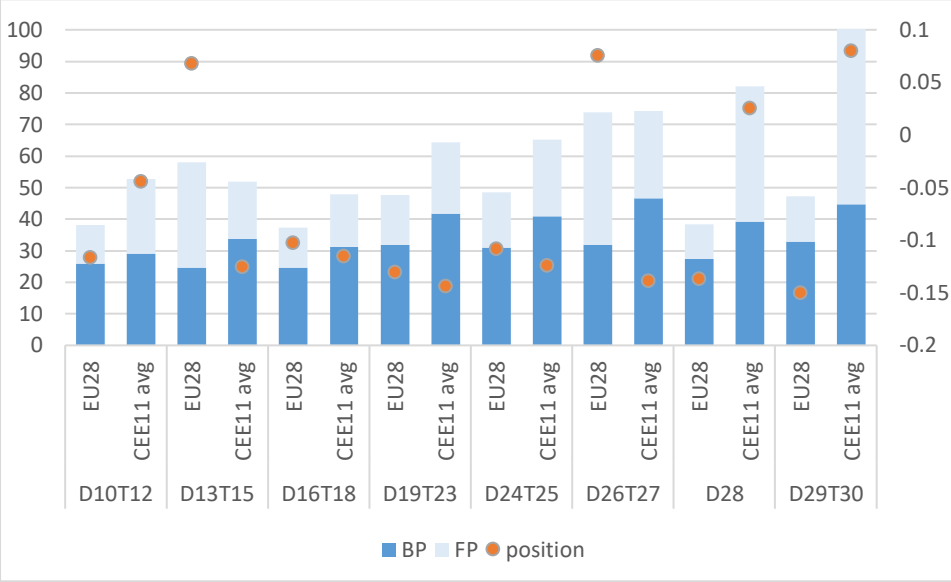
1.3.2.2. Industry level

Aggregate trends hide relatively large variability in terms of the GVC involvement for CEE-11 across different sectors and industries. Therefore, we proceed with the analysis at the industry level. Overall, as illustrated in Figure 1.10, CEE-11 group in most industries displays on average higher GVC participation than EU-28 as a region (excluding intra-EU trade) but occupies more downstream position, with notable exceptions in *Machinery and equipment* (D28), *Transport equipment* (D29T30) and *Food products, beverages and tobacco* (D10T12), where CEE-11 gains dominance of the forward integration over the backward participation. The difference in GVC position between average CEE-11 and EU-28 region is most pronounced in *Textiles, wearing apparel, leather and related products* (D13T15) and *Computers, electronic and electrical equipment* (D26T27) where CEE-11 are integrated in GVCs in downstream stages with the predominance of foreign value added in their gross exports, whereas old EU members tend to participate in more upstream activates with high values of domestic value added embodied in third countries' exports.

Developments of average forward and backward participation in the EU-28 and CEE-11 in selected industries are depicted in Appendix 1. Here we consider averages of participation indices for EU-28 member states without excluding the intra-EU trade. In industries such as D10T12 *(Food*

products, beverages and tobacco), D16T18 *(Wood and paper products; printing),* D19T23 *(Chemicals and non-metallic mineral products),* D24T25 *(Basic metals and fabricated metal products)* and D28 *(Machinery and equipment, nec)* the distance in forward and backward participation between CEE-11 countries and EU average remained stable throughout the 2005-2015 period, where EU kept a higher forward participation than CEECs, most noticeably so in D16T18 and D24T25. However, in industries D13T15 *(Textiles, wearing apparel, leather and related products),* D26T27 *(Computers, electronic and electrical equipment)* and D29T30 *(Transport equipment)*, EU-28 exhibited considerably higher forward participation than CEE-11 and the existing large difference only seems to grow throughout the studied period. Regarding backward participation, it has remained quite stable overall, with CEECs having above EU average backward participation.

Figure 1.10: GVC participation and position indices for average CEE-11 and EU-28 region (excl. intra-EU trade) across industries in 2015



Source: Authors' calculations based on TiVA (OECD) database.

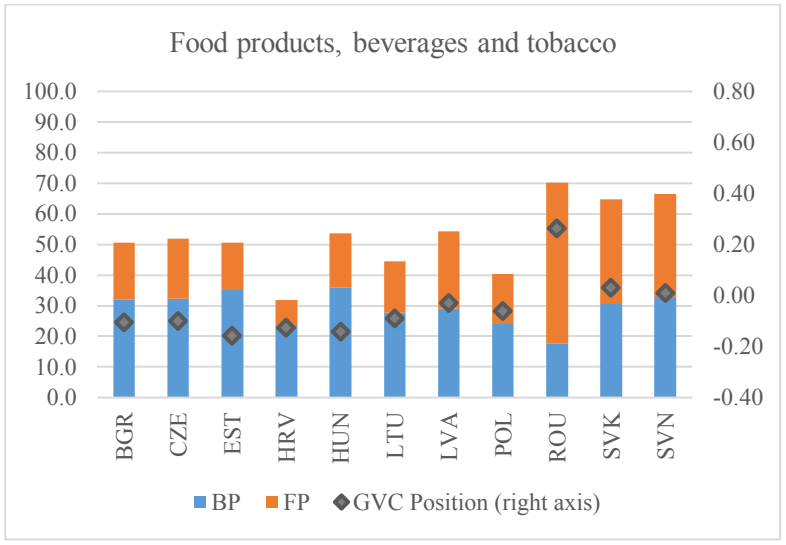
GVC participation and position of individual CEE-11 countries across industries is analysed in Figure 1.11a and Figure 1.11b for the last available year (2015). The former figure presents GVC participation across

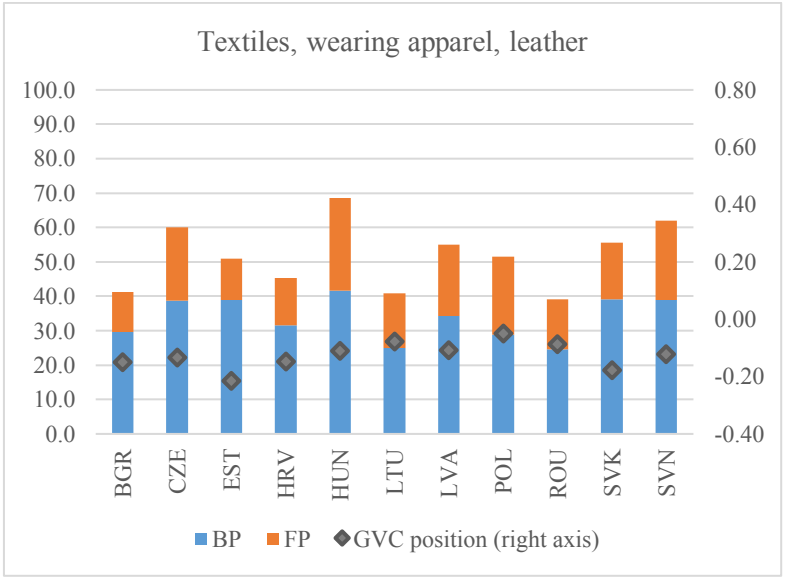
industries as a share of industry level gross exports indicating the extent of GVC participation in a particular industry, while the latter one depicts the GVC participation as a portion of total gross export showing the contribution of each industry to the GVC participation of the particular country. According to Figure 1.11a, in *Food products, beverages and tobacco* industry, Romania has the highest GVC participation as well as the most upstream position, followed by Slovenia and Slovakia. In *Textiles, wearing apparel, and leather industry*, Hungary, Slovenia and Czech Republic have the highest GVC participation, while Poland, Romania and Lithuania rank the highest in terms of upstreamness. This holds as well in the case of *Wood and paper products*, where Hungary, Slovenia and the Czech Republic also have the highest involvement, but Slovenia occupies a most downstream position and Lithuania the most upstream. The involvement in GVC in the industry of *Chemicals, non-metallic mineral products and metals* is overall high for CEECs, in which GVC-linked export accounted for more than 50%, this holds even more for *Computers, electronic and electrical equipment*, *Transport equipment* and *Machinery and equipment*. For industries of *Chemicals, non-metallic mineral products and metals* and *Computers, electronic and electrical equipment*, the GVC participation of CEE countries doesn't differ much but their location along GVC varies considerably. For example, Latvia, Romania and Croatia hold the most upstream position with positive GVC position index in both industries, while the position of Bulgaria and Lithuania differs markedly in two industries. Bulgaria and Lithuania are quite downstream in *Chemicals, non-metallic mineral products and metals* and relatively upstream in *Computers, electronic and electrical equipment*. Regarding the GVC position, Lithuania and Latvia are the most upstream countries among CEECs in *Computers, electronic and electrical equipment*, *Transport equipment* and *Machinery and equipment*. The Czech Republic had relatively low participation and a downstream position in *Machinery and equipment*, while Romania, Poland, Croatia and Slovenia are positioned at relatively upstream stages in the above three equipment manufacturing industries.

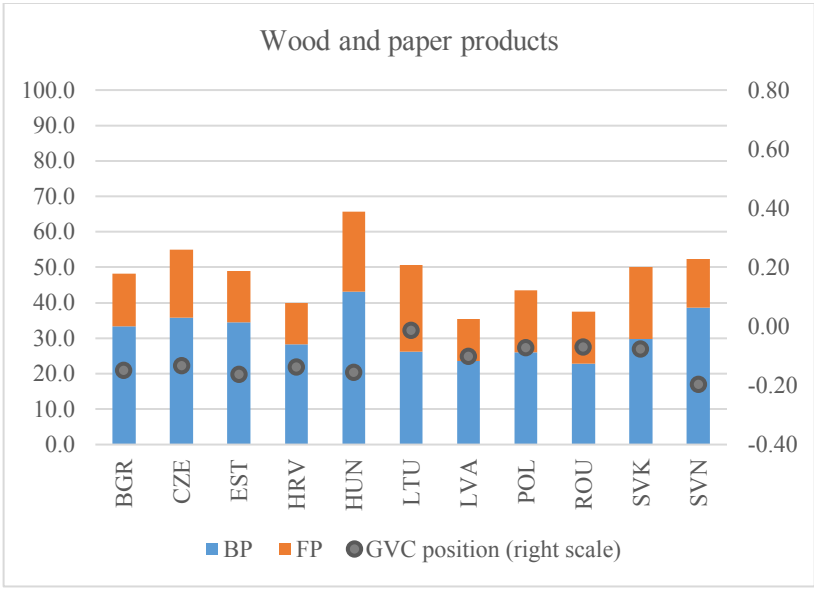
Among considered industries, *Transport equipment* and *Machinery and equipment* are industries with the highest share of supply chain trade in gross industry exports for the CEE-11 economies. This is mostly due to strong forward participation in general which results in an upstream position of CEE-11 in value chains in these two industries, especially the three Baltic countries stand out in terms of participation and upstream position. The exceptions are Slovakia, Hungary and the Czech Republic with the most downstream position. Furthermore, CEECs share a quite similar position in the global production chains of F*ood products, beverages and tobacco products*, *Textiles, wearing apparel, leather products* and *Wood and paper products* but in heavy industries, especially in *Transport equipment* and *Machinery and equipment*, the three Baltic countries are positioned at more upstream production stages. In *service* sector, CEECs have expectedly due to the nature of the services overall lower GVC participation and are positioned more downstream.

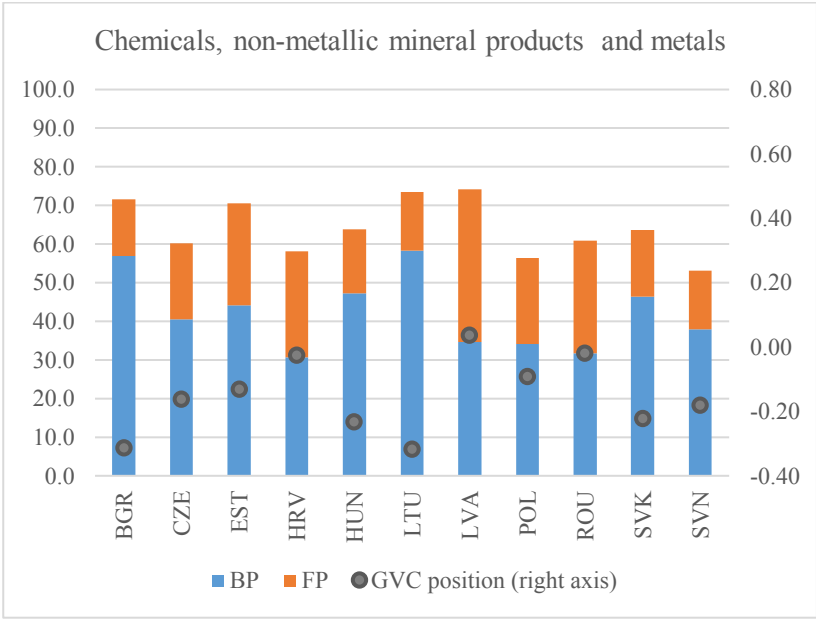
Based on Figure 1.11b we can further conclude that *Chemicals, non-metallic mineral products and metals* contribute the most to GVC-linked exports in Bulgaria, Lithuania, Poland and Slovenia, *Transport equipment* is the principal GVC integrated industry for Slovakia, Hungary and the Czech Republic, while Service sector dominates in supply chain trade in Estonia, Croatia, Latvia and Romania.

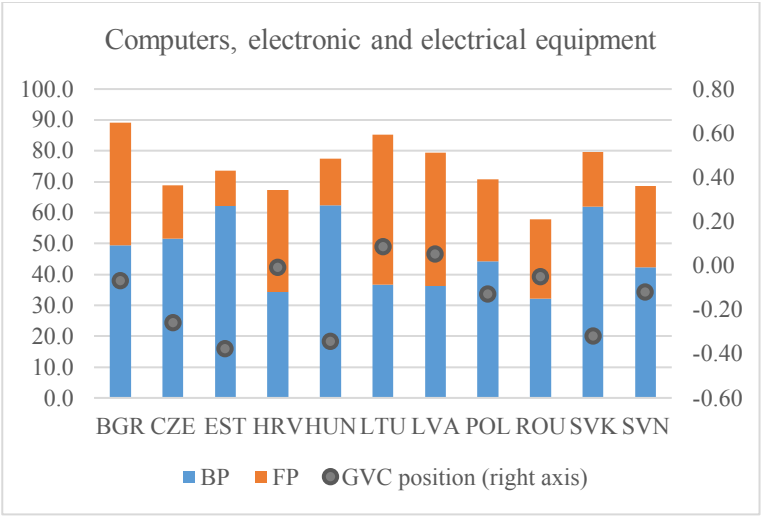
Figure 1.11a: GVC participation (calculated as a share of industry level gross exports) and position of CEE countries by industries in 2015

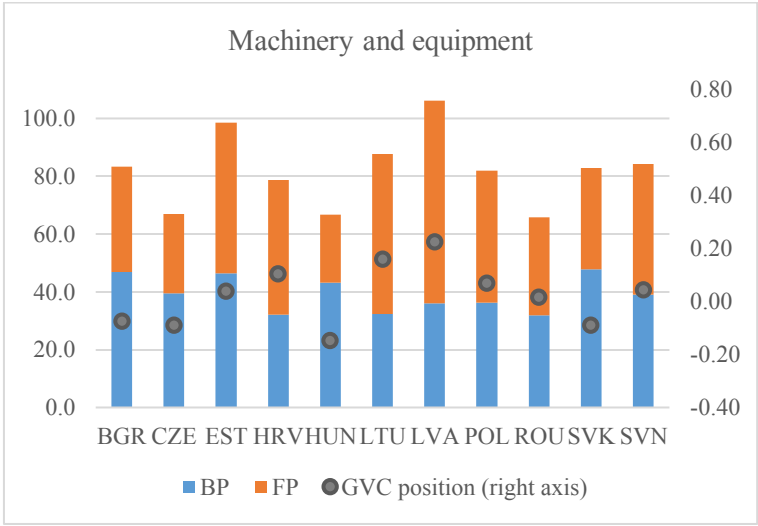


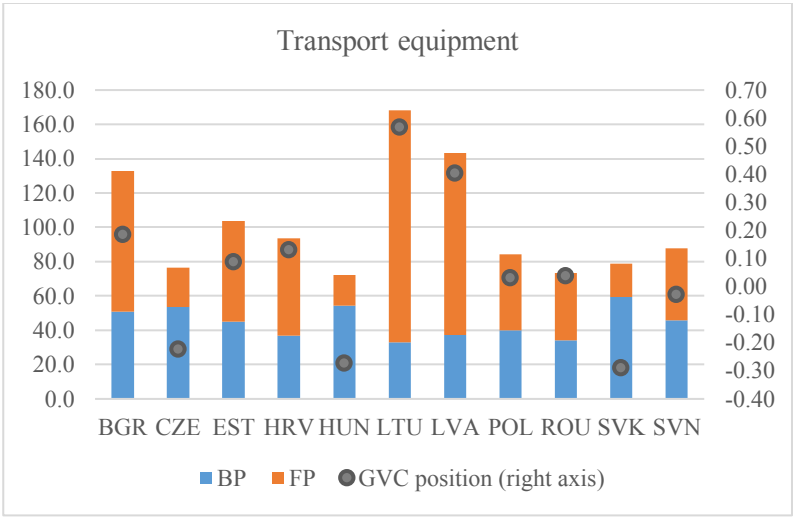


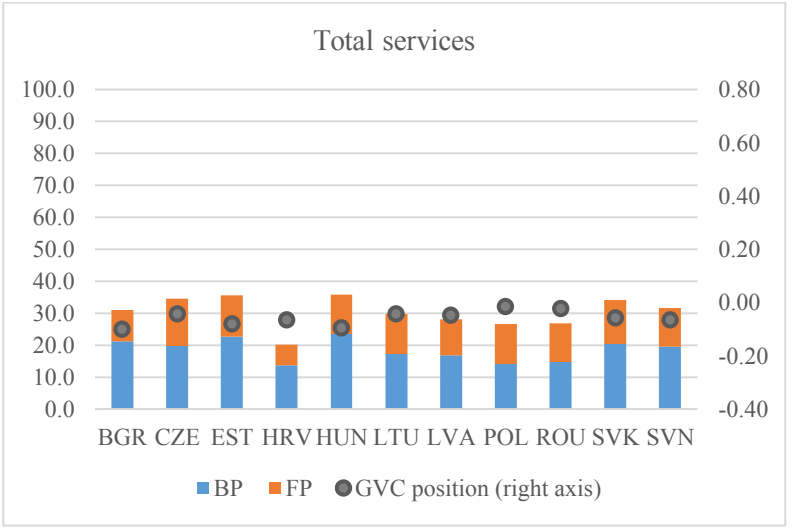

Wood and paper products
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
BGR
CZE
EST
HRV
HUN
LTU
LVA
POL
ROU
SVK
SVN
BP
FP
GVC position (right scale)


Chemicals, non-metallic mineral products and metals
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
BGR
CZE
EST
HRV
HUN
LTU
LVA
POL
ROU
SVK
SVN
BP
FP
GVC position (right axis)


Computers, electronic and electrical equipment
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)

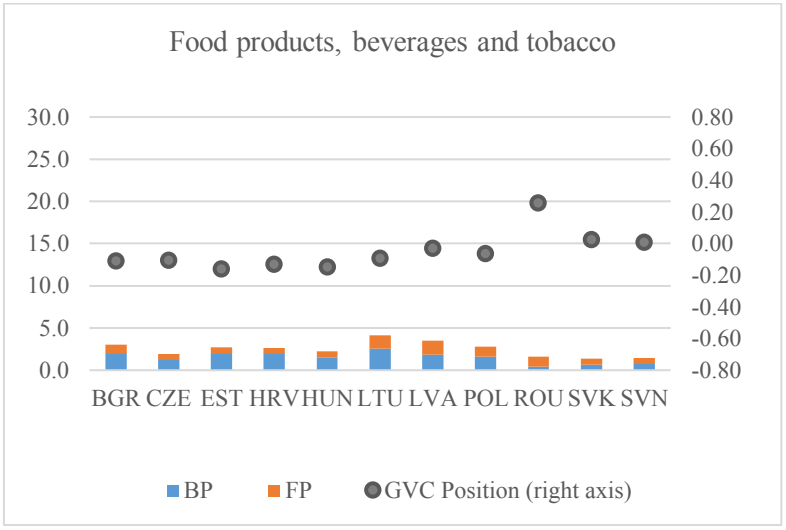

Machinery and equipment
100.0
80.0
60.0
40.0
20.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)

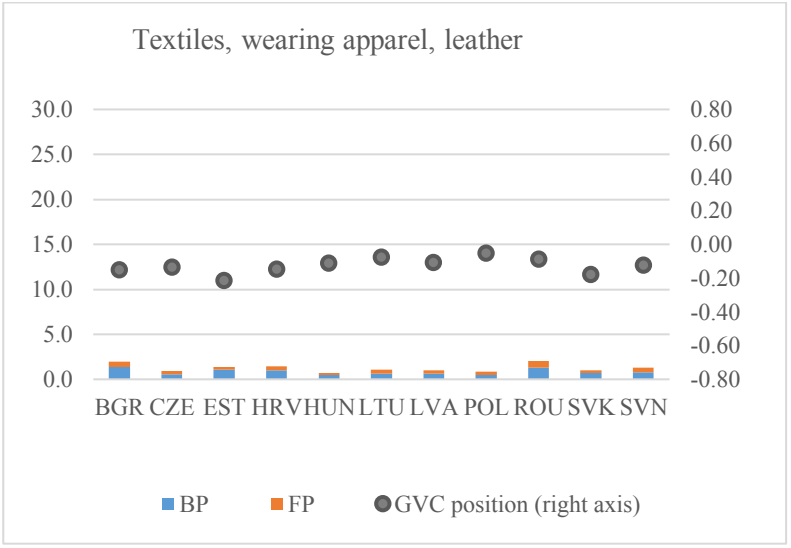


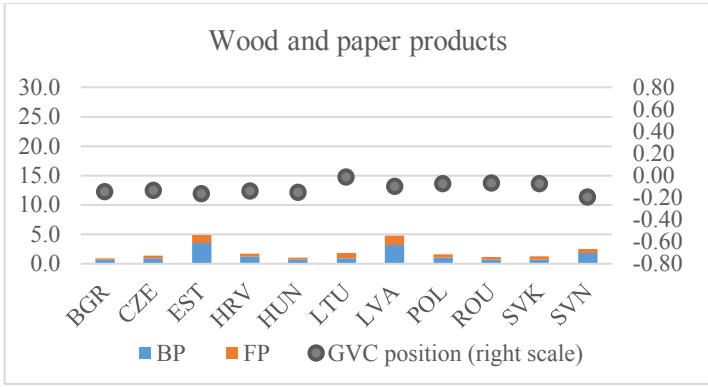


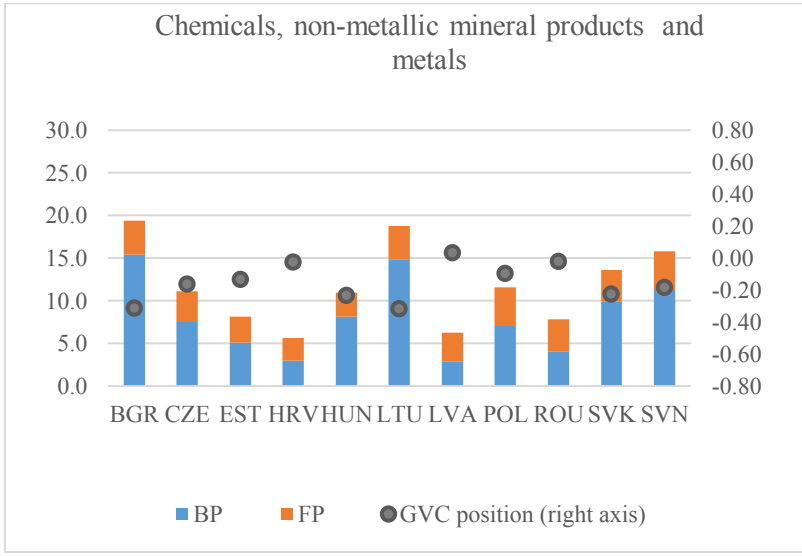
Source: Authors' calculations based on TiVA (OECD) database.

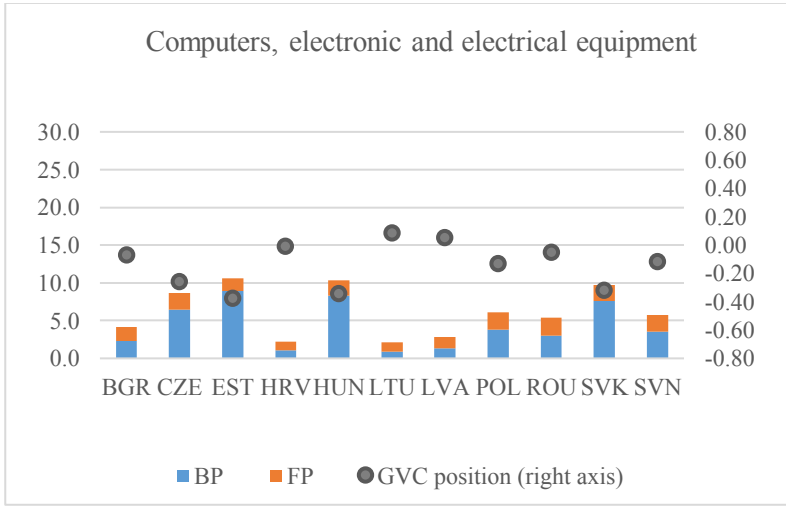
Figure 1.11b: GVC participation (calculated as a share of total gross exports) and position of CEE countries by industries in 2015

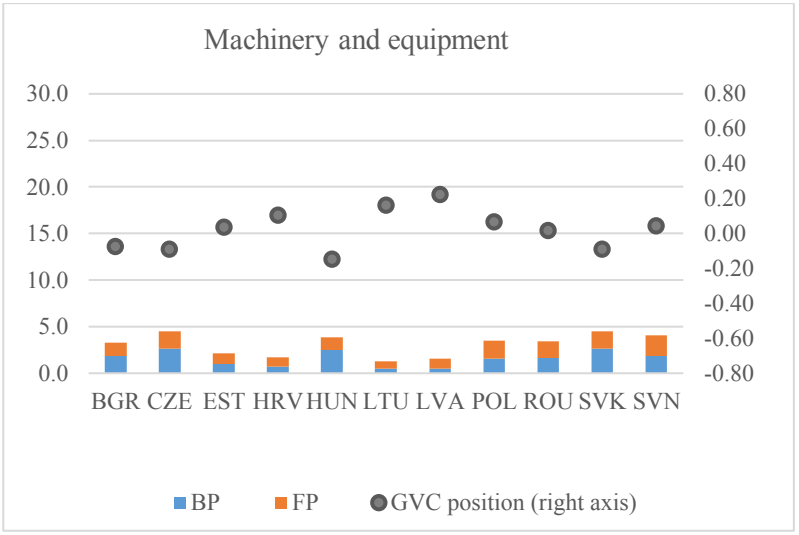


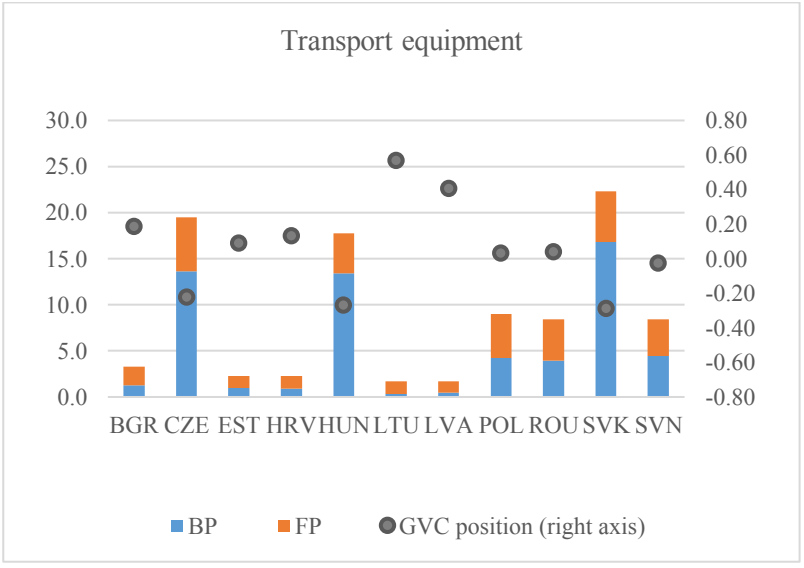


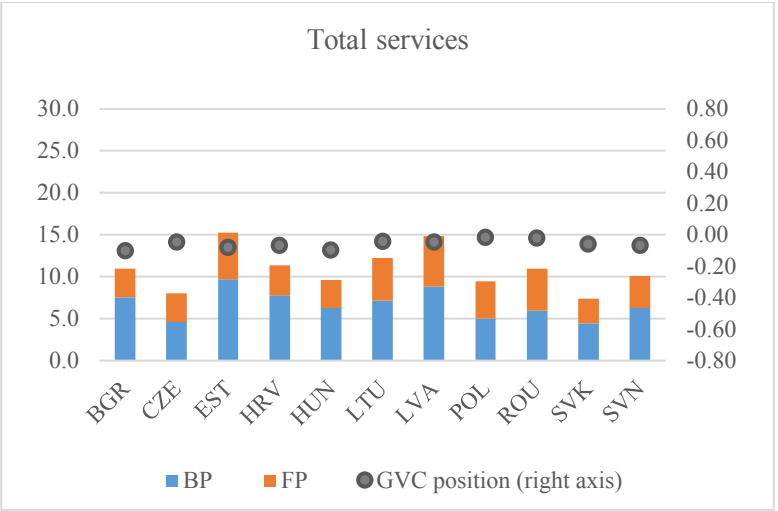

Wood and paper products
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
BGR
CZE
EST
HRV
HUN
LTU
LVA
POL
ROU
SVK
SVN
BP
FP
GVC position (right scale)


Chemicals, non-metallic mineral products and metals
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)


Computers, electronic and electrical equipment
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)


Machinery and equipment
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)


Transport equipment
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
BGR CZE EST HRV HUN LTU LVA POL ROU SVK SVN
BP
FP
GVC position (right axis)

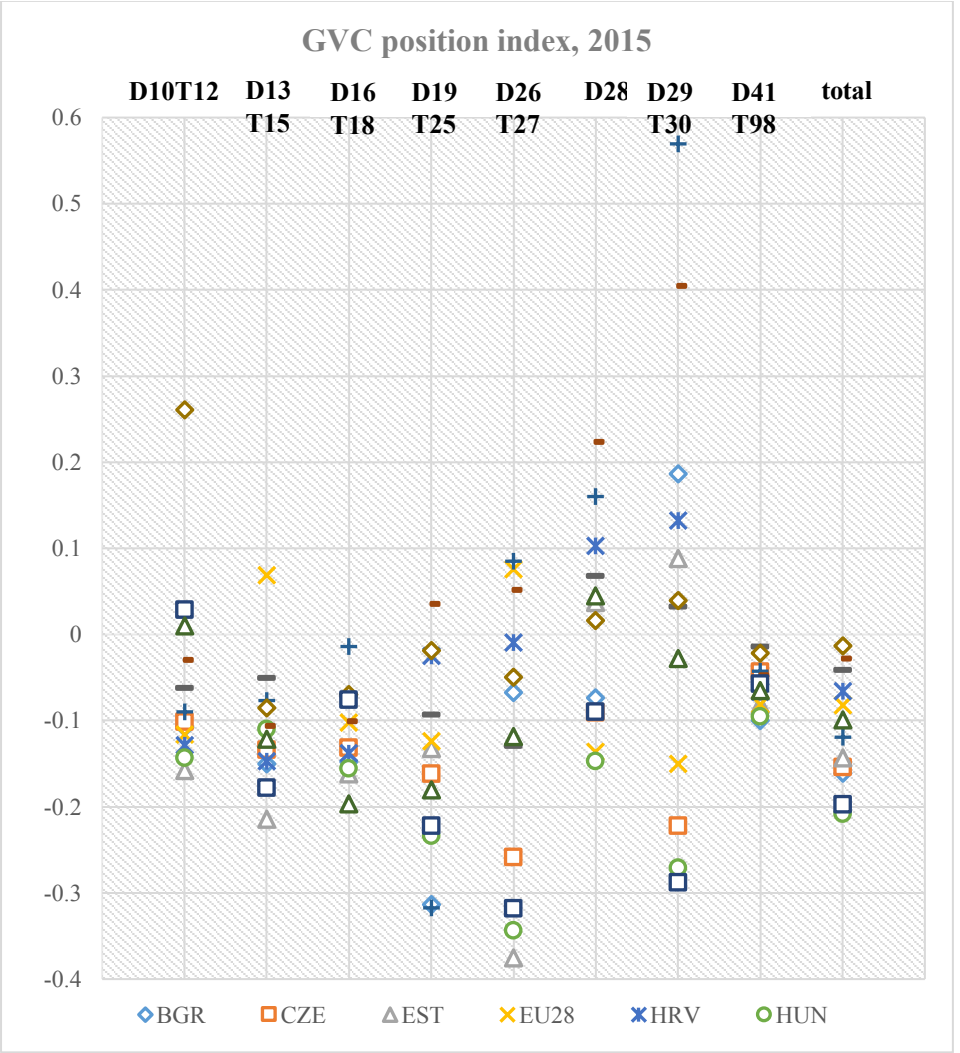


Source: Authors' calculations based on TiVA (OECD) database.

Summarizing the upstreamness rankings of CEE-11 countries across industries in Figure 1.12, indicates that overall CEE-11 countries are positioned relatively downstream in most of the manufacturing and service activities. The partial exceptions are *Transport equipment* and *Machinery and equipment* industries, where the majority of the CEE countries records positive GVC position index, i.e. meaning that forward participation surpasses the participation through the backward linkages. However, the upstreamness rankings of CEECs are not homogenous across the studied industries. Romania is the most upstream positioned CEE-11 country, and it stands out especially in *Food products, beverages and tobacco* industry. Latvia ranks the second in terms of total upstreamness, mostly on account of its upstream position in *Transport equipment*, *Machinery and equipment* and *Computers, electronic and electrical equipment* a*s well as Chemicals and non-metallic mineral products, basic metals and fabricated metal products.* Similarly, Lithuania holds upstream position in these industries with the exception of *Chemicals and non-metallic mineral products, basic metals and fabricated metal products*. In addition, it is placed most upstream among CEE-11 in *Wood and paper products.* Estonia is the most downstream positioned among Baltic countries, with positive GVC position index only in *Machinery and equipment* and *Transport equipment.*

Poland's most upstream position is in *Machinery and equipment, Services* and *Textiles, wearing apparel, leather* industries compared to other CEECs.

Figure 1.12: Upstreamness (GVC position index) of CEECs across industries in 2015



Notes: Industries on the horizontal axis. Legend: **1**- D10T12 (Food products, beverages and tobacco), **2** - D13T15 (Textiles, wearing apparel, leather and related products), **3** - D16T18 (Wood and paper products; printing), **4** - D19T25 (Chemicals and non-metallic mineral products, basic metals and fabricated metal products), **5**- D26T27 (Computers, electronic and electrical equipment), **6** - D28 (Machinery and equipment, nec), **7** - D29T30 (Transport equipment), **8** – D41T98 (Services), **9** - total

Source: Authors' calculations based on TiVA (OECD) database.

Croatia is positioned relatively upstream apart from the first three industries (*Food products, beverages and tobacco;* T*extiles, wearing apparel, leather* and *Wood and paper products*). Slovenia's upstreamness is somewhere in the middle in most of the industries, apart from *Wood and paper* industry where it occupies the most downstream position among CEE-11 and *Food products, beverages and tobacco* where it holds upstream position. The Czech Republic holds a downstream position with negative GVC position index in all industries, but without any extremes. Bulgaria is most downstream in *Chemicals and non-metallic mineral products, basic metals and fabricated metal products*, while it tends to integrate into the GVCs in upstream stages in *Transport equipment*. Slovakia and Hungary participate in GVCs in most downstream stages among the CEE-11, with the exception in *Food products, beverages and tobacco* and *Wood and paper products* for Slovakia, and *Textiles, wearing apparel, leather* industry for Hungary.

To gain further insight into the country-, industry- and year-specific effects of the CEE-11's GVC position and to identify more subtle underlying trends we run simple regression, where dependent variables is GVC position index calculated based on TiVA database, while on the right hand side we include sets of country, industry and yearly dummy variables which explain almost 50 % of the variability in the dependent variable. The results of regression decomposition are presented in Table 1.4 with robust standard errors, while Table 1.3 depicts descriptive statistics of four GVC indicators both at aggregate and industry level.

Table 1.3: Summary statistics on GVC involvement for CEE-11

	No. of Obser.	Mean	Std. Dev.	Min	Max
Aggregate level					
GVC position index	121	-.1225545	.072507	-.2646806	.0122692
GVC participation	121	49.55887	8.333045	29.88613	63.80088
BP	121	32.52606	8.503092	18.75293	47.82522
FP	121	17.03281	2.706823	10.45	21.9
Industry level					
GVC position index	968	-.06868	.1626794	-.4866298	.5770423
GVC participation	968	61.7089	25.92855	18.51218	181.6362
BP	968	34.85253	12.60359	11.10204	75.1965
FP	968	26.85637	21.4688	5.128827	135.0112

Source: Authors' calculations based on TiVA (OECD) database.

According to the summary statistics from Table 1.3, GVC-related trade accounts for almost half of the gross trade of CEE-11 which are on average integrated into the GVCs in downstream stages since their backward participation surpasses the forward contribution by a relatively large margin. Considering the average across manufacturing and service industries considered in our study the participation is even higher with the less downstream position.

Table 1.4: Country, industry and year fixed effects of GVC position (Upstreamness)
Base country BGR, base industry *Food products, beverages and tobacco* (D10T12), base year 2005

Dependent variable: **GVC position index**					
Country dummies		***Industry dummies***		***Year dummies***	
CZE	-0.063***	D13T15	-0.082***	2006	-0.006
	[0.017]		[0.013]		[0.018]
EST	-0.030*	D16T18	-0.055***	2007	-0.011
	[0.018]		[0.013]		[0.018]
HRV	0.040**	D19T25	-0.122***	2008	0.001
	[0.018]		[0.015]		[0.018]
HUN	-0.125***	D26T27	-0.072***	2009	0.020
	[0.020]		[0.016]		[0.018]
LTU	0.102***	D28	0.119***	2010	0.002
	[0.023]		[0.015]		[0.018]
LVA	0.164***	D29T30	0.071***	2011	-0.008
	[0.023]		[0.021]		[0.018]
POL	0.027*	D41T98	-0.016	2012	-0.011
	[0.016]		[0.013]		[0.018]
ROU	0.079***			2013	-0.009
	[0.019]				[0.018]
SVK	-0.093***			2014	-0.004
	[0.019]				[0.018]
SVN	-0.048***			2015	-0.003
	[0.016]				[0.018]
Constant	-0.051**				
	[0.022]				
Observations	968				
R-squared	0.484				
Adj R-Squared	0.470				

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Interestingly, the regression results from Table 1.4 reveal that none of the yearly dummy variables is statistically significantly different from 0, indicating that no common trend across all 11 CEECs can be identified. This is in line with our previous observations that CEE countries experienced rather different paths in their GVC position dynamics throughout the last decade. On the other hand, significant industry dummies suggest substantial differences crosswise industries but common to all CEE-11 economies. Compared to the base industry of *Food products, beverages and tobacco*, CEE-11's position in GVCs is significantly more downstream in *Textiles, wearing apparel, leather*, *Wood and paper products, Chemicals and non-metallic mineral products, basic metals and fabricated metal products* and C*omputers, electronic and electrical equipment*, while in *Machinery and equipment* and *Transport equipment* CEECs tend to be positioned in more upstream stages. Once we control for annual and industry fixed effects, there is still significant heterogeneity among CEECs in terms of their GVC position. Compared to Bulgaria, which is regarded in regression as the base country, Hungary, Slovakia, the Czech Rep., Slovenia and Estonia are positioned in more downstream stages less far from the final demand, while Croatia, Latvia, Lithuania, Poland and Romania exhibit significantly more upstream average position in GVCs.

1.3.2.3. Dynamic analysis of GVC participation for CEE-11

Our panel data setting allows us also conduct a dynamic panel data analysis of the GVC participation for the CEE-11 group. In addition to the sets of annual and industry dummy variables and accounting for the country-industry level heterogeneity, we also introduced German gross value added (industry-level GDP equivalent) [10] across selected industries in the empirical specification to test whether the CEE-11's GVC involvement is affected by the economic situation in their major economic partner, i.e.

[10] Source of data is Eurostat [https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a10&lang=en].

Germany. This is particularly relevant, as Germany is slowing down economically and is at the brink of falling into recession.

Due to the existence of country-industry level specific effects and likelihood of simultaneity bias, both causing some of the regressors not to be strictly exogenous, a preferred approach is the system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). It offers a large feasible instrument set by exploring instruments motivated by the moment condition, and in addition, it allows us to account for the persistence of GVC participation. To account for heteroscedasticity in our model, a two-step procedure by the Blundell-Bond GMM estimator is used to compute the variance covariance matrix based on Windmeijer-robust errors. We assess the adequacy of the instruments in an over-identified context with a Sargan test of over-identifying restrictions (Sargan 1958). We report the results of static and dynamic analysis of the backward (BP) and forward participation (FP) and GVC position, along with the statistical tests, in Table 1.5. The Sargan test of over-identifying restrictions confirms that the moment conditions are legitimate and the instruments used are jointly valid. The absence of a serial correlation of order 2 (AR(2)) is crucial for dynamic models based on differenced equations which is the case in all dynamic specifications from Table 1.5. For backward integration two lags of dependent variable were found to be appropriate, while in case of forward integration and GVC position we needed three lags for obtaining the efficient estimates.

Table 1.5: Static and dynamic panel data regression analysis of GVC participation (backward and forward) and position for CEE-11 in a 2005-2015 period

	(1) Static FE Y=BP	(2) Dynamic GMM Y=BP	(3) Dynamic GMM Y=BP	(4) Static FE Y=FP	(5) Dynamic GMM Y=FP	(6) Dynamic GMM Y=FP	(7) Static FE Y=GVC position	(8) Dynamic GMM Y=GVC position	(9) Dynamic GMM Y=GVC position
Y(-1)		0.694***	0.753***		0.558***	0.565***		0.762***	0.723***
		[0.014]	[0.012]		[0.004]	[0.003]		[0.019]	[0.009]
Y(-2)		0.013	0.035***		0.036***	0.082***		0.015**	0.079***
		[0.010]	[0.009]		[0.002]	[0.002]		[0.007]	[0.008]
Y(-2)					0.063***	0.114***		-0.005	0.050***
					[0.002]	[0.002]		[0.006]	[0.005]
lnGrossVA_DE(-1)	-1.009	0.770	-0.459	-14.840	4.485***	2.674***	-0.013	0.012	-0.008
	[1.577]	[0.790]	[1.271]	[24.460]	[0.325]	[0.415]	[0.185]	[0.008]	[0.011]
lnGrossVA_DE(-2)			-1.202			-0.822**			0.030***
			[1.132]			[0.472]			[0.011]
lnGrossVA_DE(-3)			1.296**			0.710**			-0.003
			[0.634]			[0.289]			[0.005]
Constant	47.06***	1.301	10.775	190.484	-37.36***	-20.74***	0.074	-0.131	-0.206*
	[16.919]	[8.386]	[10.013]	[266.194]	[3.485]	[6.031]	[2.017]	[0.085]	[0.113]
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes

Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	847	693	693	847	616	616	847	616	616
Number of cntry_ind	77	77	77	77	77	77	77	77	77
R-squared	0.229			0.146			0.142		
(df)	/	(91)	(104)	/	(84)	(97)	/	(84)	(97)
Sargan $\chi 2$		66.97	65.36		72.996	70.842		57.453	61.499
								67	5
(p)		(0.972)	(0.999)		(0.799)	(0.979)		(0.988 2)	(0.998 1)
AR(1) z(p)	/	-4.708***	-4.686***	/	-2.713***	-2.607***	/	-3.850***	-3.566***
		(0.000)	(0.000)		(0.000)	(0.009)		(0.000 1)	(0.000 4)
AR(2) z(p)	/	0.72326	0.63534	/	-0.47971	-0.62536	/	0.16124	0.02937
		(0.470)	(0.525)		(0.631)	(0.532)		(0.871 9)	(0.976 6)

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

We did not find any significant impact of German gross VA on GVC position or integration either via forward or backward linkages within the static analysis (Columns 1, 4 and 7 in Table 1.5), but the dynamic analysis confirms in general the important role of economic health of German industry for the extent of the participation and the position of CEE-11 in GVCs even after controlling for the fixed year effects. The positive and significant coefficients of German industry-level output measured in terms of gross VA confirm that the impact of the business cycles in German industry is relatively larger for the GVC-related trade compared to conventional final good trade flows, i.e. higher (lower) the gross VA in Germany higher (lower) the degree of the GVC involvement on average for the CEE-11.This is particularly the case for forward participation (Column 5), where the lagged value of the industry production (gross VA) in Germany is associated with increased share of domestic VA embodied in foreign exports (FP). On the other hand, the impact on backward participation is not that immediate as seen from the specification in Column 2, where the regression coefficient is insignificant. But once we introduce further lags of German industry-level output, to control for the impact over a longer time, it turned out that the impact of German GDP on backward participation (i.e. the share of foreign VA in domestic exports) operates with a 3-year lag, while for the FP the positive impact turns out to be of non-liner type (cubic function). The results, hence, suggest that an industry-level shock in Germany would put downward pressure on both forward and backward participation of CEE-11 within an industry, but the impact is more prompt and stronger for forward participation than for the backward one. This is further supported by the stronger persistence found for the backward participation, i.e. larger regression coefficient for the one year lagged dependent variable. The persistence is, hence, weaker in case of FP but it lasts for longer. As a result, the GVC position of the CEE-11 group is on average positively related to the German gross VA with a 2-year lag (Column 9), indicating that an industry-level negative shock in Germany drives CEE-11 group downstream the GVCs within the two-year time window.

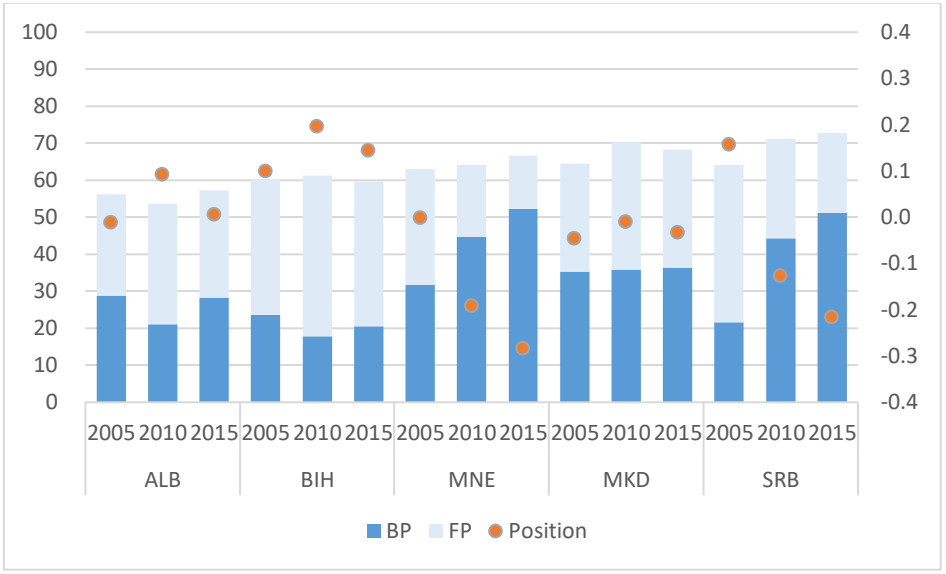
1.3.3. Comparative analysis of the GVC involvement for CEE-5

Since TiVA database only contains 11 CEE economies that are full members of the EU, we use the trade in value added data from the Eora MRIO database to analyse the GVC involvement for the rest of CEE countries, namely 5 WB countries (i.e. Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia). As argued above, the indicators are not directly comparable, hence, we carried out a separate analysis for this group of CEE countries.

1.3.3.1. Aggregated level

In Figure 1.13 we depict the extent of GVC participation for the CEE-5 both in terms of backward and forward participation and the average distance to the final demand as proxied by the GVC position index for three selected years within 2005-2015 period. Along the lines of CEE-11, WB countries also show substantial importance of the supply chain trade; throughout the entire period, GVC participation index exceeded 50% of the gross exports in all five counties. It was the highest in Serbia and North Macedonia and the lowest in Albania. The extent of overall GVC participation did not change much over the observed period with the partial exception of Serbia and Montenegro that witnessed a constant increase in GVC participation index during the 2005-2015 period. The effect of the global economic and financial crisis in 2008/2009 seems to be strongest in Albania which is the only CEE-5 country that experienced a drop in GVC participation in the year 2010 compared to 2005. Backward and forward linkages appear to have almost the same importance in driving GVC participation of North Macedonia. Finally, GVC participation of Albania and Bosnia and Herzegovina appear to be strongly driven by forward linkages. They are the most upstream positioned economies among WB countries; their GVC positions followed the inverse U-shape path during the 2005-2015 period.

Figure 1.13: Backward and forward participation and GVC position for WB countries in 2005, 2010 and 2015

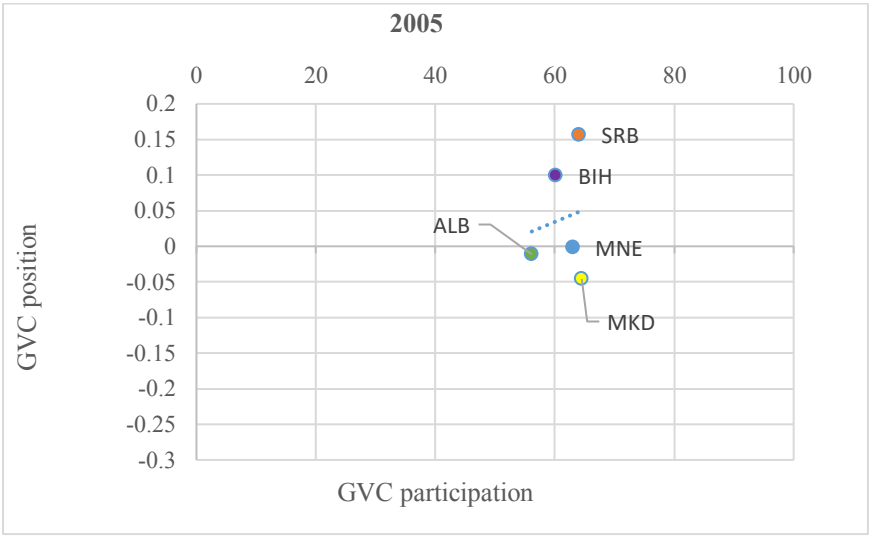


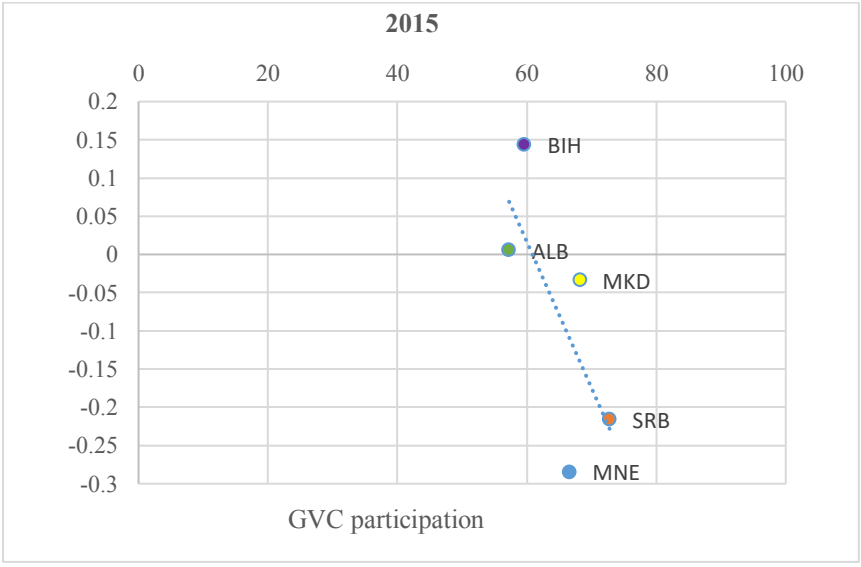
Source: Authors' calculations based on Eora database.

Figure 1.14 further plots the position of CEE-5 in the initial and final year of the period considered along the two dimensions, i.e. GVC participation and position. In line with the observation for CEE-11, the negative correlation between GVC participation and position is also evident (Figure 1.9) in WB countries but just at the end of observed period while the opposite was the case at the outset of the period considered in this analysis. This shift suggests a significant change in the extent of involvement in GVCs and divergent movements along the GVCs for the CEE-5. In 2015, Serbia and Montenegro exhibited on average the highest degree of GVC participation and were integrated in most downstream stages while Albania and Bosnia and Herzegovina were least integrated in GVCs but occupied most upstream positions. Compared to 2005, Montenegro and Serbia witnessed a similar change in GVC involvement – in both countries, there was a significant increase in backward participation coupled with downstream movement along the GVCs. The rest of CEE-5, i.e. Albania, Bosnia and Herzegovina, North Macedonia maintained a relatively stable

degree of participation and position in GVCs in 2015 in comparison to 2005.

Figure 1.14: Scatter plot between GVC participation and position in 2005 and 2015





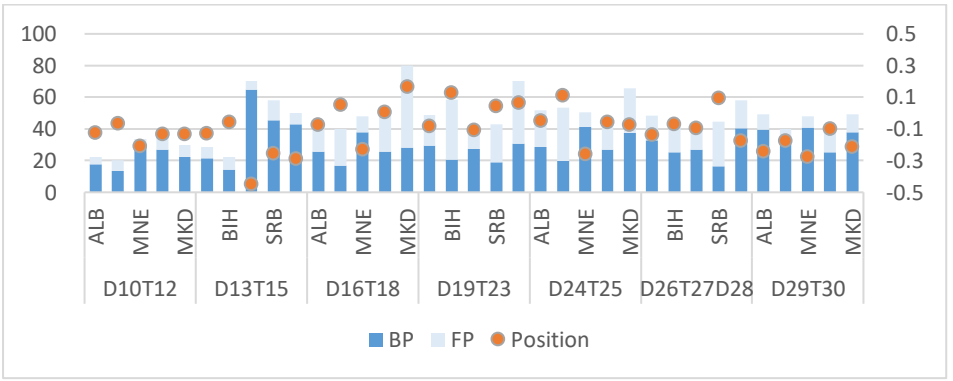
Source: Authors' calculations based on Eora database.

1.3.3.2. Industry level

GVC participation and position of individual CEE-5 countries across industries is analysed in Figures 1.15a and 1.15b for the last available year (2015). The former figure presents GVC participation across industries as a share of industry level gross exports indicating the extent of participation in a particular industry, while the latter one depicts the GVC participation as a portion of total gross export showing the contribution of each industry to the GVC participation of the particular country. Figure 1.15a shows that GVC participation of WB countries is characterised by the dominance of backward linkages across all manufacturing industries, indicating that WB countries highly depend on the upstream foreign suppliers. This is especially true in *Textiles, wearing apparel, leather and related products* (D13T15) and *Transport equipment* (D29T30).

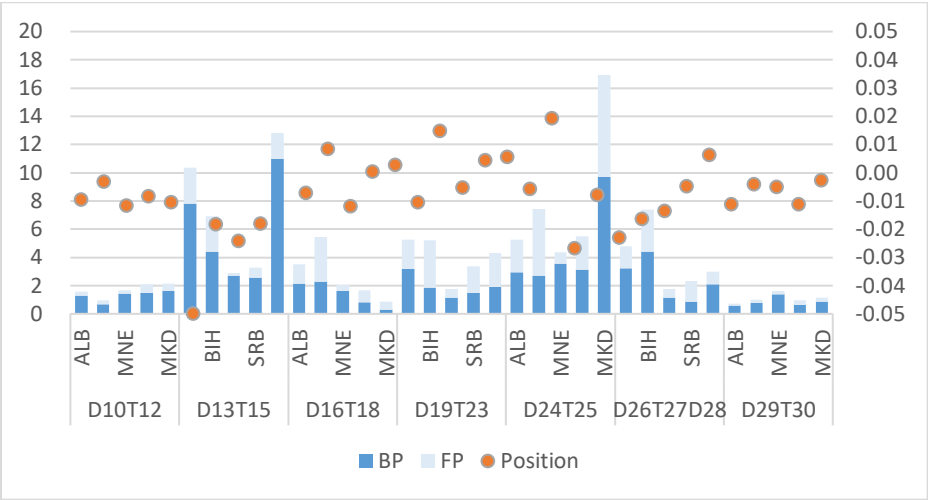
Based on Figure 1.15b we can further conclude that *Textiles, wearing apparel, leather and related products* (D13T15) and *Basic metals and fabricated metal products* (D24T25) are the principal two industries contributing the most to GVC-linked exports in WB countries. Opposite to the group of CEE-11, where textile industry holds marginal contribution to supply chain trade, WB countries are highly integrated in textile GVC; supply chain trade in textiles contributes more than 10% of gross exports in Albania and North Macedonia.

Figure 1.15a: Forward and backward participation (calculated as a share of industry level gross exports) and GVC position for WB countries across selected industries in 2015



Notes: D10T12 (Food products, beverages and tobacco), D13T15 (Textiles, wearing apparel, leather and related products), D16T18 (Wood and paper products; printing), D19T23 (Chemicals and non-metallic mineral products), D24T25 (Basic metals and fabricated metal products), D26T28 (Computers, electronic and electrical equipment & Machinery and equipment, nec), and D29T30 (Transport equipment).
Source: Authors' calculations based on Eora database.

Figure 1.15b: Forward and backward participation (calculated as a share of gross exports) and GVC position for WB countries across selected industries in 2015



Notes: D10T12 (Food products, beverages and tobacco), D13T15 (Textiles, wearing apparel, leather and related products), D16T18 (Wood and paper products; printing), D19T23 (Chemicals and non-metallic mineral products), D24T25 (Basic metals and fabricated metal products), D26T28 (Computers, electronic and electrical equipment & Machinery and equipment, nec), and D29T30 (Transport equipment).
Source: Authors' calculations based on Eora database.

With respect to GVC position, Figures 1.15a and 1.15b show the industry of *Wood and paper products, printing* (D16T18), *Chemicals and non-metallic mineral products* (D19T23) and *Basic metals and fabricated metal products* (D24T25) stand out to be the most upstream ones for WB countries on average in 2015, suggesting the reliance of WB countries on their natural resources in these industries. *Transport equipment* (D29T30) and *Food products, beverages and tobacco* (D10T12) are industries that exhibit the most homogenous position across WB countries, while the

differences are noticeable in other industries. At an industry level, the high upstream position of North Macedonia in *Wood and paper products* (D16T18) and very downstream position of Montenegro in *Textiles, wearing apparel, leather* (D13T15) stand out.

1.4. Network analysis of CEECs' trade in value added

In this section, we outline our methodological approach and present key results from network analysis of CEECs' position in European and global trade networks by employing a social network analysis approach (see Wasserman & Faust, 1994) using a special software UCINET VI for analysis of network data (Borgatti, Everett & Freeman, 2002) and the NetDraw network visualization module. After a brief summary of the key aspects of social network analysis as a distinction methodological field, we continue with presenting key centrality data for CEECs. This is followed by a core-periphery analysis of European and global trade networks and a calculation of coreness indices for each CEEC. Recognising the importance of GVC integration for the CEE trade performance we carry out network analysis on trade in value added data (TiVA dataset already described in the previous section). Trying to capture core-periphery dynamics, we analyse our data for three 5-year intervals between 2005 and 2015 (e.g. 2005, 2010 and 2015). In presenting the key results of our network analysis, it is important to underscore the explorative nature of social network analysis and managing the "burden on the reader" in presenting results across 8 selected industries for 3 different time period.

1.4.1. Network methodology

A network can most simply be defined as a graph with some additional information about the vertices (units of observation), and the ties (links) between them; or mathematically as (Wasserman & Faust, 1994):

- A set of vertices (actors): $U = \{u_1, u_2, \dots, u_n\}$
- A set of ties (relationships) between vertices: $R = \{r_1, r_2, \dots, r_m\}$

- And where a network can be operationalised as: $N = (U, R)$

It is as this point important to emphasize that the field of social network analysis emerged from social science research, in particular sociometry (Freeman, 2004), and the study of human relations within small groups (Wasserman & Faust, 1994). Hence, as a methodology, social network analysis has emerged mostly to capture binary types of relations between actors in a network. Opsahl, Agneessens & Skvoretz (2010, p. 245) emphasize how "most social net-work measures are solely defined for binary situations and, thus, unable to deal with weighted networks directly". In this context, a weighted or valued network is a network where the relational tie may have different values (has a different weight) – for example, trade flow between two countries. In network terms, this can be operationalised mathematically as (Wasserman & Faust, 1994):

- A real-valued $n \times n$ adjacency matrix w, where w_{ij} corresponds to the (possibly weighted and/or directed) tie between i and j
- Where in case of the directed network $w_{ij} \neq w_{ji}$ (and $w_{ij} = w_{ji}$ for the undirected network)
- And where a weighted network can be operationalised simply as: $N = (U, W)$.

1.4.1.1. Network centrality measures

As we have already mentioned, the concept of centrality relates to the various positions of actors (in our case countries) in a network (global or European trade network) and the corresponding roles of those actors in such networks given their structural position and specific relational ties. In many ways, centrality can be thought of as an actor's level of embeddedness within a network (Granovetter, 1985). The idea of centrality, operationalised in a series of different centrality measures by Freeman (1978), has evolved from the study of communication patterns within social groups in the 1940s, political integrations in the 1950s and innovation diffusion patterns in the 1970s (Freeman, 1978).

In social network analysis, Freeman (1978) established and popularised the concept of centrality by introducing three particularly important and distinct concepts of centrality, which have since then become the building blocks of network analysis (Wasserman & Faust, 1994). However, they have only quite recently (Opsahl, Agneessens & Skvoretz, 2010) been also extended to weighted (valued) networks.

Three key node centrality measures by Freeman (1978):

- **Degree centrality**: relates to the so-called "involvement" of a node (actor) in a network. In binary networks, this corresponds to the number of direct ties (adjacencies) to other nodes in a network. If the network is directed (meaning the direction of a tie is relevant – i.e. giving advice or asking for advice) this concept splits into the concepts of in-degree centrality and out-degree centrality. The biggest disadvantage of this measure is that it takes into account only the immediate network structure of a given node and not the so-called global network structure (Wasserman & Faust, 1994).
- **Closeness centrality**: addresses the underlying limitation of degree centrality and takes into account the whole (global) network. Despite its name, it is actually a measure of the distance of a given node to all other nodes in a network, as it is operationalised as the inverse sum of the shortest (geodesic) distance to all other nodes from a given node (Wasserman & Faust, 1994). Closeness centrality is the reciprocal of the node's farness from all other nodes (Perez & Germon, 2016). Thus, a high closeness centrality score implies the node (actor) is actually far away from all other nodes in a network. The limitation of this important centrality measure is that it does not appropriately underscore if a given node (actor) occupies a uniquely valuable structural position.
- **Betweenness centrality**: Relates to the unique position of a node (actor) and thus its ability to exert control, since it lies on the shortest (only) path between two or more nodes in a network.

While several other measures of centrality have been subsequently developed, the three above presented measures of centrality conceptualised by Freeman (1978) represent the backbone of social network analysis and have, thus, been also included in our analysis. Table 1.6 below summarises the three weighted centrality measures we employed in our analysis, as developed by Opsahl, Agneessens and Skvoretz (2010).

Table 1.6: Overview of employed centrality measures for weighted networks

Centrality measure	Description	Weighted centrality measure operationalisation	Comment
Degree	The number of vertices to which a particular focal vertex is connected to (Freeman, 1978).	$C_D^{w\alpha}(i) = k_i \times \left(\frac{s_i}{k_i}\right)^{\alpha} = k_i^{(1-\alpha)} \times$ Where: *i* corresponds to the focal vertex; *j* corresponds to all other vertices; *N* corresponds to the total number of network vertices; *x* corresponds to the adjacency matrix; *w* corresponds to the weighted adjacency matrix; and α corresponds to the positive tuning parameter (in our analysis α=1).	This weighted centrality measure corresponds to the number of ties k_i to other vertices from a given focal vertex, multiplied by the *"average weight"* of ties over these vertices, and adjusted by a *"tuning parameter"* (Opsahl, Agneessens & Skvoretz, 2010).
Closeness	Inverse sum of geodesic (shortest path) distances to all remaining vertices from a particular vertex (Opsahl, Agneessens & Skvoretz, 2010).	$C_C^{w\alpha}(i) = \left[\sum_j^N d^{w\alpha}(i,j)\right]^{-1}$	Opsahl, Agneessens & Skvoretz (2010, p. 247) summarise Freeman's (1978) concepts of *closeness* and *betweenness* centrality as being based on the *"identification and length of shortest paths"* among network vertices. In the case of weighted networks the following formula is used to calculate geodesic distance: $d^{w\alpha}(i,j) = \min\left(\frac{1}{(w_{ih})^{\alpha}} + \ldots + \frac{1}{(w_{hj})^{\alpha}}\right)$
Betweeness	Degree of unique geodesic distances, where one focal vertex lies on the geodesic distance between two other nodes and is able to 'control' the flow (Opsahl, Agneessens & Skvoretz, 2010).	$C_B^{w\alpha}(i) = \frac{g_{jk}^{w\alpha}(i)}{g_{jk}^{w\alpha}}$ Where: g_{jk} corresponds to the number binary geodesic distances between two vertices; and g_{jk} *(i)* is the total number of g_{jk} through vertex *i*	

1.4.1.2. Core-periphery analysis

The general idea behind the core-periphery analysis in social network analysis is linked to the general idea of identification of boundaries of a network, as well as within a network (between various parts of a network). Most intuitively, a network "core" corresponds to a cohesive (densely) connected subgraph (Doreian & Woodard, 1994). The notion of a core-periphery structure in its most basic conception, corresponds to a simple blockmodel as a type of positional-role analysis (Faust & Wasserman, 1992), where the core corresponds to a 1-block (ties between actors) and the periphery as a 0-block (no ties between actors) (Borgatti & Everett, 1999). The positional aspect of this simple blockmodel implies that actors within the core 1-block have a (similar) relationship (tie) with others in the block, while the role aspect relates to the underlying system of relations (coreness) (Faust & Wasserman, 1992). The underlying assumption behind this simple discrete blockmodel is that there is also a semi-periphery corresponding to a core-periphery region or an imperfect 1-block (Borgatti & Everett, 1999).

Mathematically, this can be operationalised as follows for a discrete (binary) network (Borgatti & Everett, 1999):

$$\rho = \sum_{i,j} a_{ij}\delta_{ij}$$

$$\delta_{ij} = \begin{Bmatrix} 1 \text{ if } c_i = \text{CORE or } c_j = \text{CORE} \\ 0 \text{ otherwise} \end{Bmatrix}$$

Where:

- a_{ij} corresponds to a presence or absence of a tie in observed data,
- c_i relates to the corresponding class (core or periphery) an actor i gets assigned to,
- δ_{ij} (pattern matrix) indicates the presence or absence of a tie in the ideal image,

- ρ is 1 when A (the matrix a_{ij}) and Δ (the matrix of δ_{ij}) are identical (when A has a perfect core-periphery structure).

As summarised by Borgatti and Everett (1999, p. 379): "A network exhibits a core/periphery structure to the extent that the correlation between the ideal structure and the data is large" which implies a high ρ value.

The continuous model approach to core-periphery analysis abandons a three-block discrete approach of core, semi-periphery and periphery for a continuous approach where each node is assigned a so-called coreness measure. According to Borgatti and Everett (1999, p. 387): "In a Euclidean representation, this would correspond to distance from the centroid of a single point cloud. If we assume that the network data consist of continuous values representing strengths or capacities of relationships, an obvious approach is to continue using correlation to evaluate fit but define the structure matrix" as: $\delta_{ij} = c_i c_j$, where C corresponds to a non-negative value vector of coreness degrees of each node. For more details, please refer to Borgatti and Everett (1999, p. 379). In our analyses, we calculated the continuous coreness measures within UCINET (Borgatti, Everett & Freeman, 2002) using the Network/Core-periphery/Continuous command.

1.4.2. Data

To discriminate between coreness within European and global trade network we performed core-periphery analysis separately for global trade flows considering a full 64-by-64 country valued matrix from TiVA database and for European trade network only accounting for EU and EFTA member states in a 32-by-32 country valued matrix. All the indices and measurements were performed at the level of the 8 industries, as discussed in the previous chapter for years 2005, 2010 and 2015. Data for the analysis was obtained from the TiVA database. Hence, we were again only able to consider in our analysis eleven CEE countries (excluding countries from the Western Balkans).

We performed a network analysis on the export of the value added data. More specifically, we considered domestic value added embodied in foreign final demand (i.e. *FFD_DVA* data from TiVA database) which captures the value added that industries export both directly, through exports of final goods or services and, indirectly via exports of intermediates that reach foreign final consumers (households, government, and as investment) through other countries. The measure reflects how domestic industries (upstream in a value-chain) are connected to consumers in other countries, even where no direct trade relationship exists. The indicator, therefore, illustrates the full upstream impact of final demand in foreign markets to domestic output. We analyse valued data expressed in 1 million USD units.

1.4.3. Export of value added network analysis

1.4.3.1. Centrality measures

Given a large number of generated measures (8 industries, 3 time period, several types of centrality measures) a full list of all calculated weighted centrality measures for the export of VA is reported in Appendix 2. Below in Table 1.7, we provide just an illustrative example of the export of VA for food products, beverages and tobacco category (D10T12) in 2005.

Table 1.7: Weighted centrality measures for export of VA for food products, beverages and tobacco category (D10T12) in 2005

	2005							
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigen	Betweenness
BGR	164.600	195.300	-30.700	77.000	66.000	0.014	0.005	1.359
CZE	962.500	896.200	66.300	64.000	64.000	0.096	0.044	3.242
EST	96.300	135.600	-39.300	79.000	68.000	0.004	0.004	0.290
HRV	407.900	285.900	122.000	66.000	66.000	0.044	0.012	1.845
HUN	744.100	736.200	7.900	65.000	65.000	0.075	0.040	2.248
LTU	246.900	249.700	-2.800	70.000	67.000	0.015	0.008	1.177
LVA	121.400	186.600	-65.200	74.000	69.000	0.004	0.006	0.688
POL	1765.200	1325.200	440.000	64.000	64.000	0.201	0.056	3.242
ROU	431.600	534.500	-102.900	65.000	65.000	0.039	0.008	2.248

SVK	315.100	479.900	-164.800	66.000	64.000	0.025	0.016	2.597
SVN	137.300	244.700	-107.400	71.000	67.000	0.013	0.012	0.961
CHN	8263.900	5359.800	2904.100	63.000	63.000	-0.508	-0.355	8.018
DEU	12382.400	12788.200	-405.800	63.000	63.000	0.982	0.402	8.018
JAP	3514.000	11202.100	-7688.100	63.000	63.000	-0.277	-0.867	8.018
USA	9853.900	23071.400	-13217.500	63.000	63.000	-0.684	-1.000	8.018

Notes: OutDegree: out-degree (outward) centrality; InDegree: in-degree (inward) centrality; OutClose: out-degree closeness; InClose: in-degree closeness; OutEigen: out-degree eigen vector centrality; InEigen: in-degree eigen vector centrality; Betweenness: betweenness centrality.
Source: Authors' calculations based on TiVA (OECD) database.

Most interestingly, in terms of betweenness centrality (control), we can observe that both Poland and the Czech Republic had the highest betweenness centrality measures (3.242); however, still below the betweenness centrality measures of the four most central countries (USA, China, Japan and Germany). In the second group of CEECs, in terms of betweenness centrality, we can observe Slovakia (2.597), Hungary (2.248) and Romania (2.248). This is followed by a third group of CEECs, including: Croatia (1.845), Bulgaria (1.359) and Lithuania (1.177). The last group of CEECs includes countries with much lower betweenness centrality measures, namely: Slovenia (0.961), Latvia (0.688) and Estonia (0.290). Examining all the weighted centrality measures showcased in Appendix 2, it is evident that CEE-11 countries are more peripheral compared to the largest global traders (e.g. China, USA, Germany and Japan) by all measures.

However, to gauge common characteristics of centrality position of CEE-11 group in different industries and years and general centrality of individual CEECs crosswise industries and years considered in our analysis we proceed with regressing these resulting centrality measures on sets of country, industry and annual dummy variables. The results of the regression decompositions of centrality measures are presented in Table 1.8 with robust standard errors reported in brackets. As seen from the R^2, the country-, industry- and year-specific effects explain a large share, i.e.

between 50% and 83%, of the variability in the dependent variables (various centrality measures).[11]

Interestingly, the regression results from Table 1.8 reveal that in general CEE-11 countries became more central in terms of closeness centrality throughout the 2005-2015 period, as indicated by significantly negative regression coefficients for annual dummies denoting that in year 2010 (and even more so in 2015) the average shortest path length to other nodes in the network decreases; which indicates higher centrality compared to the year 2005. We believe this can at least partly be explained by the accession of the CEECs into the EU. Similarly, the centrality of CEE-11 has increased from 2005 to 2015 in terms of the eigenvector centrality measure which shows a node's importance while giving consideration to the importance of its neighbours. On the contrary, a negative coefficient for the year 2015, although only significant at 10%, in case of betweenness centrality indicates the negative trend in terms of this centrality measure (control, uniqueness). Overall, these results suggest that the influence of CEE-11 economies in global trade network increased in terms of their integration, while they lost some of their importance (uniqueness/control) in terms of the shortest paths through the network during the 2005-2015 period.

The regression results from Table 1.8 show that once we control for annual and industry fixed effects, there is still significant heterogeneity among CEECs in terms of their centrality position according to various centrality measures. Compared to Bulgaria, which is regarded in our regression specifications as the base country, Poland, the Czech Republic, Hungary, Romania, and Slovakia are more central overall, while Estonia and Latvia

[11] The regression analysis is based on data for three selected years (i.e. 2005, 2010 and 2015), the years considered in the network analysis. Preferably, the regression would be based on annual data, but given the GVC participation is highly persistent as found by dynamic analysis reported in sub-chapter 1.3.2.3., the rapid changes in GVC involvement and network positions are not likely, so the major trends should be traced as well based on the five year interval data.

exhibit a more peripheral position in the global trade network across all centrality measures. Also, Lithuania tends to be more peripheral in terms of inward closeness and eigenvector centralities but not with respect to betweenness centrality. This shows that while Lithuania has relatively and structurally speaking, been somewhat left behind in the integration, it has managed to main its relative unique position (betweenness centrality). Croatia doesn't differ significantly from Bulgaria with respect to most of the centrality measures, while Slovenia occupies a more central position in terms of outward closeness and eigenvector centralities but less central according to betweenness centrality.

Table 1.8: Country, industry and year fixed effects of CEE centrality measures *(base country BGR, base industry Food products, beverages and tobacco - D10T12, base year 2005)*

VARIABLES	(1) OutClose	(2) InClose	(3 OutEigen	(4) InEigen	(5) Betweennes s
Country dummies					
CZE	-3.625***	-3.292***	0.180***	0.098***	2.418***
	[1.019]	[0.623]	[0.016]	[0.006]	[0.416]
EST	3.083**	3.917***	-0.015**	-0.022***	-1.005***
	[1.378]	[0.774]	[0.007]	[0.004]	[0.307]
HRV	-0.125	1.083*	0.000	-0.001	-0.550*
	[0.944]	[0.565]	[0.008]	[0.005]	[0.302]
HUN	-3.292***	-2.000***	0.102***	0.071***	1.560***
	[1.021]	[0.529]	[0.014]	[0.006]	[0.292]
LTU	0.583	1.750***	-0.006	-0.011***	-0.174
	[1.046]	[0.587]	[0.007]	[0.004]	[0.307]
LVA	7.333***	4.125***	-0.015**	-0.020***	-1.097***
	[2.088]	[0.730]	[0.007]	[0.005]	[0.324]
POL	-3.833***	-4.083***	0.247***	0.210***	3.563***
	[0.998]	[0.724]	[0.025]	[0.016]	[0.572]
ROU	-3.458***	-2.125***	0.089***	0.078***	1.671***
	[0.991]	[0.557]	[0.022]	[0.007]	[0.297]
SVK	-2.708***	-2.458***	0.054***	0.022***	1.775***
	[1.014]	[0.572]	[0.008]	[0.003]	[0.520]

SVN	-1.875*	1.500***	0.014**	-0.001	-0.430*
	[0.993]	[0.512]	[0.007]	[0.004]	[0.256]
Industry dummies					
D13T15	0.697	4.061***	0.027	-0.011	1.674***
	[0.672]	[0.460]	[0.018]	[0.010]	[0.264]
D16T18	-1.667**	3.970***	0.048***	0.018**	0.948***
	[0.802]	[0.494]	[0.016]	[0.008]	[0.220]
D19T23	-2.909***	-0.758	0.015	0.040***	-0.573**
	[0.755]	[0.481]	[0.010]	[0.009]	[0.289]
D26T27	-0.515	4.485***	0.032**	0.027***	1.399***
	[0.860]	[0.433]	[0.013]	[0.008]	[0.234]
D28	2.182*	7.030***	0.001	0.036***	2.410***
	[1.119]	[0.611]	[0.011]	[0.008]	[0.349]
D29T30	3.242**	10.515***	0.026**	-0.004	2.576***
	[1.298]	[0.561]	[0.012]	[0.008]	[0.559]
D41T98	-3.697***	-2.091***	0.027**	0.014*	-1.199***
	[0.867]	[0.590]	[0.011]	[0.007]	[0.332]
Year dummies					
2010	-2.045***	-0.420	0.025***	0.012**	-0.281
	[0.684]	[0.334]	[0.008]	[0.005]	[0.231]
2015	-2.727***	-0.807**	0.029***	0.025***	-0.433*
	[0.661]	[0.334]	[0.009]	[0.005]	[0.223]
Constant	69.008***	65.674***	-0.015	0.006	0.745***
	[1.199]	[0.513]	[0.011]	[0.008]	[0.283]
Observations	264	264	264	264	264
R-squared	0.531	0.830	0.703	0.845	0.639
Adj R-Squared	0.495	0.817	0.680	0.833	0.611

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Regarding the overall CEE-11 region centrality across different industries, Out-Closeness centrality is highest in the *Wood and paper products, Chemicals and non-metallic mineral products, basic metals and fabricated metal products* and *total services*. In-Closeness tops in *total services*. Interestingly, the industries with highest GVC participation and most upstream position, i.e. *Machinery and equipment* and *Transport equipment,* tend to be least central in terms of closeness centrality, but most central in terms of betweenness and eigenvector centralities. This suggests

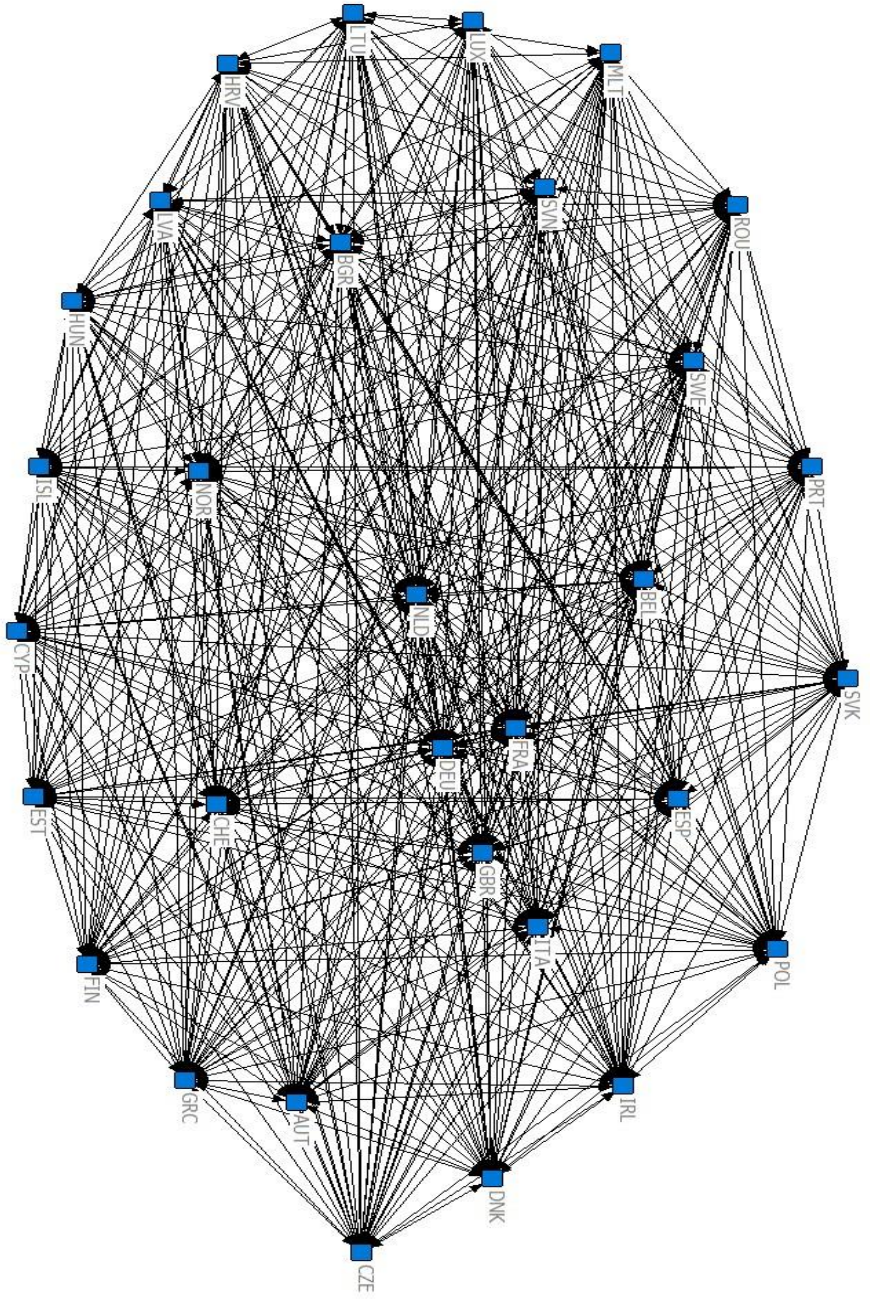
that the path from CEE-11 to other nodes in the network is not the shortest one, but it seems to be relatively important (bottleneck) for the shortest paths through the network in these two industries. On the other hand, betweenness centrality is lowest for the *Chemicals and non-metallic mineral products, basic metals and fabricated metal products* and *total services*.

1.4.3.2. Core-periphery analysis

As an illustration, Figure 1.16 provides an illustrative visualization of the EU trade networks for exports of food products, beverages and tobacco based on value added for 2005 based on metric multidimensional scaling of valued data (based on similarities). This industry has been selected since it enters as the base industry in the regression analysis further in the study. The NetDraw algorithm employs a circular visualization algorithm, where more "core" countries are depicted closer to the centre and more "peripheral" countries are depicted further away from the centre.

As we can, for example, see from the 32-country European network, in general CEE-11 countries are located on the rim of the network circle. However, Bulgaria and Slovenia appear to be relatively closest to the centre of the circle and the "core" of Western European countries of Germany and France, as well as the UK and Netherlands.

Figure 1.16: Illustrative visualization of the EU trade network based on metric multidimensional scaling of valued data (similarities) for exports of food products, beverages and tobacco (D10T12) based on value added for 2005 (done in NetDraw)

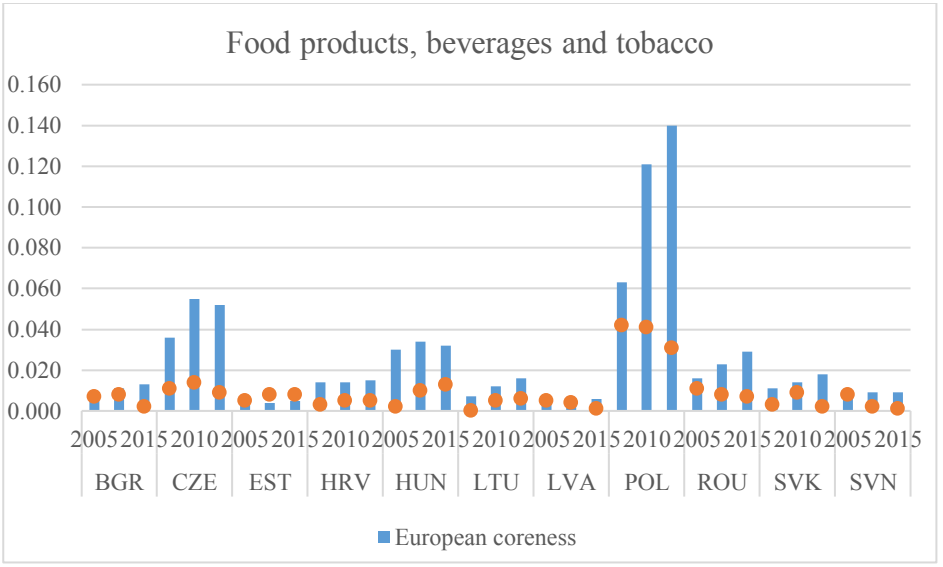


Source: Authors' calculations based on TiVA (OECD) database.

Based on core-periphery analysis we obtain continuous coreness measures both in the European and global trade network for the CEE-11 countries across eight industry groups considered. They are graphically depicted in Figures 1.17 (a-h). As we can, for example, see within the first graph for the food products, beverages and tobacco industry (D10T12) Poland had by far the highest relative coreness scores, particularly in the European network. For example, in 2005 its coreness score corresponding to the European network was 0.063 and 0.042 in the global network. In that year, Germany's coreness score was highest in the European network (0.562) and the USA had the highest coreness score (0.622) in the global network. By 2015, Poland's coreness score increased to 0.140 in the European network (Germany: 0.571) and actually fell to 0.031 in the global network (USA: 0.708).

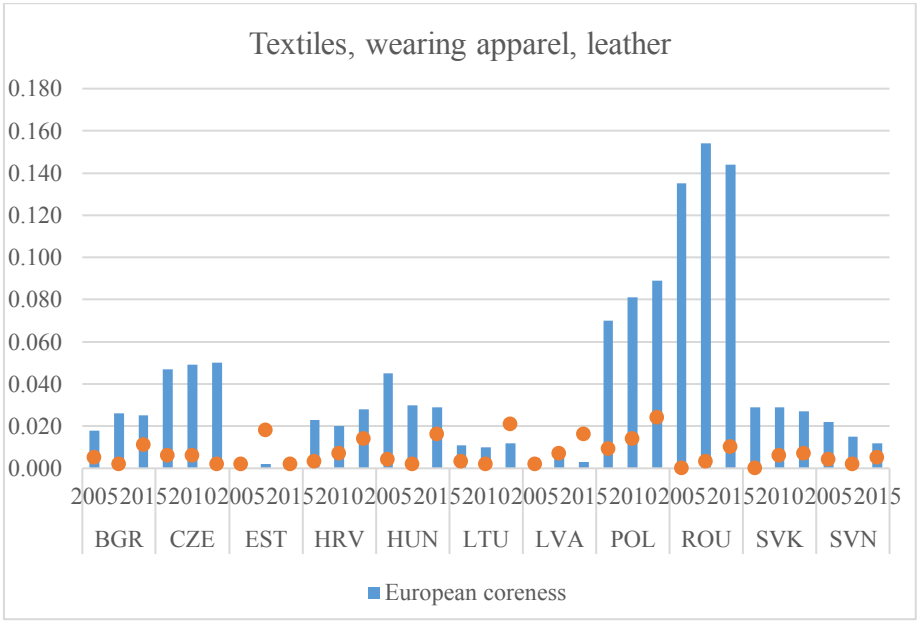
Looking at the textiles, wearing apparel and leather industry, we can see Romania and Poland display much higher coreness scores than the rest of the group. For example, Romania's coreness score within the European network was 0.135 in 2005 (Italy: 0.705) and highest in 2010 with 0.154 (Italy: 0.726), while decreasing to 0.144 in 2015 (Italy: 0.715). In terms of the global network, all CEECs displayed very low coreness measures in 2005, 2010 and 2015.

Figure 1.17a: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015
（see next page）



Source: Authors' calculations based on TiVA (OECD) database.

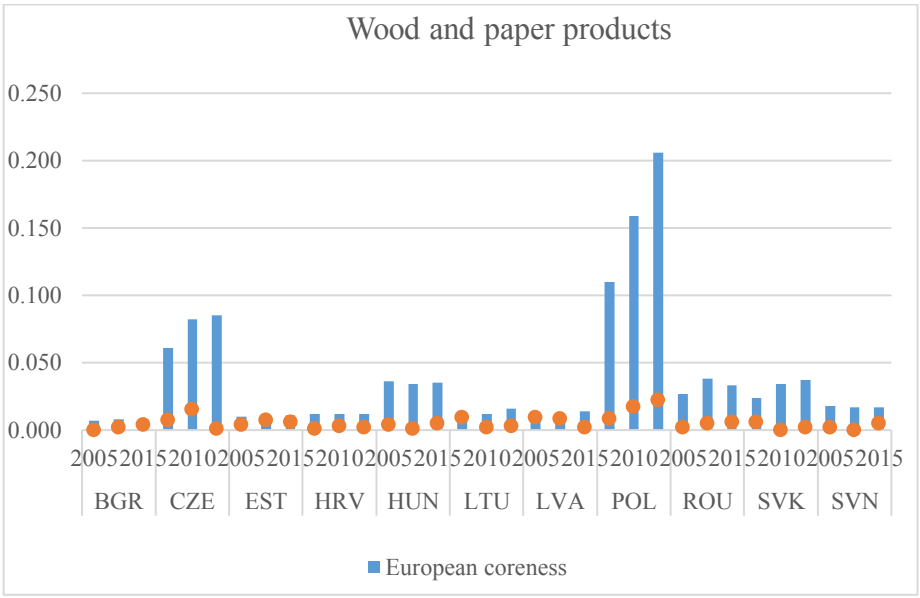
Figure 1.17b: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



Source: Authors' calculations based on TiVA (OECD) database.

A similar picture can be seen for the wood and paper products' industry, where coreness scores of CEECs were very low in terms of the global network. In terms of the European network, Poland and the Czech Republic had much higher relative coreness scores than the rest of the CEECs. For example, Poland's coreness score within the European network was 0.110 in 2005 (Germany: 0.661) and increased to 0.206 in 2015 (Germany: 0.743).

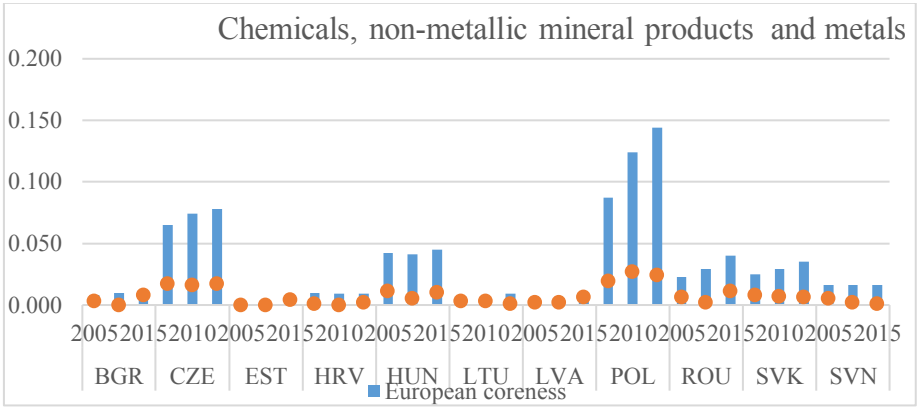
Figure 1.17c: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



Source: Authors' calculations based on TiVA (OECD) database.

With regards to the chemicals, non-metallic mineral products and metals' industry, a similar picture can be observed as for the wood and paper products' industry beforehand. Poland, the Czech Republic and Hungary display much higher relative coreness scores than the rest. For example, Poland's coreness score within the European network was 0.087 in 2005 (Germany: 0.657) and increased to 0.144 by 2015 (Germany: 0.717). In terms of the global network, Poland's coreness went from 0.019 in 2005 (USA: 0.779) to 0.024 by 2015 (USA: 0.662).

Figure 1.17d: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015

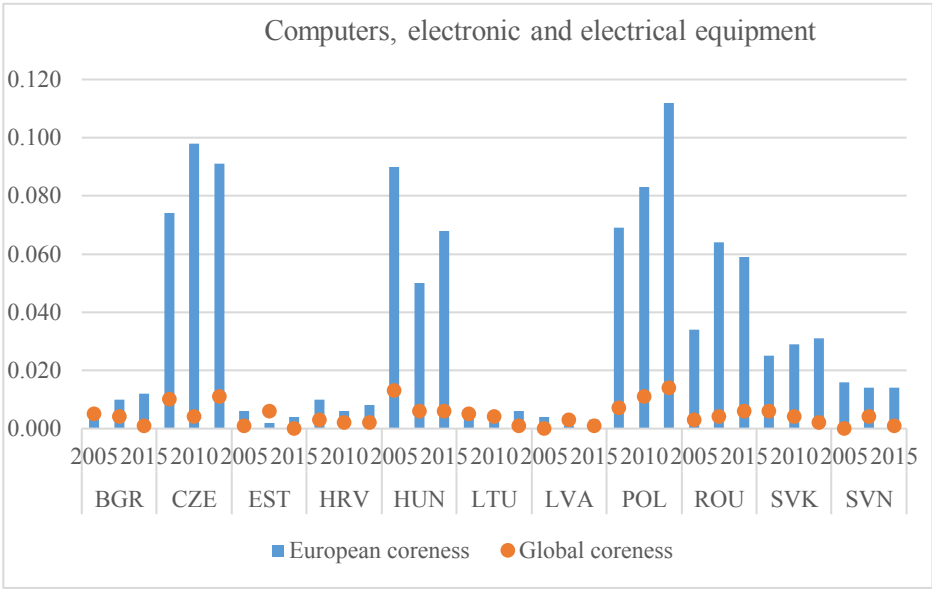


Source: Authors' calculations based on TiVA (OECD) database.

A particularly relevant industry is the computers, electronics and electrical equipment industry, where several CEE-11 countries display higher coreness scores, but mostly within the European network. For example, the Czech Republic's coreness score was 0.074 and Poland's 0.069 in 2005 in the European network (Germany: 0.610). By 2015, their coreness scores were 0.112 for Poland and 0.091 for the Czech Republic (Germany: 0.793). In the global network, however, both countries had relatively small coreness scores. However, it is worth pointing out that while Poland managed to double its global-network coreness score from 0.007 to 0.014 between 2005 and 2015 (USA: 0.705 in 2005, China: 0.771 in 2015), the Czech Republic's coreness score remained relatively unchanged (2005: 0.010; 2015: 0.011).

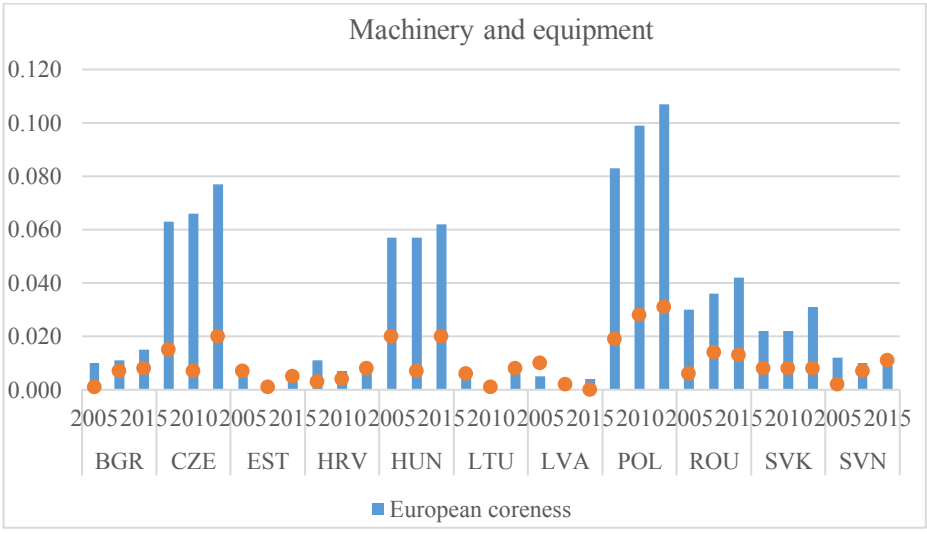
Turning next to machinery and equipment, we can observe an almost identical picture, but with somewhat higher coreness scores in terms of the global network. For example, Poland's coreness score was 0.083 in 2005 in the European network (Germany" 0.786) and 0.019 in the global network (USA: 0.699). By 2015, Poland's coreness score increased to 0.107 in the European network (Germany: 0.849) and 0.031 (China: 0.629) in the global network.

Figure 1.17e: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



Source: Authors' calculations based on TiVA (OECD) database.

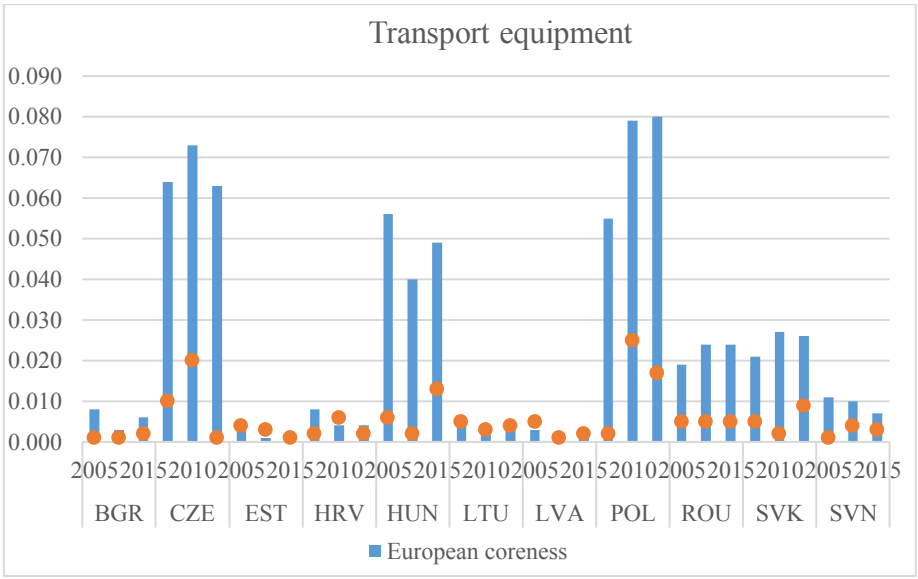
Figure 1.17f: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



Source: Authors' calculations based on TiVA (OECD) database.

While the coreness structure was quite similar also for the transport equipment industry, it must be noted that Poland managed to, at least in relative terms, substantially increase its coreness scores within the global network. For example, its coreness score within the global network went from 0.002 in 2005 (USA: 0.911) to 0.017 in 2015 (USA: 0.858).

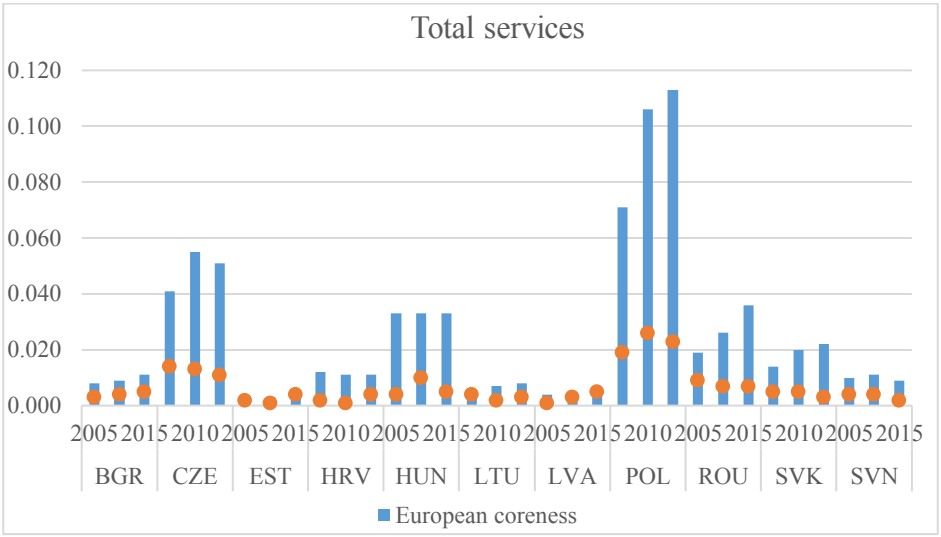
Figure 1.17g: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



Source: Authors' calculations based on TiVA (OECD) database.

Lastly, in terms of total services' industry, Poland display by far the highest coreness scores, both in the European and global networks. For example, its coreness within the European network was 0.071 in 2005 (Germany: 0.543) and rose to 0.113 by 2015 (Germany: 0.579). In the global network, Poland's coreness went from 0.019 in 2005 (USA: 0.829) to 0.023 by 2015 (USA: 0.815).

Figure 1.17h: Continuous coreness measures in European and global trade in VA network for CEE-11 by industries in 2005, 2010, 2015



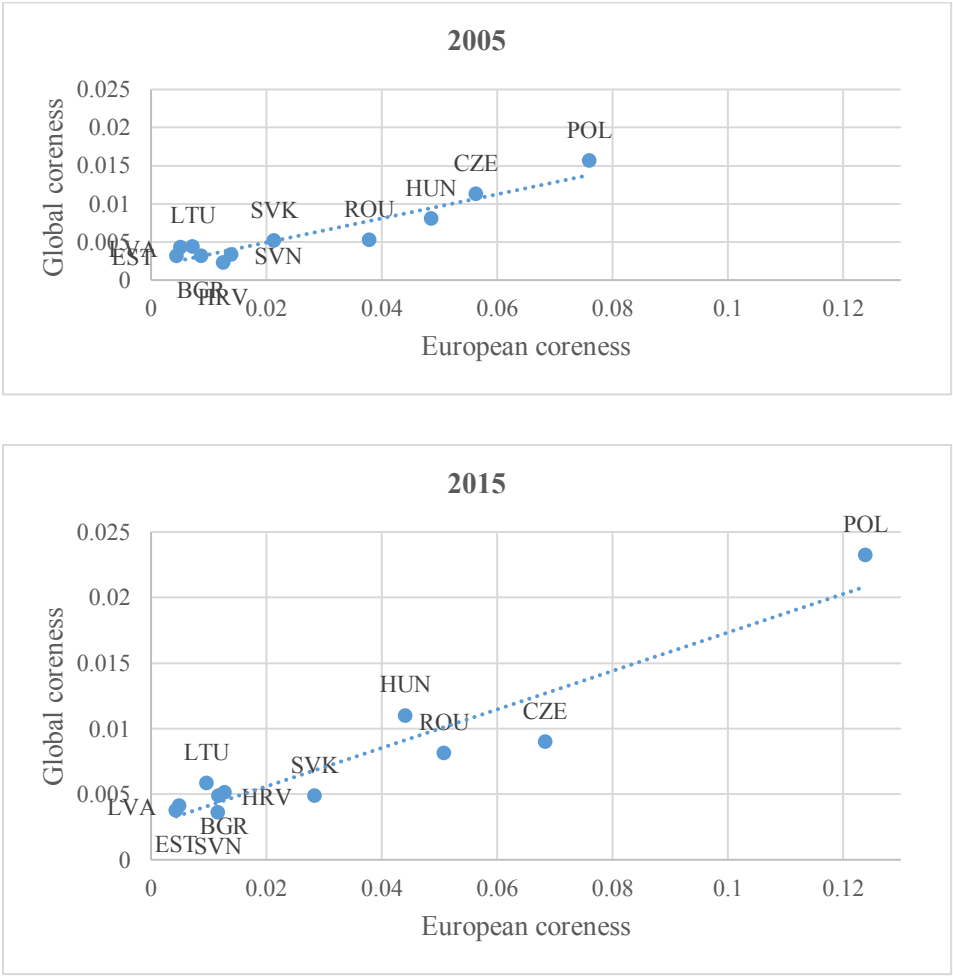
Source: Authors' calculations based on TiVA (OECD) database.

Based on averaging the coreness results across the industries considered, Figure 1.18 plots CEE-11 countries' coreness in European and global trade networks. Table 1.9 further categorises the CEECs based on calculated continuous coreness and European orientation (i.e. ratio of European to global coreness) in 2015, while Table 1.10 illustrates shifts of CEE-11 in global and European coreness between 2005 and 2015. It is evident from Figure 1.18 and Table 1.9, that Poland, the Czech Republic, Hungary and Romania represent the core CEECs both in the European and global trade networks, while the rest of CEE-11 are much more peripheral. However, they differ to some extent with respect to the relative coreness in European versus global trade networks. For example, the Czech Republic, Romania, Slovakia and Slovenia are among the CEE countries displaying the highest European orientation in the sense that their ratio between European and global coreness is amongst the highest at the end of the period considered.

According to Figure 1.18 and Table 1.10, Poland gained the most among CEE-11 both in terms of European and global coreness during the 2005-2015 period. The shift towards the centre in global and European trade networks could be observed as well for the Bulgaria, Lithuania and

Romania. On the other hand, Latvia was the only CEE-11 country that moved towards the periphery both in European and global networks between 2005 and 2015. The remaining CEECs either increased their European or global coreness. On the one hand, Estonia, Croatia, Hungary and Slovenia moved towards global centre whilst headed towards European periphery suggesting their increased global diversification. The opposite was the case for the Czech Republic and Slovakia that, as it seems, further increased its reliance on the European trade network.

Figure 1.18: European and global coreness for CEE-11 (average across industries) in 2005 and 2015



Source: Authors' calculations based on TiVA (OECD) database.

Next, we estimated country, industry and year fixed effects of the CEE-11's coreness measures in the same manner as above for the centrality measures. This time we ran our regression analyses for three alternative dependent variables, i.e. European coreness, global coreness and the ratio of European vs global coreness. The explanatory power of the country, industry and yearly dummy variables is again high in both the European and global coreness specification with R^2 as high as 76% and 56%, respectively. On the other hand, the variability of relative European coreness is much more modestly explained with R^2 below 20%. The results of the regression decomposition are presented in Table 1.11.

Table 1.9: CEE-11 categorisation based on coreness and European orientation (i.e. ratio of EU to global coreness) in 2015

EUROPEAN ORIENTATION / CORENESS	Above average European orientation	Below average European orientation
Relatively central (above CEE-11 average)	**CZE, ROU**	**HUN, POL**
Relatively peripheral (below CEE-11 average)	**SVK, SVN**	**BGR, EST, HRV, LTU, LVA**

Source: Authors' calculations based on TiVA (OECD) database.

Table 1.10: Global and European coreness shifts of CEE-11 between the year 2005 and 2015

EUROPEAN CORENESS / GLOBAL CORENESS	Towards European centre	Towards European periphery
Towards global centre	**BGR, LTU, POL, ROU**	**EST, HRV, HUN, SVN**
Towards global periphery	**CZE, SVK**	**LVA**

Source: Authors' calculations based on TiVA (OECD) database.

The regression results from Table 1.11 confirm that Poland, the Czech Republic, Hungary and Romania have the highest coreness within the European and global networks (and to some extent also Slovakia within the European trade network). On the other hand, the three Baltic countries tend to be most peripheral, especially in the European network context. European coreness ranking for CEE-11 based on country fixed effects is illustrated in Figure 1.19. Overall, the group of CEE-11 increased its coreness from 2005 to 2015, both globally and Europe-wise. However, no significant changes are found for the European orientation. This is in line with our previous observations that CEECs experienced rather different trends with respect to European versus global coreness throughout our observation period. In comparison to Bulgaria, the Czech Republic, Hungary, Poland, Slovakia and Romania tend to have significantly higher relative European orientation. At the industry level, relatively strong European orientation is detected in *Textiles, wearing apparel, leather and related products* (D13T15), *Wood and paper* products (D16T18) and *Computers, electronic and electrical equipment* (D26T27).

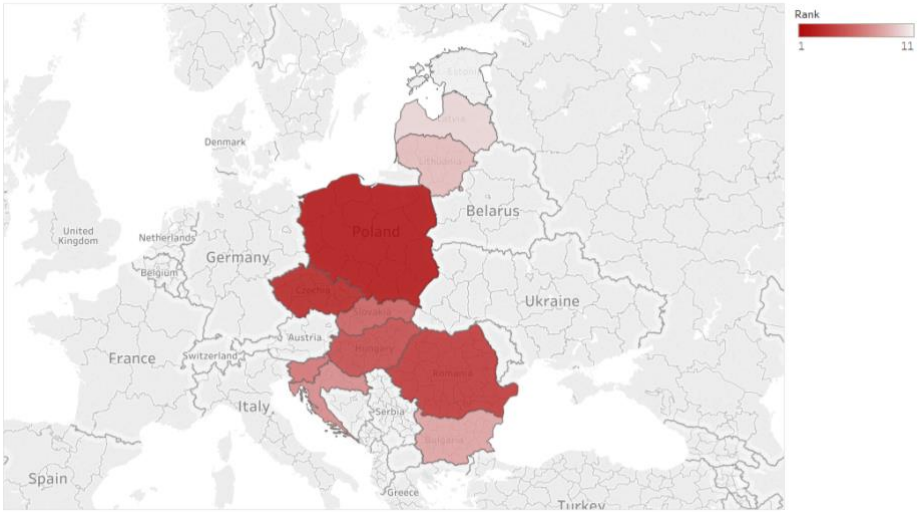
Table 1.11: Global vs EU coreness of CEE-11 - country, industry and year fixed effects (*base country BGR, base industry Food products, beverages and tobacco - D10T12, base year 2005*)

VARIABLES	(1) Global coreness	(2) European coreness	(3) relative European coreness
Country dummies			
CZE	0.007***	0.054***	8.763**
	[0.001]	[0.003]	[3.975]
EST	0.000	-0.007***	-2.752***
	[0.001]	[0.002]	[1.046]
HRV	-0.000	0.001	0.307
	[0.001]	[0.002]	[1.180]
HUN	0.004***	0.033***	4.541***
	[0.001]	[0.004]	[1.584]
LTU	0.000	-0.003*	-1.474
	[0.001]	[0.002]	[1.049]
LVA	0.000	-0.006***	-2.392**
	[0.001]	[0.002]	[1.055]

POL	0.017***	0.091***	2.514*
	[0.002]	[0.007]	[1.328]
ROU	0.003***	0.035***	4.419*
	[0.001]	[0.008]	[2.293]
SVK	0.001	0.014***	2.015*
	[0.001]	[0.001]	[1.172]
SVN	-0.001	0.002	1.600
	[0.001]	[0.002]	[1.264]
Industry dummies			
D13T15	-0.002	0.013**	3.808**
	[0.002]	[0.006]	[1.774]
D16T18	-0.004***	0.012***	6.466**
	[0.001]	[0.004]	[2.684]
D19T23	-0.002*	0.006**	1.117
	[0.001]	[0.003]	[1.058]
D26T27	-0.004***	0.008**	3.509***
	[0.001]	[0.003]	[1.008]
D28	0.001	0.005*	-0.371
	[0.001]	[0.003]	[0.867]
D29T30	-0.004***	-0.002	3.226
	[0.001]	[0.003]	[1.974]
D41T98	-0.002**	-0.001	0.304
	[0.001]	[0.003]	[0.891]
Year dummies			
2010	0.001	0.004*	0.694
	[0.001]	[0.002]	[0.870]
2015	0.002**	0.007***	1.508
	[0.001]	[0.003]	[1.230]
Constant	0.005***	0.002	1.108
	[0.001]	[0.003]	[1.362]
Observations	264	264	250
R-squared	0.595	0.778	0.230
Adj R-Squared	0.563	0.760	0.166

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Figure 1.19: European coreness ranking for CEE-11 based on country fixed effects from regression in Table 1.10 (Column 2)



Source: Authors' calculations based on TiVA (OECD) database.

1.5. Relation between GVC position and centrality

As argued by Antràs & De Gortari (2017) the countries' centrality location and the position along the GVC are interrelated. Their model predicts that relatively more central countries will tend to gain comparative advantage and specialise in relatively downstream stages. To test whether this regularity holds for the CEE-11 we estimated a regression model, in which upstreamness was measured by GVC position index (dependent variable) and explained by geographical centrality at the industry level, controlling for time, industry, county and country-year dummy variables:

$$Upstreamness_{ikt} = \beta_0 + \beta_1 Centrality_{ikt-1} + \sum \beta_{2.i} d\_country_i + \sum \beta_{3.j} d\_industry_k + \sum \beta_{4.t} d\_year_t + \\ + \sum \beta_{5.it} d\_cntry\_year_{it} + u_{ikt} \qquad (1)$$

Following the approach in Antràs & De Gortari (2017) we define centrality in terms of proximity to other countries with large production in particular

industry *k*. We compute centrality for each country *i* in industry *k* in selected year *t* (t = {2004, 2009, 2014}) in the following manner:

$$Centrality_{ikt} = \sum_{jkt} \frac{GDP_{jkt}}{Dist_{ij}} \quad (2)$$

We measure centrality within Europe, hence *j* accounts for the EU-28, EFTA and WB-5 countries. We use distances from the CEPII's GeoDist Database (see Mayer & Zignago, 2011), while the industry level GDP is taken from Eurostat (2019). Centrality positions across industries are shown in Appendix 3. This is the reduced-form approach which doesn't allow us to make inference on the causality but rather tests the correlation. Based on the results presented in Table 1.12, we can, in general, confirm the hypothesis that the more central a particular country is, the lower is the average upstreamness of this country in GVCs. However, the results are not fully robust once we include country-fixed effects.

Table 1.12: Regression analysis of GVC position (upstreamness) as a function of geographical centrality of industrial production for the CEE-11 in years 2005, 2010, 2015

	(1) GVC position TiVA	(2) GVC position TiVA	(3) GVC position TiVA	(4) GVC position TiVA	(5) GVC position TiVA	(6) GVC position Eora
lnCentrality_prod(-1)	-0.009**	-0.009**	-0.197***	-0.094	-0.103	-0.172*
	[0.004]	[0.004]	[0.027]	[0.067]	[0.067]	[0.099]
Constant	-0.015	-0.015	1.023***	0.442	0.511	1.382***
	[0.029]	[0.033]	[0.155]	[0.356]	[0.364]	[0.497]
Year dummies	no	yes	yes	yes	yes	yes
Industry dummies	no	no	yes	yes	yes	yes
Country dummies	no	no	no	yes	yes	yes
Country-year dummies	no	no	no	no	yes	yes
Observations	264	264	264	264	264	231

R-squared	0.006	0.006	0.356	0.476	0.492	0.547
Adj R-Squared	0.00241	-0.00519	0.331	0.433	0.401	0.454

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table 1.13: Regression analysis of upstreamness position as a function of trade centrality measures for the CEE-11 in years 2005, 2010, 2015

	(1) GVC position TiVA	(2) GVC position TiVA	(3) GVC position TiVA	(4) GVC position TiVA	(5) GVC position TiVA	(6) GVC position TiVA	(7) GVC position TiVA
OutClose	0.011***						
	[0.003]						
InClose		0.012***					
		[0.003]					
OutEigen			-0.558***				
			[0.132]				
InEigen				-0.420**			
				[0.210]			
Betweenness					-0.021***		
					[0.005]		
Coreness						-2.219	
						[1.448]	
European Coreness							-1.313***
							[0.395]
Constant	-	-	-0.021	-0.014	-0.001	-0.006	-0.013

	0.745***	0.775***					
	[0.235]	[0.243]	[0.070]	[0.073]	[0.073]	[0.074]	[0.072]
Year dummies	yes	yes	yes	yes	yes	yes	yes
Industry dumm.	yes	yes	yes	yes	yes	yes	yes
Country dumm.	yes	yes	yes	yes	yes	yes	yes
Country-year dumm.	yes	yes	yes	yes	yes	yes	yes
Observations	264	264	264	264	264	264	264
R-squared	0.510	0.511	0.521	0.493	0.524	0.491	0.503
Adj R-Squared	0.423	0.424	0.436	0.402	0.439	0.400	0.414

Notes: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Further, we test the centrality-downstreamness nexus also based on different centrality and coreness measures in trade in value added from the network analysis and report the results in Table 1.13. The results from Table 1.13 confirm for all but global coreness a strong and statistically significant relation between downstream GVC position and centrality in terms of closeness, eigenvector centrality, betweenness and European coreness as indicated by significantly negative regression coefficients for the latter sets of measures and positive ones for the former closeness measure for which lower values indicate more central nodes. The results suggest that those CE-11 countries occupying more downstream positions in the GVCs tend to be more central in terms of (i) having the short path to every other country in the network (closeness centrality), (ii) influence they have in global trade network (eigenvector centrality), (iii) importance for the shortest paths through the network (betweeness centrality), and (iv) closeness to the core of the European network (European coreness).

1.6. Concluding remarks

In this chapter, we carried out the comparative analysis for the CEECs and portrayed their GVC participation, GVC position and network centrality in the context of the CEECs' embeddedness in the European and global trade network. The analysis was based on two datasets: (i) TiVA for CEE-11 and (ii) Eora for the five Western Balkan states (CEE-5).

To sum up, overall the CEE as a region increased the extent of its integration in the GVCs throughout the 2005-2015 period, but in line with general global trend, the peak in the importance of supply chain trade was reached in the years 2011 and 2012, while we are witnessing the stagnation in the GVC importance since the year 2012. Among CEE-11 countries, the GVC participation is the highest in Slovakia and lowest in Croatia, while amid the group of WB countries (i.e. CEE-5) so-called supply chain trade represents the highest share in gross exports of Serbia and North Macedonia and the lowest one in Albania. CEE countries with a higher extent of participation in GVCs tend on average to be located more downstream. Downstream position is also significantly associated with more central position in terms of geographical proximity to other countries with large production and, moreover, also within the trade network. This result points to the importance of studying further the linkages between the GVC position in terms of upstreamness/downstreamness and the trade network centrality; both theoretically and empirically. Highly significant and strong relation between the two concepts might indicate the potential of the network centrality measures to complement the conventional GVC position indicators. This is an interesting avenue for future research.

Further, we found significant differences in the way how the extent of participation and position in GVCs changed across industries and CEE countries indicating heterogeneous investment opportunities in CEE region depending on the industry, stage in the production and trade orientation. Most of the CEE countries, with the exception of Croatia, Romania and Latvia among CEE-11 and Bosnia and Herzegovina in the CEE-5 group, increased their participation in GVCs during the 2005-2015

period. Hungary, Slovenia, Romania, Croatia, Bosnia and Herzegovina and Albania have moved more upstream by 2015 compared to the initial year 2005, the position of Lithuania, Slovakia, North Macedonia remained relatively stable, while the rest of CEECs, i.e. Bulgaria, the Czech Republic, Estonia, Poland, Serbia and Montenegro moved downstream.

Aggregate trends hide relatively large variability in terms of the GVC involvement for CEECs across different sectors and industries. CEE-11 group in most industries displays higher GVC participation than EU-28 region (excluding intra-EU trade) but occupies a more downstream location, with notable exceptions in *Machinery and equipment* (D28), *Transport equipment* (D29T30) and *Food products, beverages and tobacco* (D10T12), where CEE-11 gains dominance of the forward integration over the backward participation. In contrast to CEE-11, WB countries tend to participate in GVCs in more upstream stages in the industries of *Wood and paper products, printing* (D16T18) and *Chemicals and non-metallic mineral products* (D19T23) and *Basic metals and fabricated metal products* (D24T25) suggesting the reliance of WB countries on their natural resources in these industries, while in *Transport equipment* (D29T30) backward linkages were relatively stronger compared to forward ones in contrast to CEE-11.

Dynamic panel data analysis revealed a strong persistence in the extent of GVC participation and position for the CEE-11 group. The persistence in forward participation is weaker than for the backward involvement; however, it lasts for longer. After controlling for the persistence in GVC involvement, our results confirmed the important role of economic health of Germany in general for the extent of the participation and position of the CEE-11 group in GVCs within considered industries. The results, hence, suggest that an industry-level shock in Germany would put downward pressure on both forward and backward participation of the CEE-11 group even after controlling for the fixed year effects, but the impact is more prompt and stronger for forward than for the backward participation where we found considerable lag in the influence. As a result, the GVC position of CEE-11 group on average tends to move downstream

as a response to an industry-level negative shock in Germany within the two-year time window.

Network analysis of domestic value added embodied in foreign final demand showed that in general CEE-11 countries became more central in terms of closeness and eigenvector centrality but not in terms of betweenness centrality throughout the 2005-2015 period indicating increasing CEE's influence in terms of their integration in the trade network and shortening the path length from CEE to other nodes in the network, while they lost some of their importance (uniqueness/control) in terms of the shortest paths through the network during 2005-2015 period. Furthermore, the core-periphery analysis shows Poland, the Czech Republic, Hungary and Romania represent the core CEECs both in the European and global trade networks, while the rest of CEE-11 countries are much more peripheral. However, they differ to some extent with respect to the relative coreness in European versus global trade networks. The Czech Republic, Romania, Slovakia and Slovenia are among the CEE countries displaying the highest European orientation. At the industry level, relatively strong European orientation is detected in *Textiles, wearing apparel, leather and related products* (D13T15), *Wood and paper* products (D16T18) and *Computers, electronic and electrical equipment* (D26T27).

From a dynamic perspective, the group of CEE-11 elevated its coreness from 2005 to 2015, both globally and even more Europe-wise. Concerning individual countries, Poland gained the most among CEE-11 both in terms of European and global coreness during the 2005-2015 period. The shift towards the centre in global and European trade networks could be observed as well for the Bulgaria, Lithuania and Romania. In contrast, Latvia was the only CEE-11 country that moved towards periphery both in European and global networks between 2005 and 2015. The remaining CEECs either increased their European or global coreness. On the one hand, Estonia, Croatia, Hungary and Slovenia moved towards global centre whilst headed towards European periphery suggesting their increased global diversification. The opposite was the case for the Czech

Republic and Slovakia that, as it seems, further increased its reliance on the European trade network.

To summarize, CEECs as a region increased the extent of their integration in the GVCs and increased their European and global network coreness throughout the 2005-2015 period across the industries considered in our study. These trends indicate that the CEE region overall enhanced its GVC competitiveness and became a more attractive location for investments in globally dispersed production networks. However, the strengthening of GVC integration in most of the CEECs amplifies the exposure to potential disruptions in the global production and trade networks which may arise as a result of: (i) a recent weakening of the fundamentals of the multilateral trade system, (ii) increased global tendency towards protectionist measures; (iii) escalation and spread of US-China trade war; (iv) more intense and faster transmission of demand and supply shocks through intense vertical production links and increased interdependence within the constellation of the GVCs. Our study suggests that on average, backward participation was relatively more hurt during the global crisis period, which is in line with the theoretical prediction of trade barriers being more detrimental to trade in downstream stages than in more upstream ones.

Several policy and managerial implications may be drawn for our study. First, the significant differences in the way how the extent of participation and position in GVCs changed across industries and the CEECs point to rather heterogeneous investment opportunities; depending on the industry of activity, stage in the production process and the trade orientation. Therefore, potential (foreign) investors considering organising production networks in the CEE region need to take into account not just the industry but also the industry-stage specifics across the CEECs. Second, the exposure to risk of increased trade barriers or other GVC related risks tend to be higher in CEECs specialised in relatively more downstream stages within GVCs and being less diversified with respect to range of the industries and the positions in GVCs, since according to theoretical and empirical indications the exposure to risk of increased trade barriers or other GVC related risks tend to be higher in such cases. Further, CEECs

seem to be vulnerable to industry-specific business cycles in Germany, hence the policy measures should aim at (i) facilitating geographical diversification of trade and production relations, for instance through increasing the awareness of the firms how to leverage the wide network of EU's deep and comprehensive free trade and investment agreements, (ii) promotion of multilateral trade rules for improving the predictability of the global economic environment and, (iii) helping firms, especially small and medium sized, in adopting smart and agile supply chain risk management practices complementing "just-in-time" approaches with "just-in-case" strategies.

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PART II
Countries in focus

Chapter 2
Serbia in Global Value Chains

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2.1. Introduction

The production process of goods and services is becoming increasingly fragmented and different activities are being located across countries, comprising global value chains. This causes greater trade in intermediate products and makes exports more reliant on the ability to source inputs from abroad. Within this changing reality, traditional statistics (derived from customs and international payments data) becomes a less reliable measure of value provided by the individual country in its exports (Bjelić, 2013; Damijan & Rojec, 2015). Moreover, the complexity of the global production networks diminishes the effectiveness of the analysis of the country's involvement in global value chains (GVCs), when it is based on gross trade data. Therefore, we base our analysis of the position of Serbia in global value chains on foreign affiliates' trade statistics and trade in value-added statistics.

The main aim of this chapter is to describe the patterns of foreign direct investment, the activity of foreign affiliates and the nature of participation

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of Serbian economy and its individual industries in global value chains. First, we presented general patters and dynamics of foreign direct investment flows in Serbia. We then performed descriptive analysis of the involvement of Serbia in global value chains, using the theoretical framework of Koopman, Wang and Wei (2014), which integrates earlier approaches of Hummels, Ishii, and Yi (2001) and Johnson and Noguera (2012). This framework, based on the input-output methodology of Leontief (1936), uses the data on trade in terms of value-added derived from international harmonised input-output tables, breaking down the traditional indicator of gross exports into several value-added components. We then explore the rate and nature of the involvement of the Serbian economy in global value chains using the indicators derived from this new value-added trade statistics, observing both country-level and industry-level exports, in order to provide a more detailed and comprehensive picture of the extent of a country's involvement in such chains.

Our analysis of foreign direct investment and foreign affiliates' trade covers the period from 2010 onwards, due to data considerations, whereas the analysis based on trade in value added observes the period between 2005 and 2015. The observed period oversaw the expansion of international trade, its collapse as a consequence of the Global financial crisis and its subsequent recovery. This allowed us to estimate how changes in the global economic environment affected the position of Serbia in global value chains. We use two main data sources in our analyses. The first one, Foreign Affiliates Trade Statistics (FATS) provided by the Statistical Office of the Republic of Serbia, was developed according to EU Regulation[16] and international standards, since Serbia as a candidate country for the EU membership is obliged to report this data to Eurostat. The other source we used is Eora-UNCTAD Global Value Chains database, derived from Eora Multi-Region Input-Output database. This database provides the widest coverage of trade in value-added in terms of observed countries and years and its data is consistent with the

[16] Regulation EC No 716/207 of the European Regulation (EC) No 716/2007 of the European Parliament and of the Council of 20 June 2007 on Community statistics on the structure and activity of foreign affiliates (Text with EEA relevance).

related sources such as OECD-WTO Trade in Value-added database (Aslam, Novta, & Rodrigues-Bastos, 2017). Recently it has been gaining importance as a data source used in the analysis of global value chains (Mensah & Fofana, 2018; Slany, 2019; Tham & Kam, 2017).

The remainder of this section is organised as follows. In the first section we describe the activities of foreign affiliates in Serbia and analyse overall involvement of Serbia in global value chains. In the second section, we present the industry-level analysis of the participation in global value chains. The final section concludes.

2.2. The Patterns of Foreign Direct Investment in Serbia

During the last decade, Serbia was an attractive destination for foreign direct investments. A significant role in that process was reserved for transnational companies, making their own branches in Serbia and improving the Serbian economy`s possibilities to join the global value chains. Investors come mostly from EU countries: Netherlands, Austria, Luxembourg, Germany, Italy, Slovenia, Greece, Cyprus, and France. There are also investors from other regions. One of top five investor`s origin country is Russia. The most intensive investments from Russia in Serbian economy happened in 2011 with a value of 488 mill. EUR. During 2010 and 2012, Russia obtained the highest rank between partner countries, but with a lower volume level, 216 mill. EUR in 2010 and 232 mill. EUR in 2012. There is an obvious increase of the UAE`s and Switzerland`s increased impact, especially in 2014, 2015 and 2016.

Table 2.1. Top five FDI origin countries for Serbia, 2010-2018 (in mio EUR)

Rank	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Russian Federation 216.218	Luxemburg 885.040	Russian Federation 232.451	Netherlands 379.753	Netherlands 372.685	Netherlands 361.698	Netherlands 341.839	Netherlands 542.750	France 710.7
2	Slovenia 180.388	Austria 613.192	Austria 168.969	Russian Federation 189.705	Switzerland 139.077	Austria 352.470	Switzerland 234.580	Austria 248.658	Hong Kong 434.6
3	Cyprus 108.664	Russian Federation 488.499	Netherlands 153.498	Austria 151.841	Austria 119.231	Luxemburg 172.305	Luxemburg 232.948	Italy 195.610	Netherlands 317.5
4	France 107.746	Netherlands 215.499	Luxemburg 134.520	Luxemburg 102.703	Italy 101.130	Italy 144.863	Austria 232.425	Germany 185.375	Germany 263.7
5	Germany 103.543	Germany 198.723	France 131.379	France 99.341	Greece 89.696	UAE 120.509	Germany 179.561	Russian Federation 170.380	Russian Federation 237.3

Source: National Bank of Serbia (2019), *Republic of Serbia's Balance of Payments*, https://www.nbs.rs/internet/cirilica/80/platni_bilans.html, (accessed on 20. 04. 2019)

Analyzing the cumulative value of EU`s foreign direct investments, oriented towards Serbia for period 2010-2017, we can conclude that a dominant share of FDI came from EU. It is 73% of the overall volume - or, nearly three quarters of FDI in the Serbian economy. It is a high value of more than 11 billion EUR. The country that follows, as an origin country of a significant value of investments, is Russia, with the value of almost 1.5 billion EUR and the share of 9% in cumulative FDI. After the Switzerland with the share of 6%, other origin countries have very modest share of only 2%, or 1%: UAE, China, USA, Hong Kong.

The rise of foreign direct investments is one of a few indicators of the regional countries` reintegration in the world economy. The interest for investing in these countries, year after year, has obtained different levels. The criteria for analysing differences of investment levels are: origin of capital, the amounts of investment and the orientation towards main sectors. In the beginning of the period 2010-2018, the FDI started a period of the growth (see Figure 2.1). However, in 2012, its dynamics has been changed, with a sharp decrease. The recovery started the following year, in 2013. The first year with obtained increase was 2013, with the increase

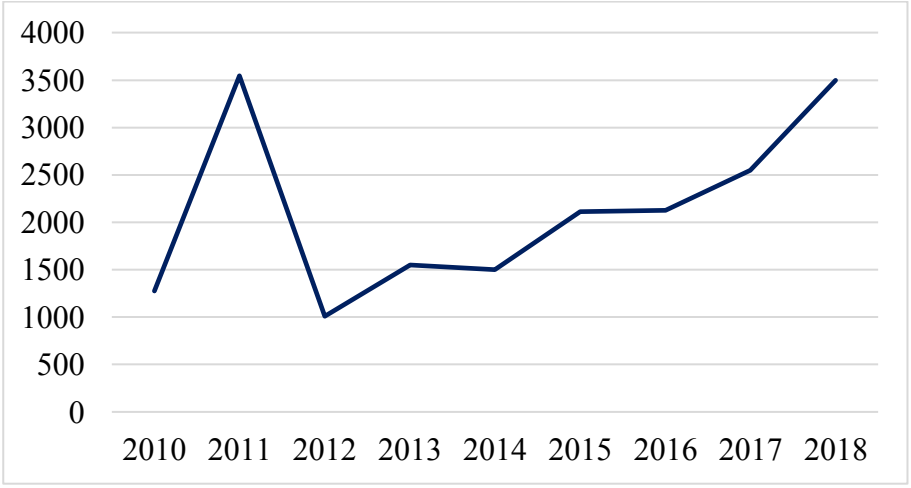
of the financial liabilities of 1547 mill. After the stagnation in 2016, a new phase of increase started in 2017, with the level of 2548.1 mill. EUR and in 2018, a slightly higher amount of 3495.8 mill. EUR.

Table 2.2: Cumulative FDI to Serbia, 2010-2017 (in mill. EUR)

	Amount (mil. EUR)	Percentage (%)
EU	11,315.35	73
Russia	1,472.34	9
Switzerland	904.16	6
UAE	367.09	2
China	288.15	2
USA	254.81	2
Hong Kong	240.82	2
Montenegro	140.36	1
Korea	91.34	1
Bosnia and Herzegovina	84.87	1
Rest of the world	363.83	2

Source: The Delegation of the EU to the Republic of Serbia (2019) *FDI to Serbia*, https://europa.rs/serbia-and-the-eu/trade/fdi-in-serbia/?lang=en, (accessed on 20.03.2019)

Figure 2.1: Total net increase of financial liabilities for FDI, 2010-2018 (in mill. EUR)



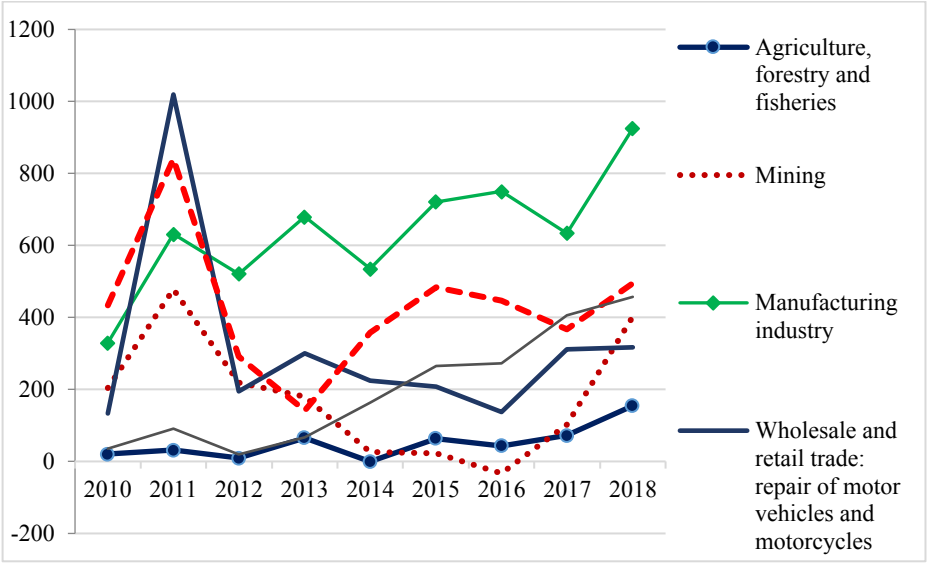
Source: National Bank of Serbia Data, *Republic of Serbia's Balance of Payments*, Internet: https://www.nbs.rs/internet/cirilica/80/platni_bilans.html, (20.04.2019).

Observed by sectors, the most attractive sectors for FDI were: Financial activities and insurance activity, Wholesale and retail trade: repair of motor vehicles and motorcycles, Manufacturing industry, Construction, Agriculture, with forestry and fisheries and Mining.

The interest of investors by sectors was not equal during the period 2010-2018. At its start, in 2010, the most interesting sector was a sector of Financial activities and insurance activity, with the value of 432 mill. EUR. Next year, situation changed, with the sharp increase of the Wholesale and retail trade: repair of motor vehicles and motorcycles, with the value of even 1019 mill. EUR. The interest for Financial activities and insurance activity, remained high. In 2012 all these sectors obtained a decrease. The main position was taken over by the sector Manufacturing industry, with the value of 521 mill EUR in 2012. This top position remained with the high values in interval 535-924 mill. EUR, until the 2018.

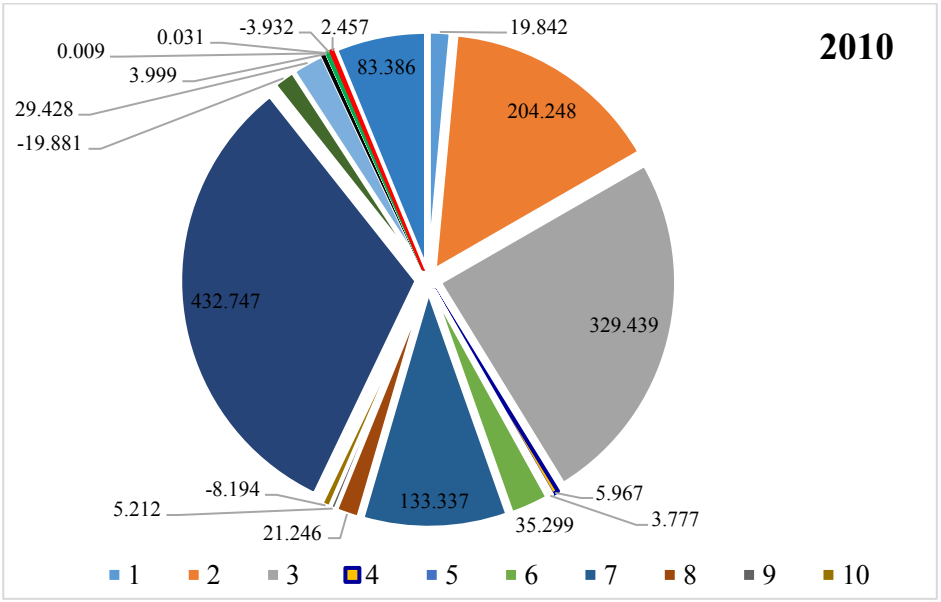
Until the 2018 the share of different sectors remained similar, although some changes are visible. As the Financial activities and insurance activity was the most interesting sector in 2010, at the end of the observed period, in 2018, the Manufacturing industry took over that primary role, with the value of 924 mill. EUR. In 2018, this sector is followed by Financial activities and insurance activity with the value of 494 mill. EUR and Construction, with the value of 457 mill. EUR. More detailed statistics regarding the dynamics of sector-level foreign direct investment inflows are presented in the Table A4.1 in the Appendix 4.

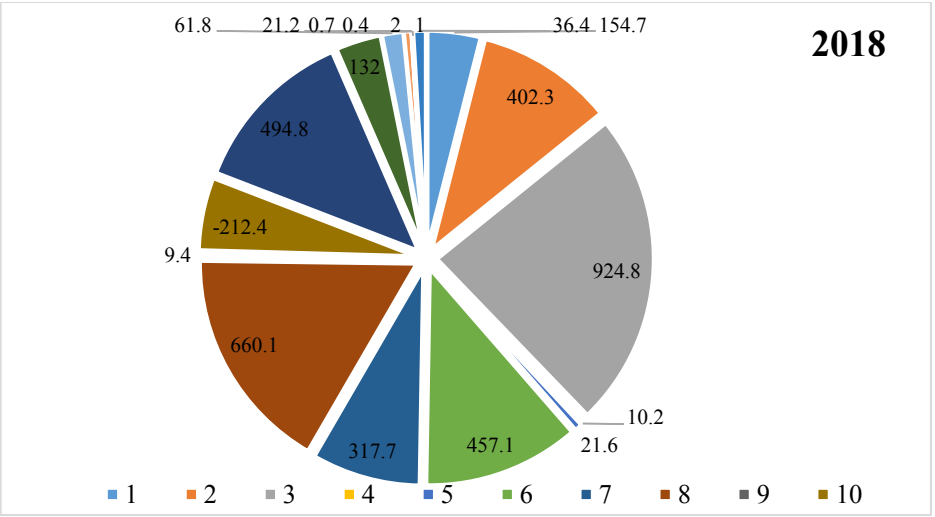
Figure 2.2: Foreign direct investments inflows by selected sectors, 2010-2018 (mill. EUR)



Source: National Bank of Serbia Data, *Republic of Serbia's Balance of Payments*, Internet: https://www.nbs.rs/internet/cirilica/80/platni_bilans.html, (accessed on 20.04.2019)

Figure 2.3: Foreign direct investments inflows by sectors in 2010 and 2018 (mill. EUR)





Notes: 1-Agriculture, forestry and fisheries, 2- Mining, 3- Manufacturing industry, 4- Electricity, gas, steam and air conditioning supply, 5- Water supply: wastewater management, control of waste disposal and similar activities, 6- Construction, 7- Wholesale and retail trade: repair of motor vehicles and motorcycles, 8- Traffic and storage, 9- Services of accommodation and nutrition, 10- Information and communication, 11- Financial activities and insurance activity, 12- Real estate, 13- Professional, scientific, innovation and technical activities, 14- Administrative and support service activities, 15- Education, 16- Health and social protection, 17- Art; Entertainment and recreation, 18- Other service activities, 19- Unclassified
Source: National Bank of Serbia Data, *Republic of Serbia's Balance of Payments*, Internet: https://www.nbs.rs/internet/cirilica/80/platni_bilans.html, (20.04.2019.)

The use of the foreign direct investment statistics is informative and presents general patterns of the involvement of Serbia in the global value chains. However, not all aspects of the activities of multinational companies in Serbia can be observed using the traditional statistics only. A complementary analysis based on the new foreign affiliates statistics and trade in value-added statistics is therefore presented in the following sections.

2.3. The Participation of Serbia in Global Value Chains

In this section, we seek to describe the presence of foreign affiliates in Serbian economy and participation and position of Serbia in global value

chains (comparing the later to other countries in the region). We first consider the activities of foreign affiliates and present the structure of these affiliates according to their country of origin and activity. We then turn to presenting the value of Serbian exports using traditional statistics, combining it with data on domestic content in gross exports. We continue by graphically presenting the participation index of Serbia and its structure (backward and forward linkage) as well as the position of Serbia in global value chains and its change over time. Next, we compare the involvement of Serbia in global value chains with other West Balkan countries. Finally, we consider the structure of foreign value-added embodied in Serbian exports, as well as the structure of Serbian indirect value-added embodied in other countries' exports.

The inflow of foreign direct investment in Serbia was especially significant after 2000 when the country was fully reintegrated into the world economy. We see from the data previously presented that the largest company investors in Serbia come from the European Union member states. Foreign direct investment is a specific form of foreign private capital movement that enables the investor company to take control over the company in which it invests internationally.

We begin the descriptive analysis with the analysis of foreign affiliates activity in Serbia (Table 2.3). Total number of foreign affiliates in Serbia was 2,478 in 2011, rising to 2,740 affiliates in 2017. These affiliates employed 174,605 employees in Serbia in 2011 but this number reached 245,573 in 2017.

The foreign affiliates operating in Serbia represented 3.2% out of total number of companies in 2017, according to the Statistical Office of the Republic of Serbia (RZS) data, with similar share recorded back in 2011. But this foreign affiliates operating in Serbia have a share of 38.2% in Serbia's total production recorded in 2017, as well as 33.5% share of generated value-added that year with only 22.28% share of Serbia's labour force in the same year. The influence of foreign affiliates in Serbia is

steadily rising from their share of 32.4% in production, 29.8% in generated value-added and 17.1% in labour force back in 2011.

Table 2.3. Activity of Foreign Affiliates in Serbia

	No. of Foreign Affiliates	No. of Employees in Affiliates	Turnover	Production Value	Added Value	Labour cost
			mil. RSD			
2011	2478	174,605	2,178,829	1,384,486	397,445	195,312
2012	2708	181,953	2,523,346	1,547,017	479,329	214,637
2013	2642	189,414	2,725,001	1,789,085	504,724	233,905
2014	2624	198,797	2,813,511	1,855,490	520,461	250,675
2015	2615	198,732	2,875,772	1,908,835	530,611	262,597
2016	2713	223,125	3,163,174	2,076,645	597,734	294,229
2017	2740	245,573	3,498,493	2,355,815	668,147	337,993

Source: Statistical Office of the Republic of Serbia.

Concerning the origin of Controlling entities, it is very similar to the origin of countries sources of FDI for Serbia. Most of the foreign affiliates operating in Serbia originate from EU member countries, 78% of total number of affiliates in Serbia in 2017. Most of the EU affiliates are from former Yugoslav republics, Slovenia and Croatia, with 10% and 7.5% share in total number of affiliates in 2017, respectively. These economies are followed by other important trade partners of Serbia – Italy, Austria and Germany. From Non-EU group dominate affiliates from Switzerland and USA as well as from other former Yugoslav republics – Bosnia and Herzegovina, North Macedonia and Montenegro.

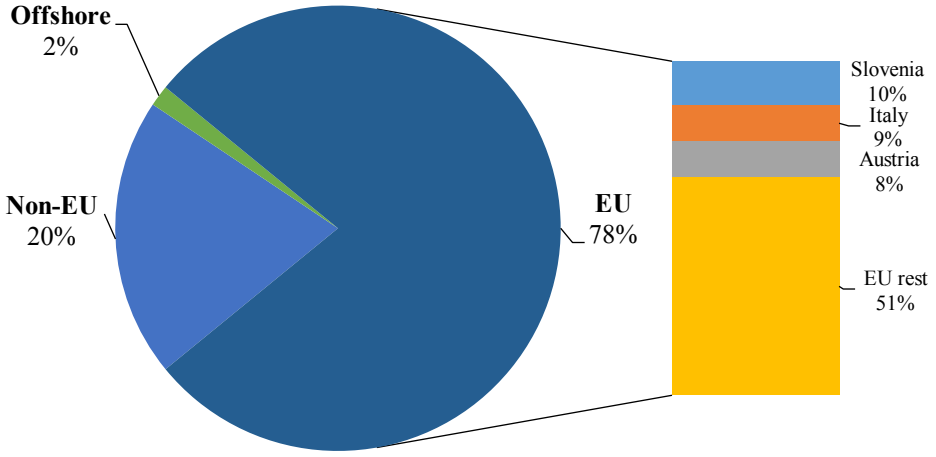
Other important countries of affiliates origin include Russian federation and PR China. The 2% of foreign affiliates operating in Serbia, or 42 in number, comes from offshore financial centres around the globe.

If we observe some other indicators, rather than number of affiliates, we can observe that foreign affiliates operating in Serbia of German origin employ most of the people, 32,816 workers in 2017. Foreign affiliates established by Russian capital have the largest production value in 2017

(361,280 mil. RSD), but foreign affiliates of Dutch origin have the largest value-added in the same year (76,520 mil. RSD).

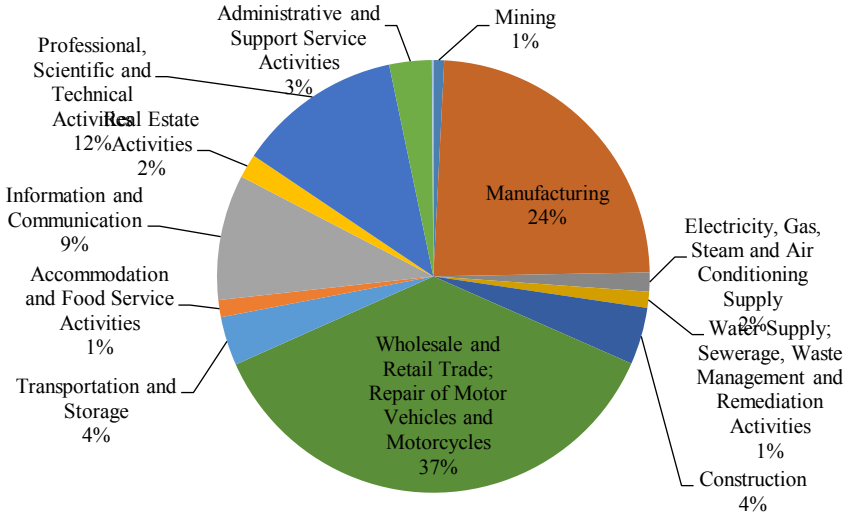
Sectoral distribution of foreign affiliates operating in Serbia in 2017 show that Wholesale and Retail trade is the most popular sector of operation with 37% share of all affiliates. Manufacturing sector is the second most important sector with the share of 24% of foreign affiliates in Serbia in 2017. Other sectors with significant share include: Professional, scientific and technical activities (12%), Information and communication (9%), Transport and storage (4%) and Construction (4%).

Figure 2.4. Affiliates by origin (2017)



Source: Authors' representation according to Statistical Office of the Republic of Serbia data

Figure 2.5. Affiliates by activity (2016)

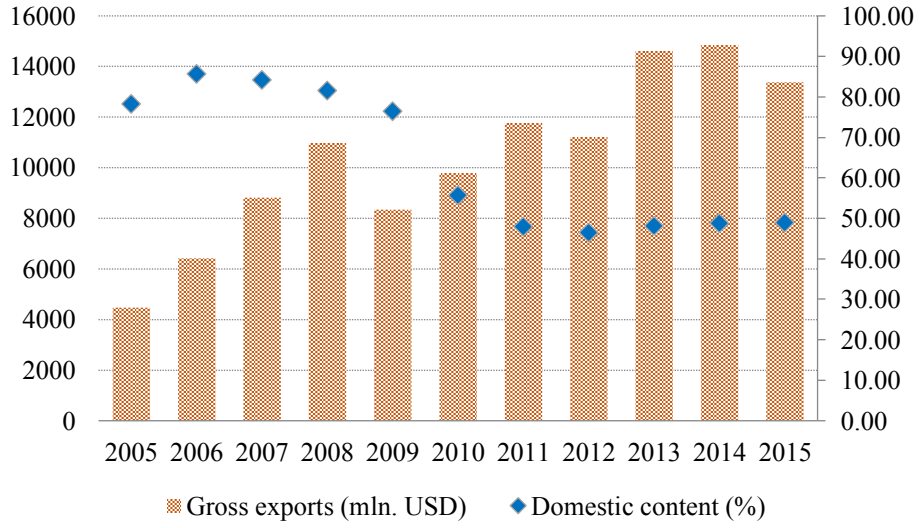


Source: Authors' representation according to Statistical Office of the Republic of Serbia data

Even if the Manufacturing sector has almost less than twice the number of affiliates comparing to Wholesale and Retail Trade Repair of Motor Vehicles and Motorcycles, it has recorded more than double number of people employed in 2017 (131,203 workers). Foreign affiliates in manufacturing have also recorded the largest turnover in Serbia in 2017, with significantly higher level of production value and value-added in the same year comparing to the other sectors.

We now turn to a brief overview of Serbian gross exports, using traditional statistics provided by the Statistical Office of the Republic of Serbia. Alongside, we also consider the share of domestic content in exports, as defined by Koopman *et al.* (2014), calculated using the data from UNCTAD-Eora database. The variables are presented in Figure 2.6.

Figure 2.6. Gross exports and the share of domestic content in Serbia (2005-2015)



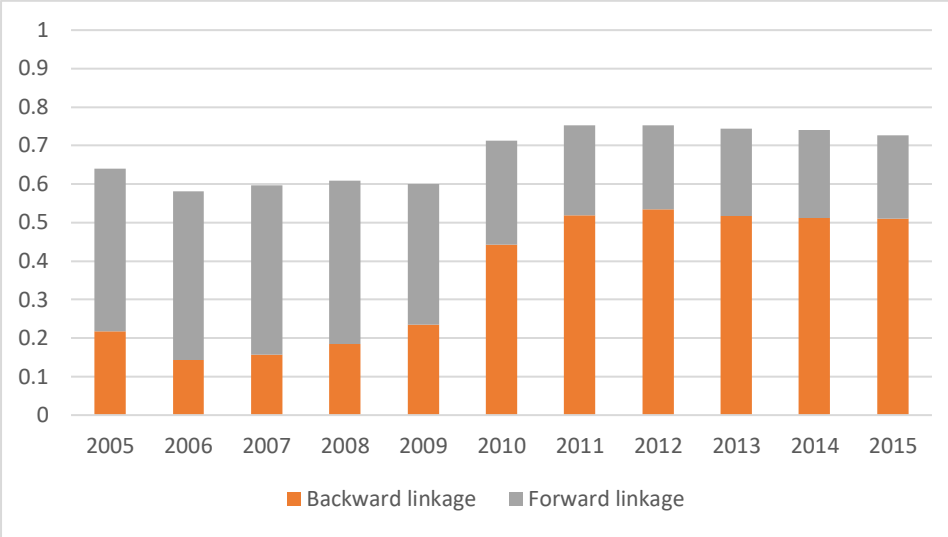
Source: Authors' calculation based on the Statistical Office of the Republic of Serbia and UNCTAD-Eora database.

In the first four years of the observed period, Serbia witnessed strong and stable export growth. In 2008, the gross export value of Serbia was more than doubled compared to the 2005 level, reaching 10.97 billion USD. Foreign direct investment, trade liberalisation and increased integration in the world economy contributed to this growth (Bjelić, 2012; Kastratović, 2016; Kovačević, 2009). In the same period, domestic content in exports was stable and high, varying between 78% and 86%. In 2009, the gross export value dropped, following the global trend in international trade set by the Global financial crisis. Gross exports recovered in the following years, although the export growth was unstable. The maximal value of exports of 14.8 billion USD was reached in 2014 and was followed by the decline in exports of about 10% the next year. Despite this recovery of gross export values, Serbia recorded a significant drop in domestic content of exports in the post-crisis period, which reached its minimum value in 2012 (46.62%), and maintained that level in the following years. This decrease in domestic content of exports could be explained by the growing presence of transnational companies, such as Fiat, which based part of their

operations in Serbia and contribute greatly to Serbian gross exports, but at the same time heavily rely on imported intermediary products as inputs in their production processes. Lower values of domestic content in exports indicate that Serbia became less self-reliant on inputs used in its export-oriented production. Although lower self-reliance is to be expected from countries with the small internal market such as Serbia, it does show that the expected benefits of increased exports recorded by traditional trade statistics could be overstated.

In Figure 2.7 we graphically described the dynamics of the involvement of the Serbian economy in global value chains in the period between 2005 and 2015. In describing these dynamics, we use the participation index and its components, backward and forward linkage, deriving them from trade in value-added statistics. The participation index increased 9 percentage points in the observed period, indicating a growing involvement of Serbia in global value chains. This implies that the Serbian economy is increasingly opening itself. However, the main driver of this increased integration in global value chains is backward linkage. From 2006 to 2012 Serbia almost quadrupled the extent of backward linkage (backward linkage index rose from 0.14 to 0.53). In this period, contrary to its export strategy, Serbia moved upstream in global value chains and changed the composition of its exports, strongly increasing the importance of primary products and lower value-added activities (Kozomara, 2013). At the same time, the nature of participation of Serbia in global value chains changed: importing intermediate inputs in producing its exports became relatively more important than exporting the intermediate goods and services which other countries use to produce their exports. In other words, foreign value-added embodied in Serbian exports gained a lot of relative significance in the observed period, which is consistent with previously presented domestic content dynamics.

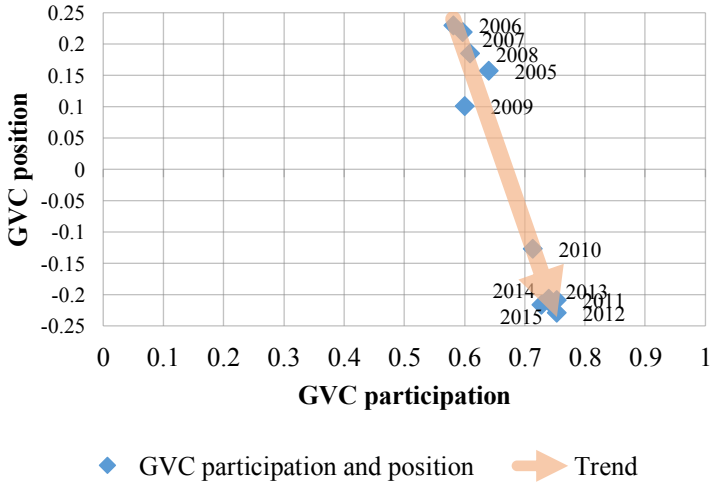
Figure 2.7: Participation of Serbia in global value chains (2005-2015)



Source: Authors' calculation based on UNCTAD-Eora database.

Participation and position of Serbia within global value chains is simultaneously described in Figure 2.8. Here we graphically present the conjunction of the participation index and the position index.

Figure 2.8. Participation and position of Serbia in global value chains (2005-2015)

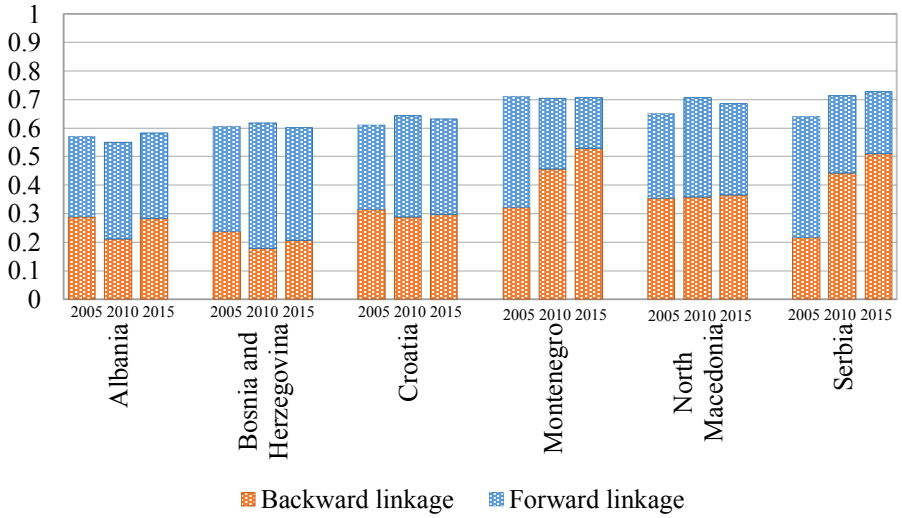


Source: Authors' calculation based on UNCTAD-Eora database.

The position index describes relative upstreamness of a country and in its calculation, we follow the standard definition, which derives it from backward and forward linkage indices (Koopman, Powers, Wang, & Wei, 2010). Each point in Figure 2.8 denotes average participation and position of Serbia in a particular year. The relationship between participation and position of Serbia in global value chains and its dynamics are described using the trend arrow. Figure 2.8 shows that even though Serbia increased the extent of its participation in global value chains in the observed period, it moved considerably downstream. This could indicate that Serbia increasingly specialises in later stages of production within global value chains, relying strongly on imported inputs. This tendency seems to change little recently, as the relationship between global value chains participation and position of Serbia remained stable between 2011 and 2015.

How the participation and position of Serbia in global value chains compares to the ones of other countries in the region is described in Figure 2.9. Figure 2.9 suggests that the extent of participation in global value chains of Serbia is similar to the extent of participation observed in other countries. Serbia and North Macedonia recorded an increase in global value chains participation in the observed period, while the participation of the other countries remained relatively stable. Albania, Bosnia and Herzegovina and Croatia appear to have slightly lower global value chains participation compared to the other three West Balkan countries.

Figure 2.9. Participation of West Balkan countries in GVCs (in 2005, 2010 and 2015)



Source: Authors' calculation based on UNCTAD-Eora database.

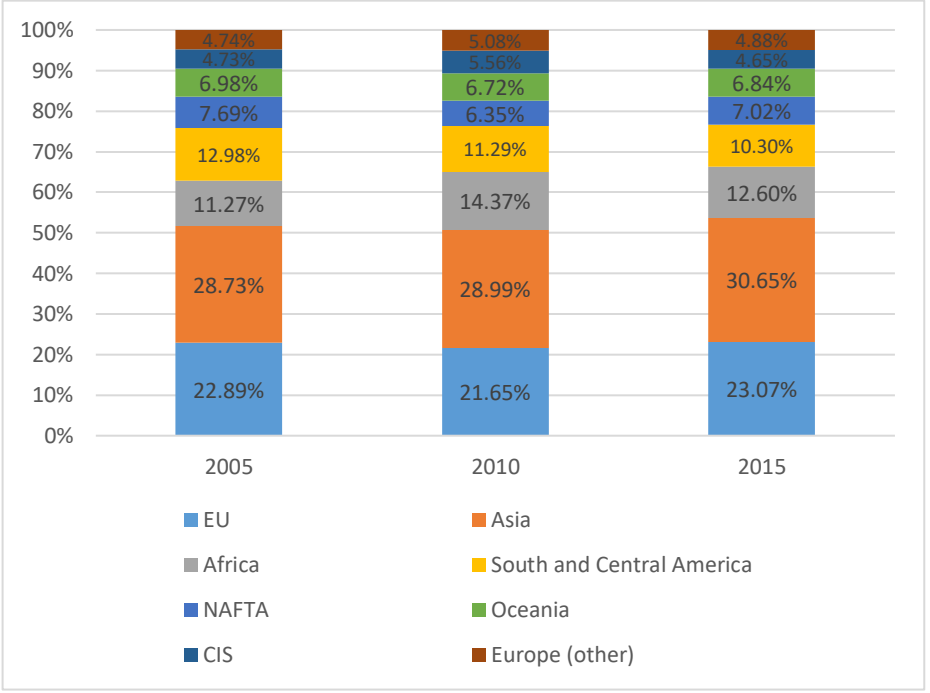
Montenegro witnessed the change of global value chains position similar to the one identified in Serbia – in both countries there was a significant increase in backward linkage and downstream movement within the chain. Backward and forward linkages appear to have almost the same importance in driving global value chains participation of Croatia and North Macedonia. The situation did not change much over the observed period. Finally, global value chains participation of Albania and Bosnia and Herzegovina appear to be strongly driven by forward linkages.

The geographic structure of foreign value-added sources in Serbian exports is shown in Figure 2.10. The majority of foreign value-added embodied in Serbian exports in 2015 comes from European countries (32.6%), particularly from the member states of the European Union. Another major source of inputs for export-oriented production of Serbia includes Asian countries (most notably China and Japan which contributed 4.71% and 2.89% to foreign value-added in Serbia in 2015, respectively). The structure of foreign value-added in Serbia remained stable in the entire

observed period, except in the case of China, which significantly gained importance as the supplier of foreign value-added in Serbian exports.

The structure of Serbian indirect value-added exports by destination regions is presented in Figure 2.11. Over the entire observed period, member states of the European Union absorbed the largest share of Serbian indirect value-added exports. Their share slightly declined over time, from 32.11% in 2005 to 28.65%. Another important destination for value-added exports of Serbia is member countries of the Commonwealth of Independent Nations. Their share is Serbian indirect value-added export is growing and in 2015 it reached 25.76%. Their significance, which has recently become comparable to the European Union members, is somewhat surprising, as the traditional statistics indicate that the European Union is by far the most important trading partner of Serbia. China absorbed between 3.09% and 3.90% of total Serbian value-added in the observed period.

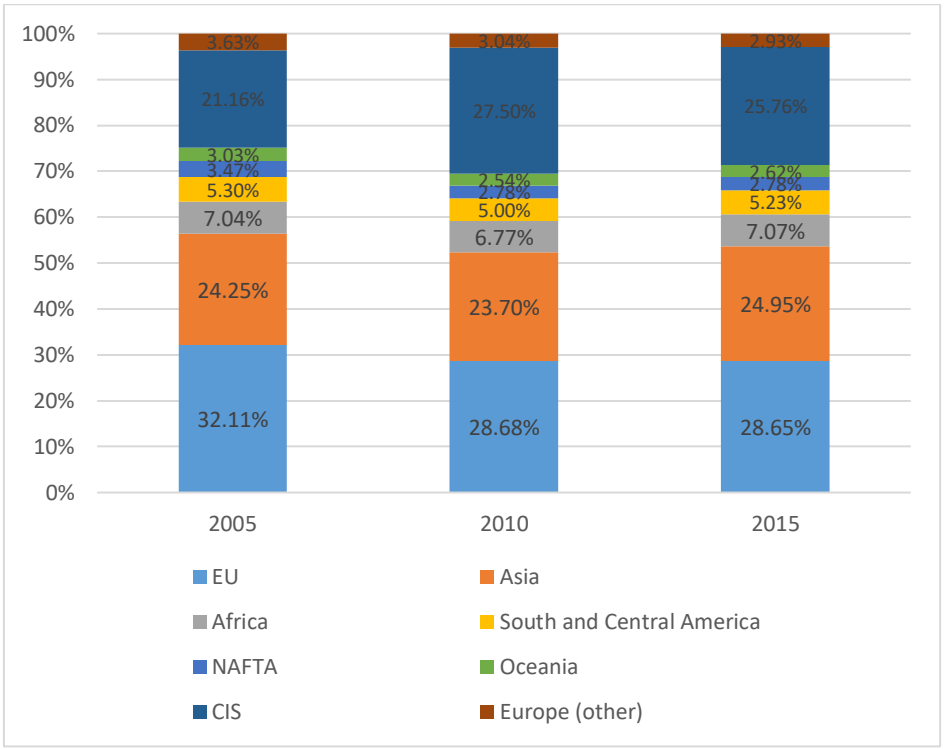
Figure 2.10: Sources of foreign value-added in Serbia (in 2005, 2010 and 2015)



Source: Authors' calculation based on UNCTAD-Eora database.

This could indicate that despite the value of gross exports of Serbia to European Union is large, the value-added embodied in these exports is much smaller and the member countries of the European Union do not use these Serbian exports in their own export-oriented production. Contrastingly, member states of the Commonwealth of Independent Nations use inputs produced in Serbia which contain higher value-added in their own export-oriented production. In any case, the structure presented in Figure 2.8 implies that geography could play an important role in intermediate products trade, as the European countries made up the absolute majority of Serbian indirect value-added exports throughout the observed period. As for the other regions, Asia maintained a significant share in Serbian indirect value-added exports in all observed years. The importance of other regions was relatively minor and did not change much over time.

Figure 2.11: Destinations of indirect value-added of Serbia (in 2005, 2010 and 2015)



Source: Authors' calculation based on UNCTAD-Eora database.

2.4. Industry Overview of the Participation in Global Value Chains

In this section we seek to describe the position of Serbia in GVCs from the perspective of various, selected industries, observing the period between 2005 and 2015. The main data source is UNCTAD-Eora database. Based on the classification of industries in this database, the selected industries to be analysed are: Food and Beverages; Textiles and Wearing Apparel; Wood and Paper; Petroleum, Chemical and Non-Metallic Mineral Products; Metal Products; Electrical and Machinery; Transport Equipment.[17] The structure of the section is as follows. Analysis of the total value of Serbia's sectoral export is followed by analysis of domestic and foreign value added components of export (DVA and FVA) for the period from 2005 to 2015. In addition, domestic value added in foreign export, i.e. indirect value added (DVX) is analysed for the whole observed period. On this basis, the GVC participation index with its components is calculated, as well as the GVC position index, whose values per industry are analysed for the period between 2005 and 2015. A more detailed analysis of the involvement of industries in global and European value chains is conducted for years in focus: 2005, 2010 and 2015.

Observing the total value of Serbia's sectoral export, it can be noticed that the value of export of all considered industries increased between 2005 and 2015. The sharp rise in the value of export of the selected industries came in 2006, with the growth trend continuing until 2009, when all industries recorded a decline in export value compared to the previous year, which can be considered as a direct consequence of the Global economic crisis. Recovery has been registered as early as next year, so the value of export of all selected industries increased starting from 2010, until 2015, when the value was reduced. Bearing in mind that the value of export in 2005 was very low compared to 2006 data, these values can be considered

[17] Services are excluded from the analysis having in mind differences in industry classification in UNCTAD-Eora database, compared to TiVA database.

extreme, significantly influencing the obtained results. In order to increase the reliability of the analysis, the period from 2006 to 2015 is more appropriate. Analyzing the selected industries, it can be noted that the average annual growth rate and the degree of increase in the value of export of the considered industries are fairly even in the period between 2006 and 2015. The average annual growth rate was around 9%, while the absolute value of export increased about 1.9 times. If we look at the period from 2005 to 2015, the values are significantly uneven between industries and they deviate significantly from the above (the value of export of the considered industries has grown on average more than 9 times with an average annual growth rate of 46%, which is the result of extreme values in 2005). The largest value of export is recorded in Metal Products industry, while the lowest value of export is recorded in Transport Equipment.

Following Aslam et al. (2017) total export has two components: DVA and FVA, which are discussed below. Looking at the period from 2005 to 2015, there is a noticeable trend of growth of the FVA component in the export of all considered industries. The increase in the share of FVA (i.e. the decrease in DVA share), indicates that foreign value added embodied in Serbia sectoral export gained a lot of relative significance. FVA share in total sectoral export has increased from 3.3% in 2005 to 26.5% in 2015. However, it should be noted that in all considered industries, the significance of FVA component increased by 2012 (when the average participation of this component for all industries was around 31%), but decreased in the last 3 years of the considered period pointing to little changes in tendency. The average annual growth rate was fairly uniform across industries (around 33%). By analyzing the individual industries, it can be noticed that, throughout the analysed period, the lowest share of FVA had Electrical and Machinery industry, while the largest share of foreign components is recorded in Textiles and Wearing Apparel. At the beginning of the period, that is, in 2005, FVA's share in total export of this industry was 6.7%. In 2012 foreign component of value added contributed by 50% in total export value of this sector. In the other sectors considered,

the significance of this component is far smaller, indicating their greater orientation towards the added value created on domestic market.

Domestic value added in foreign export (DVX) is considered as important indicator of a country's involvement in global production chains. The absolute value of this indicator shows a trend of growth in all observed industries. We should notice that, as in the case of total export, DVA and FVA, values of DVX are also extremely low in 2005, suggesting to exclude this year from the analysis when considering the absolute values. Bearing previously in mind, in the ten-year period between 2006 and 2015, the average annual rate of DVX growth was fairly uniform between industries (around 4.7%), which led to an increase in export value of about 1.3 times in all analysed industries. By the end of 2008, DVX grew in all industries, followed by a fall in the value in 2009, which, as well as the previously analysed fall in export value in this year, can be explained by the consequences of the Global economic crisis, followed by the recovery in all industries. In the period from 2011 to 2015, there was noticeable instability in the movement of this indicator. All industries record a decline in DVX values in 2012, followed by a two-year growth, in order to re-reduce value in 2015. The lowest value of this indicator in the period from 2006 to 2015 was recorded in Transport Equipment, while the highest value in the same period was recorded in the Metal Products industry.

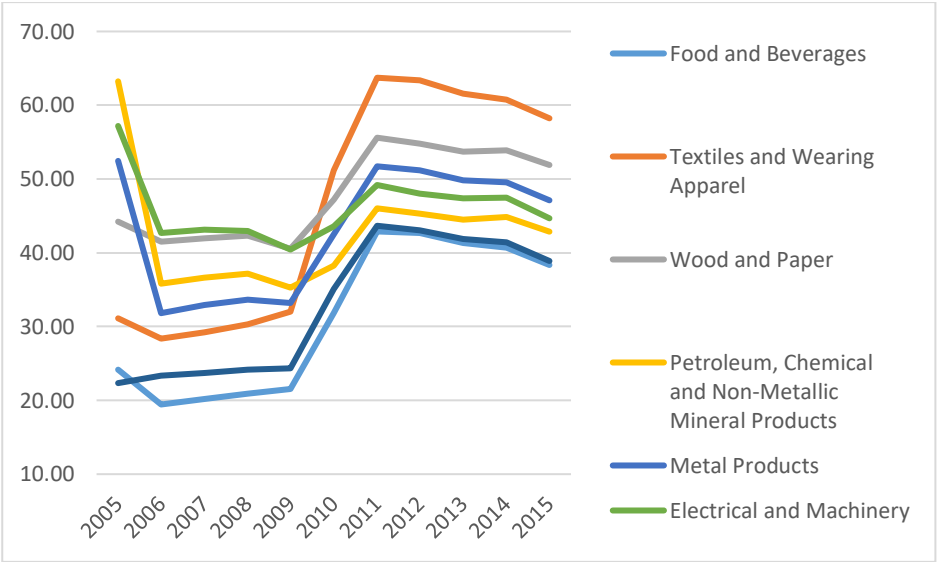
In contrast to the previously analysed absolute value of DVX, the participation of this indicator in total sectoral export recorded a downward trend in the period from 2005 to 2015 in all industries, indicating the decline in the significance of domestic value added to other countries' export, which implies reduced competitiveness of Serbian export. The industry that recorded the lowest value of DVX as a percentage of total sectoral export in the period from 2006 to 2015 is Food and Beverages (on average 13%), while Electrical and Machinery industry has the largest share (about 33% on average).

Starting from the previously discussed FVA and DVX, and following Aslam et al. (2017), we can graphically describe the dynamics of the

involvement of each industry of interest in GVC, by calculating the GVC participation index with its components - backward and forward linkages. The dynamic of GVC participation index of different industries is presented in Figure 2.12.

Figure 2.12 depicts dynamic changes in the value of the GVC participation index, indicating the dynamic changes in the involvement of Serbia in the GVCs. Growth trend in GVC participation index was recorded in the following industries: Food and Beverages, Textiles and Wearing Apparel, Wood and Paper, Metal Products and Transport Equipment. The highest average annual growth rate of the index was registered in Textiles and Wearing Apparel, consequently influencing the fact that this industry has the highest value of index since 2010. The downward trend in the index was registered in: Petroleum, Chemical and Non-Metallic Mineral Products and Electrical and Machinery, with a higher decline in Petroleum, Chemical and Non-Metallic Mineral Products. Besides that, this industry hasn't recorded the lowest value of GVC participation index. Namely, Food and Beverages is an industry with the lowest level of involvement in the global production chain since 2006.

Figure 2.12: GVC participation index by industry (2005-2015)



Source: Authors' calculation based on UNCTAD-Eora database.

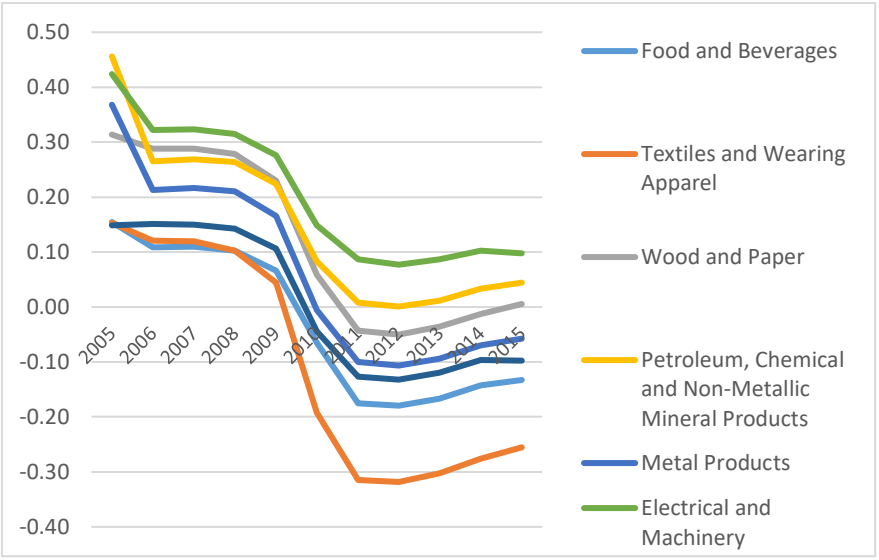
The breakdown of the GVC participation index on the components (backward and forward linkage) allows the analysis of the relative importance of these two components in the formation of the GVC participation index, in order to determine the main drivers of the involvement of each industry in global production chains. We can notice that, since 2010, in all observed industries there has been a sharp increase in the significance of the backward component of the GVC participation index, whereby in some industries this component becomes the main driver of their involvement in global production chains. This is about the following industries: Food and Beverages, Textiles and Wearing Apparel, Metal Products and Transport Equipment, indicating the growing relative importance of imported intermediate inputs used to generate output for export. Forward component of GVC participation index remained dominant over the entire period only in Petroleum, Chemical and Non-Metallic Mineral Products and Electrical and Machinery, implying that only in these industries Serbian export of intermediate goods that other countries use to produce their export is relatively more important.

Furthermore, the breakdown of the GVC participation index on backward and forward participation enables analysis of each of the observed industries in the global production chain. Thus, we can notice that all industries recorded a trend of reducing forward participation in the period from 2005 to 2015, by around 5.6% annually, i.e. from 38.7% on average, to around 19.5%. Conversely, for backward participation there is a growth trend, i.e. there was an increase in the participation of imported intermediate inputs that are used to generate output for export, in gross industry export, which was about 33% annually, increasing from about 3.3%, on industry average, to around 26.5%. Throughout the whole analysed period Textiles and Wearing Apparel was the industry that relies the most on imports of inputs for export production, where backward participation increased from 6.7% in 2005 to 45.5% in 2015. The industry that least relied on the import of inputs was Electric and Machinery, where the value of this index increased from 1.74% to 16.35% in the period from 2005 to 2015. Analysis of the forward linkage of various industries shows

that Electrical and Machinery industry had the highest degree of forward participation in the period from 2006 to 2015, where the share of DVX in total sectoral export decreased from 40.7% in 2006 to 28.3% in 2015. On the other hand, Food and Beverages had the lowest degree of forward participation in the period from 2006 to 2015, where the forward index fell from 15.7% to 11.3% in the period from 2006 to 2015, i.e. in the period in which this industry records the smallest export of inputs for the production of other countries.

To measure the relative upstreamness of a country in particular industry, we use a GVC position index that has been defined by Koopman et al. (2014).

Figure 2.13: GVC position index by industry (2005-2015)



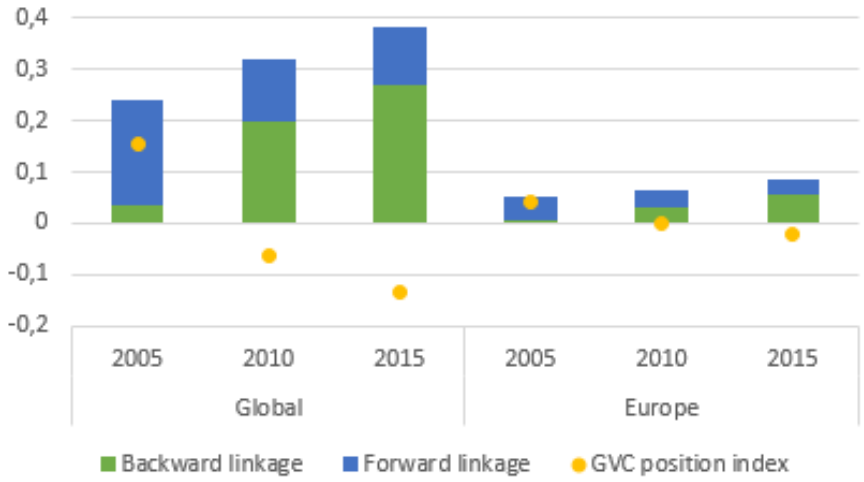
Source: Authors' calculation based on UNCTAD-Eora database.

Based on Figure 2.13, we conclude that there was a noticeable downward trend in the value of the GVC position index in all considered industries in the period from 2005 to 2015, with the pronounced fall in value occurring after the Global economic crisis. In recent years, there has been a slight recovery, i.e. the growth of the value of this indicator, which points to the improvement of the position of all industries in the global production

chain. Industry that shows the highest degree of upstreamness, i.e. that contributes more value added to other countries export then other countries contribute to their export is Electrical and Machinery.

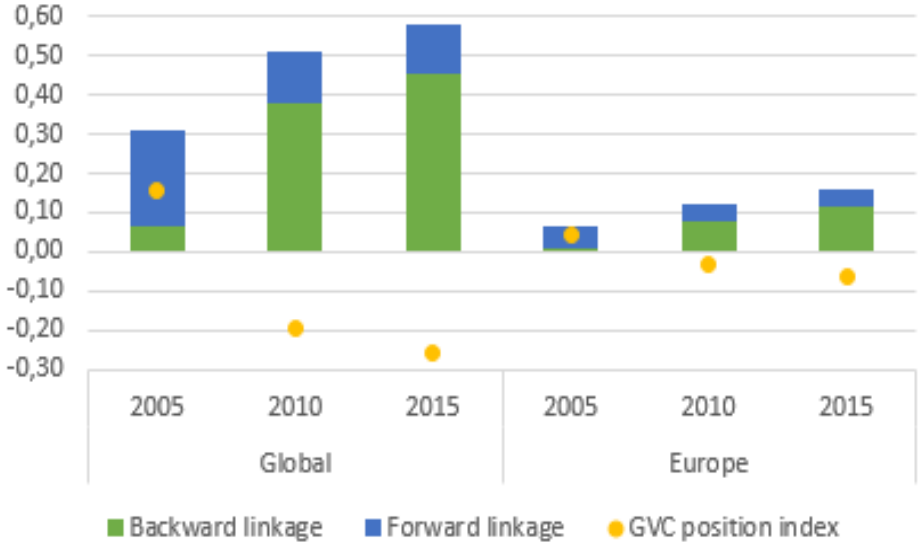
Having in mind that involvement in European value chains is of great importance for CEE countries, furthermore, each of the industries is analysed separately, considering its involvement in global as well as European value chains, observing components of GVC participation index and GVC position index, for years in focus - 2005, 2010 and 2015.

Figure 2.14: Participation and position of Food and Beverages industry in global and European value chain



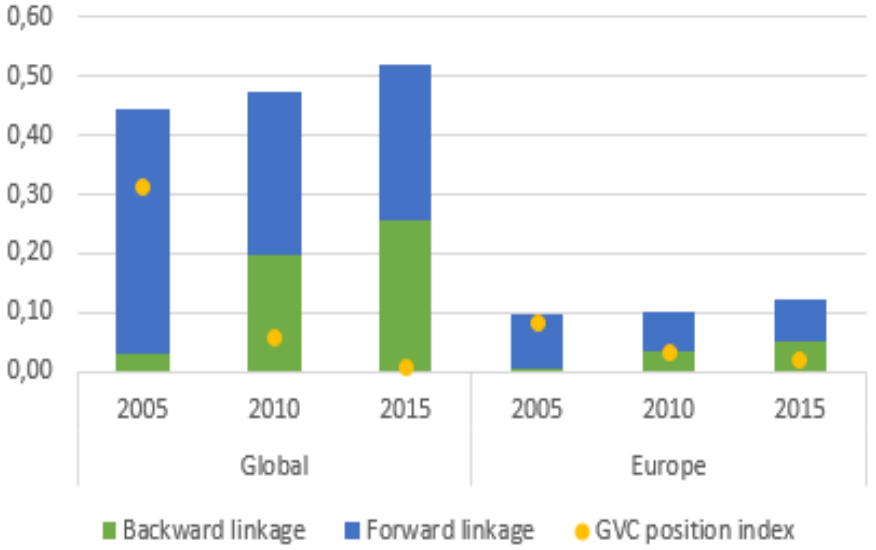
Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.15: Participation and position of Textiles and Wearing Apparel industry in global and European value chain



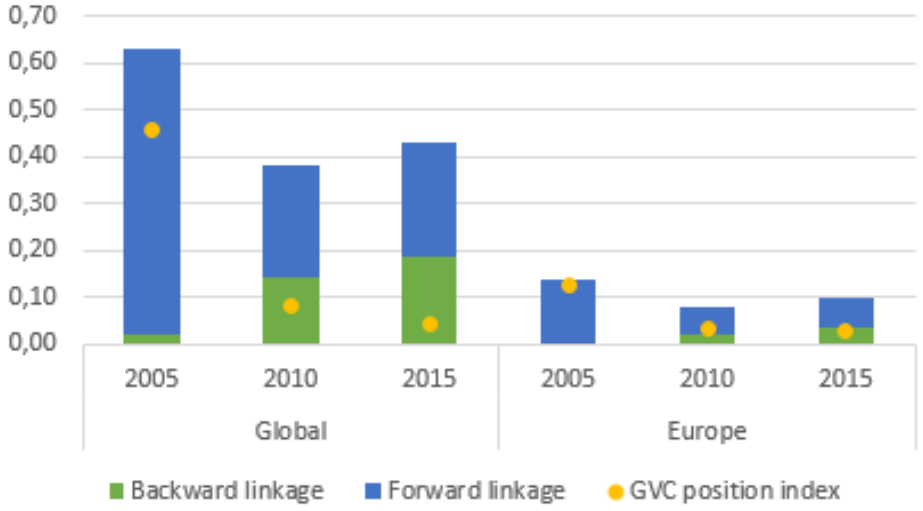
Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.16: Participation and position of Wood and Paper industry in global and European value chain



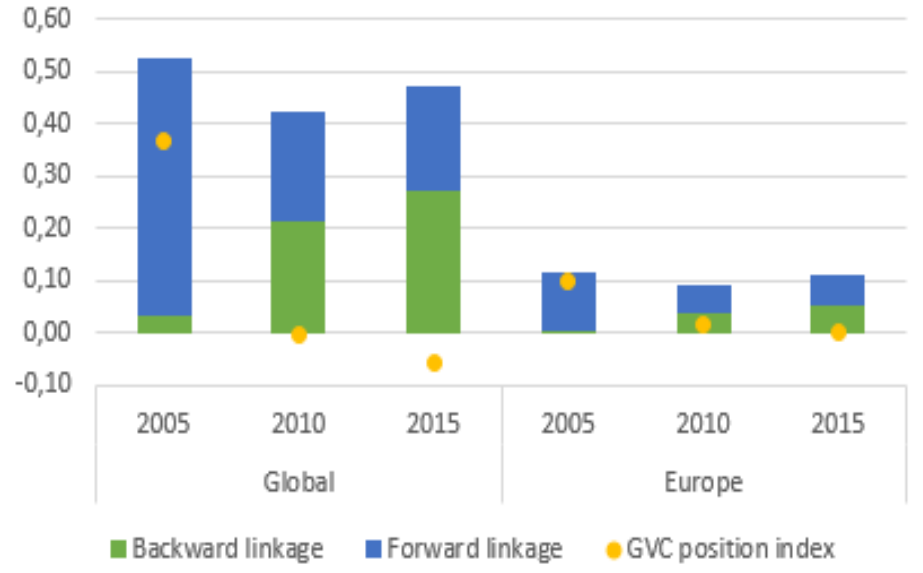
Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.17: Participation and position of Petroleum, Chemical and Non-Metallic Mineral Products industry in global and European value chain



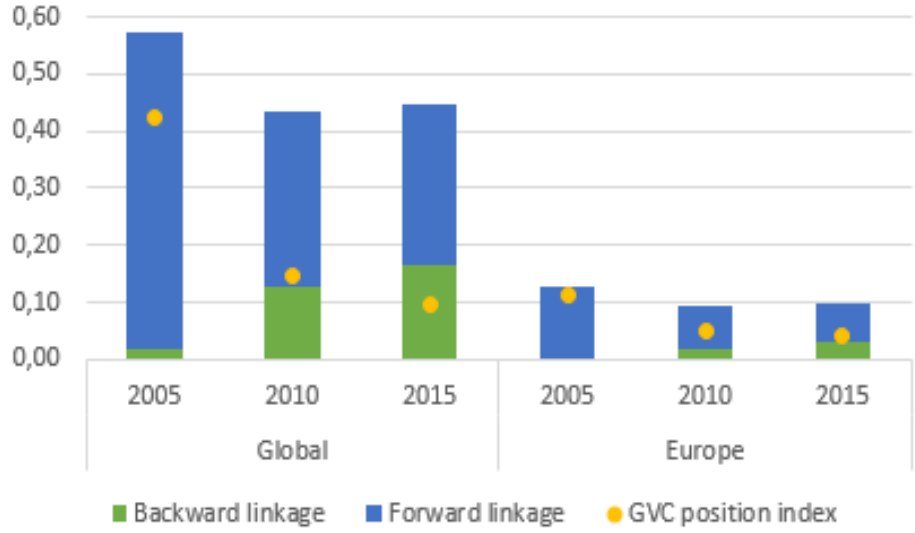
Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.18: Participation and position of Metal Products industry in global and European value chain



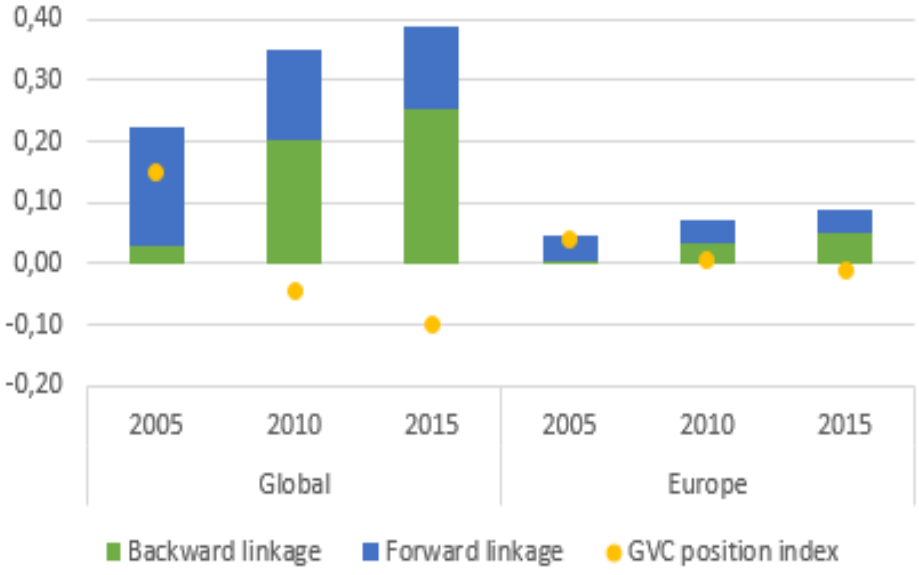
Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.19: Participation and position of Electrical and Machinery industry in global and European value chain



Source: Authors' calculation based on UNCTAD-Eora database.

Figure 2.20: Participation and position of Transport Equipment industry in global and European value chain



Source: Authors' calculation based on UNCTAD-Eora database.

It can be noticed that all industries are characterised by the same trends whether global or European value chains are observed. Dynamic of participation index indicates the greater intensity of involvement of Serbian industries in global and European value chains. However, it should be taken into consideration that this growing involvement of Serbian industries in global and European value chains is driven by backward linkages in all analysed industries, indicating that importing intermediate goods that are used to generate output for export became relatively more important than exporting intermediate goods that are used as inputs for the production of export of other countries. This suggests that the competitiveness of Serbian export of all analysed industries is diminishing. Furthermore, the declining trend of position index indicates that Serbian industries moved downstream in global and European value chains.

Industry with the greatest intensity of involvement in both global and European value chains, measured by participation index in 2010 and 2015 is Textiles and Wearing Apparel. On the other hand, the most upstream industry in both global and European value chains in 2010 and 2015 is Electrical and Machinery, which means that this industry, compared to other analysed industries, contribute more value added to other countries' export of that industry, than other countries contribute to export of Serbia.

2.5. Conclusions

In this chapter, we explored the involvement of Serbia in global value chains. We performed the exploratory analysis by using descriptive statistics. The analysis showed that Serbia increased its participation in global value chains in the period 2005-2015. This increase was strongly driven by growing foreign direct investment and the activities of foreign affiliates. Despite the improvements in integration, Serbia worsened its position in global value chains, moving downstream and specializing in later phases of production within global value chains and contributing relatively less value added to other countries' exports, than the other countries contribute to Serbian exports. In other words, the growing

involvement of Serbia in global value chains was strongly driven by backward linkages. These findings were further supported by the industry-level analysis, which revealed the same trend in all the observed industries.

While Serbia managed to integrate into global value chains, taking advantage of improved information and communication technology and trade liberalisation, its exports remain heavily dependent on foreign inputs while contributing relatively little value-added to global value chains. These results could indicate that Serbia struggles to attract foreign direct investment bringing superior technology and knowledge. Moreover, the results could imply that the export competitiveness of Serbia is decreasing. The structure of value-added sources and destinations highlights the importance of geographic distance and trade barriers in establishing partnerships within the value chains.

The results presented in this chapter raise questions regarding the actual benefits of the exports increase in Serbia. To fully take advantage of participation in global value chains, Serbia needs to raise the level of domestic content and value-added in its exports. Such repositioning towards higher value-added activities and improving forward linkage could be achieved by changing the focus in foreign direct investment promotion strategy. Namely, Serbia should seek to establish itself as a destination with the good business environment and easy access to larger markets, rather than the destination providing cheap inputs for lower value-added activities. Finally, the efforts to reposition Serbia within global value chains do not have to be limited to foreign investments. Serbia could also achieve this goal by fostering research and development activities of its domestic sector and increasing its own investment in science and technology.

In conclusion, Serbia is relatively well integrated into global value chains. However, in order to fully benefit from this integration, it requires a better position within the chain. This could potentially be attained by a combination of investment (domestic and foreign) and improving its business environment and reducing trade and investment barriers.

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Chapter 3

Slovenia in Global Value Chains

Alan Velić [18], *Katja Zajc Kejžar* [19], *Matevž Rašković* [20], *and Yang Chencheng*[21]

3.1. Introduction

With the process of globalisation and international economic integration, product fragmentation has become a vital part of modern-day production, organised in so-called global value chains (hereinafter GVCs). In GVCs production, trade of intermediate goods and to certain degree services become fragmented on an international level. Typically GVCs are a consequence of multinational companies' setting up a network of affiliates that later engage in trade of inputs and outputs (UNCTAD, 2013). Trade in services and products has been one of the key channels for international economic integration, together with foreign direct investment. The whole process of integration has been made easier by the advances in technology, such as in communication and transport sectors. Lower transport costs, shorter transport time and improved communication led many firms and corporations to consider moving part of their production abroad (OECD, 2007).

In this chapter, we focus on changes in the involvement of Slovenia in GVCs on an industry and aggregate level during the time period from 2005 to 2015. First, we describe the structure of Slovenia's exports based on the domestic value added (DVA) and foreign value added (FVA), with the emphasis on most important exporting industries and trade partners. We

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continue with the descriptive analysis of GVC participation and position on aggregated and industry level, using the theoretical framework of Koopman, Powers, Wang & Wei (2010) and Koopman, Wang & Wei (2014). For the analysis of coreness, we use the approach of Borgatti & Everett (2000) to see how Slovenia is positioned on a global and European level in each observed industry. The main data sources in this chapter are OECD TiVA database and Eurostat.

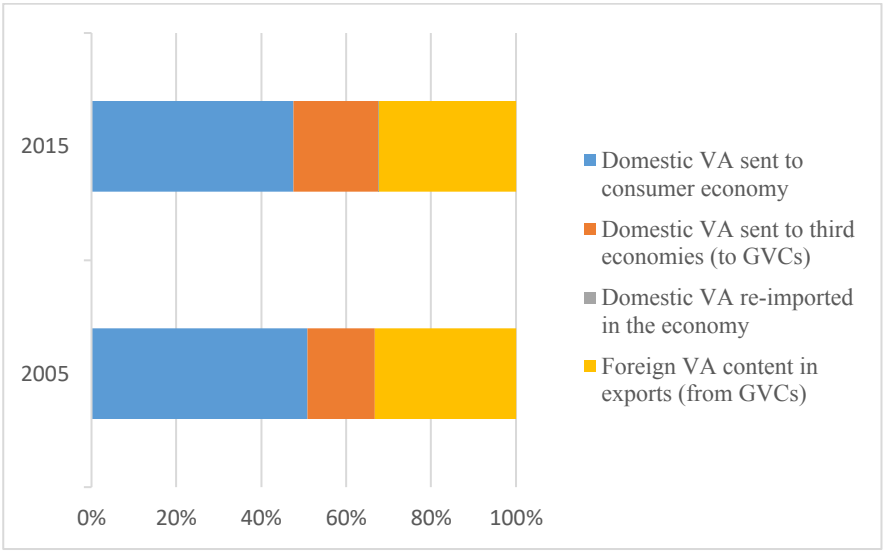
3.2. Trade in value added patterns of Slovenia

The success of Slovenia's involvement in international trade largely depends on the intensity and quality of involvement in GVCs of other companies and creating its own value chains. Share of exports of intermediate products in Slovenia had increased from 56% to 65% in the time period from 1994 to 2010. During the financial crisis, the percentage change in volume of exports of intermediate products saw a lesser decline compared to percentage share change in volume of exports of final products, which shows the importance of GVC involvement for Slovenia's exports. Kostevc and Zajc Kejžar (2017) showed that bilateral inward and outward FDI flows with an export-destination country have a strong positive effect on a firm's export survival in that market especially for the category of intermediate goods suggesting a longer export duration of supply-chain trade in Slovenia. There are two ways of GVC involvement, vertical integration through either inward or outward foreign direct investment (FDI) and through contracts. After 1999 there was a sharp decline in the share of exports via contract agreements, meaning that in 2010 exports of companies with shared or connected ownership presented the majority of the export share. The most dynamic growth was observed in vertically integrated exports through inward FDI, which provides a more stable export prospect during the recessions (Burger & Rojec, 2016).

According to the WTO data for Slovenia (Figure 3.1) total domestic value added (hereinafter DVA) in total gross exports rose by 0.9 percentage points from 2005 to 2015. Despite the decrease in the share of DVA sent

to consumer economy by 3.3 percentage points, increase in DVA sent to third economies (to GVCs) rose by 4.1 percentage points, meaning there was an increase in total DVA in a share of total gross exports. This also shows the growing importance of forward participation in GVCs for Slovenian exports.

Figure 3.1: Value added components in total gross exports (2015 and 2005)

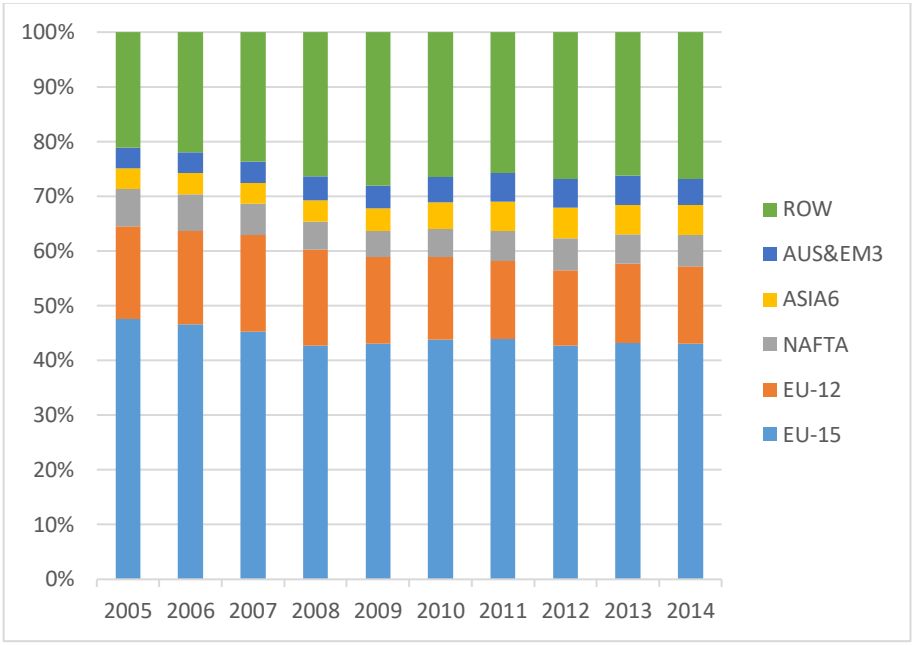


Source: World Trade Organization (WTO), *Slovenia and the WTO*

Top export industries for Slovenia in 2015, in percentage share of total gross exports, were Chemical products, Motor vehicles and Transport and storage. Among these, the Transport and storage industry had the highest DVA of 76.6%. Together, these three industries had a 19.3% DVA share in economy total gross exports. Most important partners (export destinations) in 2015 were Germany, Italy and Austria. Exports to these three partners made up a total of 25% DVA share in economy total gross exports (WTO). The structure of exported DVA is presented in Figure 3.2 and the structure of imported VA in Slovenia is presented in Figure 3.3. EU-15 stands for old country members; EU-12 stands for new EU members; NAFTA stands for the USA, Canada and Mexico; ASIA6 stands for China, Japan, South Korea, India, Indonesia and Taiwan; AUS&EM3 stands for Australia, Russia, Brazil and Turkey; ROW stands for rest of the

world. Most of the DVA throughout the period was exported to the EU member states, although their share fell by 7.3 percentage points. Despite the decrease in the share of exported DVA to EU member countries in the observed period, the export of DVA increased in absolute terms by 133.7% to old member countries and by 147.7% to new member countries from 2000 to 2014 (Golob Šušteršič, 2018).

Figure 3.2: Structure of exported DVA by regions and country groups (2005-2014)

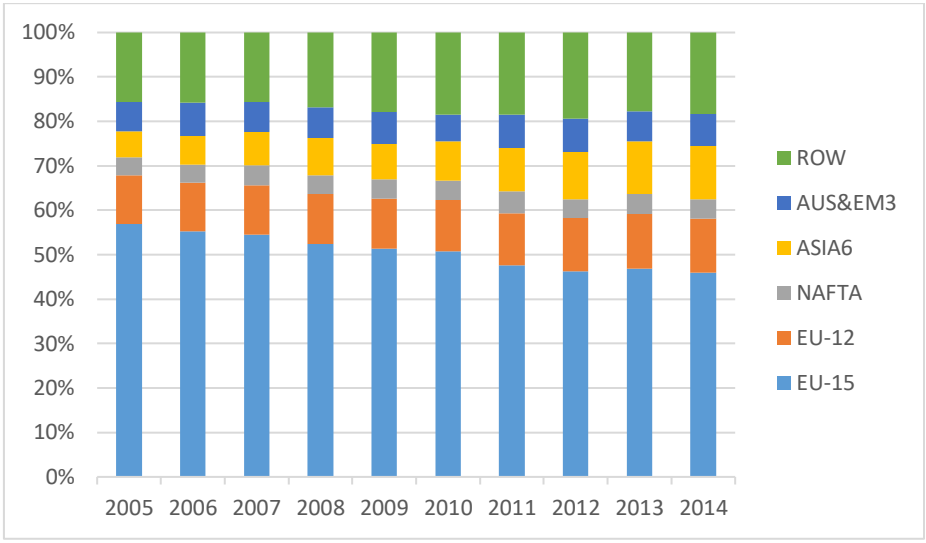


Source: Golob Šušteršič (2018)

Share in the export of DVA to the USA, Canada and Mexico decreased by 1.1 percentage points, while there was an increase ASIA6, AUS&EM3 and rest of the world categories. EU country members also played an important role in the import of VA for Slovenia. In 2005 Slovenia imported 67.9% of total value added from EU country members. Until 2014 the share decreased to 58.1%, with the share of VA imported from old member countries decreasing by 10.9 percentage points, while the share of VA imported from new member countries increased by 1.1 percentage points.

Share of ASIA6 countries more than doubled, increasing by 6.1 percentage points. This increase was mainly driven by the rise of imported VA from China, which increased by more than 860 mil € from 2000 to 2014 (Golob Šušteršič, 2018).

Figure 3.3: Structure of imported VA in Slovenia by regions and country groups (2005-2014)



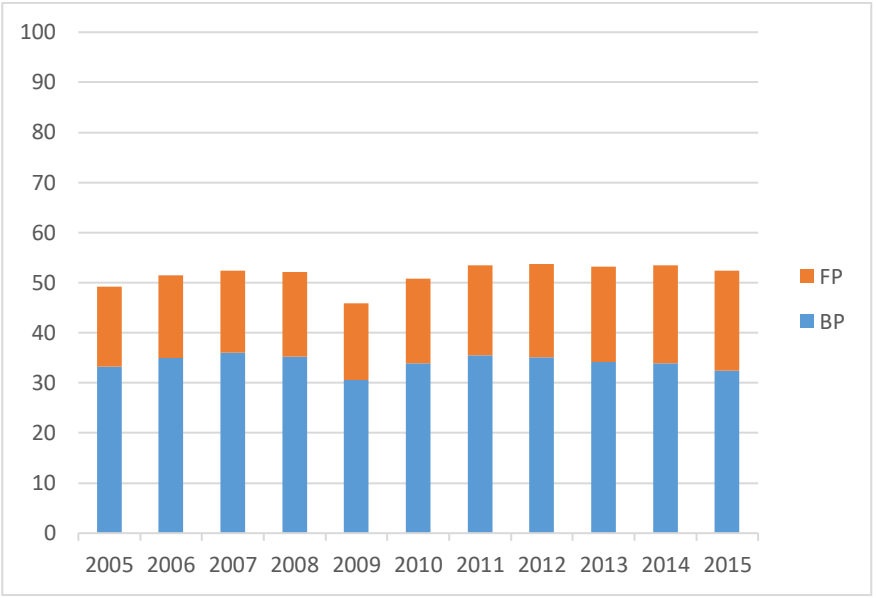
Source: Golob Šušteršič (2018)

3.3. The Participation of Slovenia in Global Value Chains

Development in GVC participation index for Slovenia in 2005 to 2015 period on a scale from 0 to 100 is presented in Figure 3.4. GVC participation index is the sum of backward participation (BP) and forward participation (FP). During this time period, the GVC participation index increased by 3.24 percentage points (or 6.59%), mainly because of the increase in forward participation, which increased by 4.06 percentage points (or 25.55%). During the global financial crisis, GVC participation fell by 6.32 percentage points, which was mostly the consequence of a decrease in backward participation, which decreased by 4.62 percentage points.

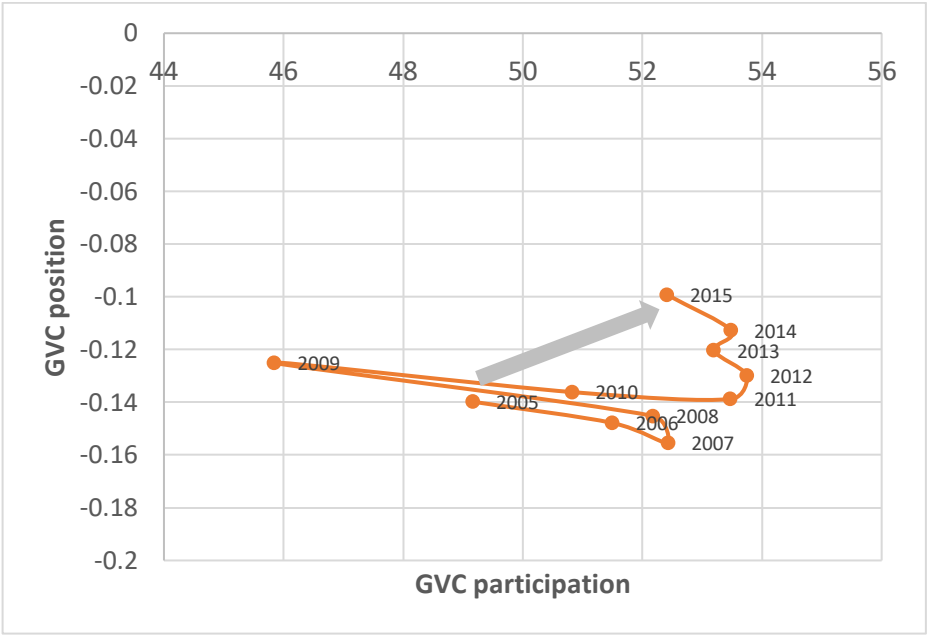
During the observed period, Slovenia moved relatively more upstream, as can be seen in Figure 3.5, where we graphically depicted the relation between GVC participation index and GVC position index. The latter denotes relative upstreamness of a country and is calculated based on forward and backward participation indices based on the approach of Koopman, Powers, Wang & Wei (2010). The arrow represents a trend of changes during the observed period, from which we can conclude Slovenia moved more upstream and increased its GVC participation at the same time. Moving more upstream might suggest that Slovenia started producing some of the intermediate products instead of merely relying on importing them.

Figure 3.4: GVC participation for Slovenia (2005-2015)



Source: Authors' calculations based on TiVA (OECD) database.

Figure 3.5: GVC position and participation for Slovenia (2005-2015)



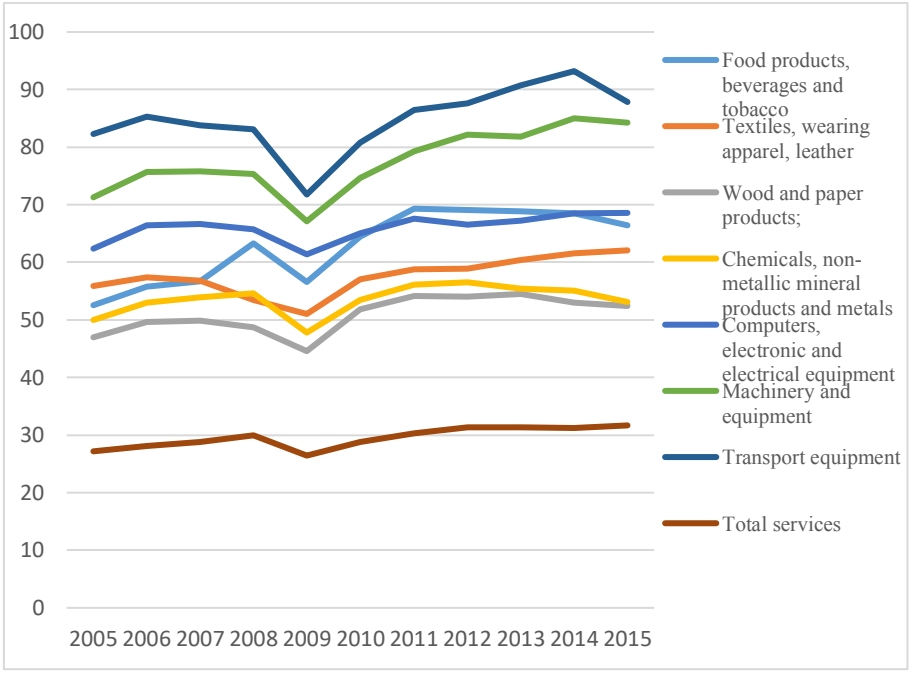
Source: Authors' calculations based on TiVA (OECD) database.

To understand these dynamics better we calculated GVC participation and GVC position index by industry (Figure 3.6 and Figure 3.7). For the purpose of analysis we chose the following industry classifications: Food products, beverages and tobacco (D10T12); Textiles, wearing apparel, leather (D13T15); Wood and paper products (D16T18); Chemicals, non-metallic mineral products and metals (D19T25); Computers, electronic and electrical equipment (D26T27); Machinery and equipment (D28); Transport equipment (D29T30); Total services (D41T98). In general, there was a noticeable positive trend in GVC participation among all industries, with the highest growth being in Food products, beverages and tobacco industry at 13.87 percentage points increase, followed by Machinery and equipment industry with a 12.91 percentage points increase. However, during the financial crisis, Slovenia experienced a decrease in GVC participation in all industries, followed by a rapid rebound wherein the following two years industries saw their GVC participation rise above the pre-crisis peak. Transport equipment industry remained the industry with the highest GVC participation throughout the 2005-2015 period, while the

Total services maintained relatively low GVC participation, which was also the case for Poland and Hungary. Trends in the European economy were an important driver in the dynamics of changes, highlighting the importance of the European market for Slovenia.

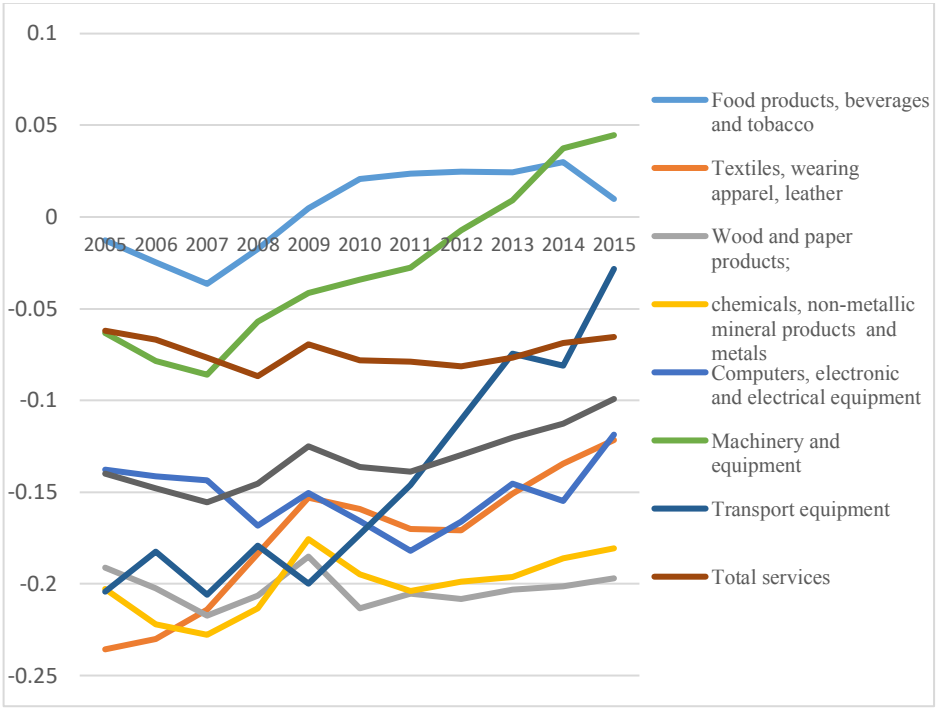
Changes in GVC position were much more dynamic compared to those in GVC participation. In the industry with the highest GVC participation, Transport equipment, we observed the highest move upstream, which saw GVC position index rise from -0.204 to -0.028. The only two industries where Slovenia moved more downstream were Wood and paper products and Total services. These were also the industries with the lowest GVC participation indices.

Figure 3.6: GVC participation index by industry for Slovenia (2005-2015)



Source: Authors' calculations based on TiVA (OECD) database.

Figure 3.7: GVC position index by industry and total for Slovenia (2005-2015)



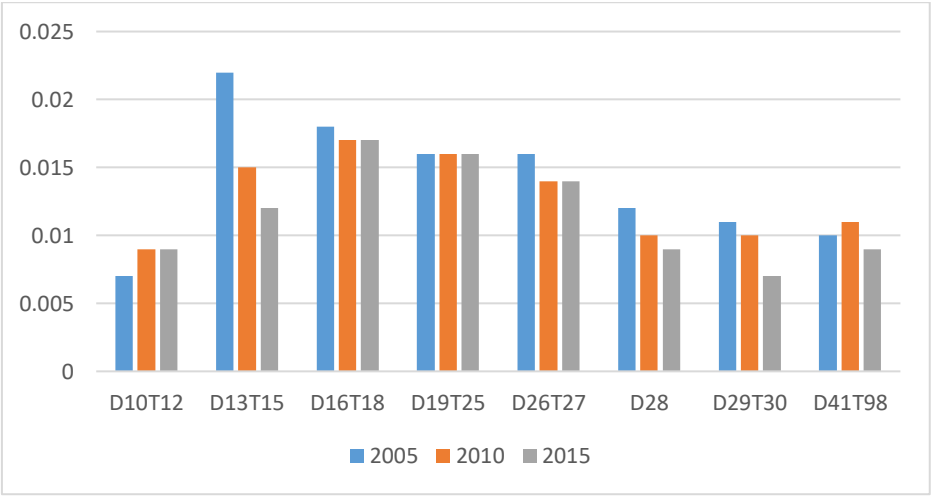
Source: Authors' calculations based on TiVA (OECD) database.

3.4. Coreness of Slovenia in global and European trade network

We calculated continuous coreness measure based on the Borgatti & Everett (2000) theoretical definitions (see Chapter 1) for the years in focus: 2005, 2010 and 2015. Results for global as well as European trade network by industry are graphically presented in Figures 3.8 and 3.9. By doing an analysis on both global and European level, we intend to compare the core-periphery changes in global and European trade in the value-added network for Slovenia.

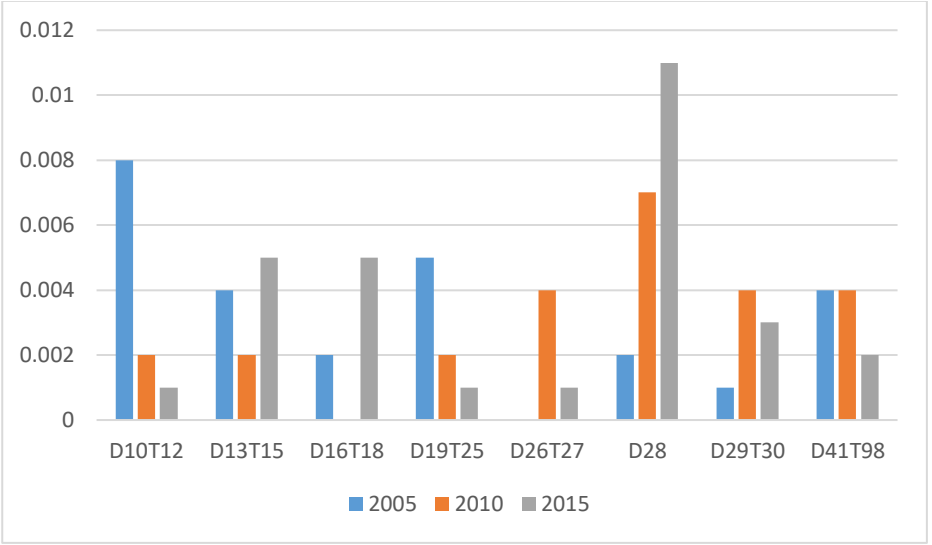
Changes to coreness in European trade network were much lesser in relative terms compared to those in global one, as seen in Figures 3.8 and 3.9. Slovenia is highly integrated into the European internal market, both in terms of economy and trade, meaning that its trade performance to a large extent depends upon the health of the European economy. The most notable change in the coreness on a European level was the decrease in coreness in *Textiles, wearing apparel, leather* (D13T15) industry. On a global level, Slovenia is a small player, partaking merely in a fraction of GVCs. Therefore large investment projects, takeovers or affiliates of foreign companies in Slovenia can make relatively large changes in its coreness. Some changes in coreness may not be directly tied to GVC dynamics in Slovenia, but come as a consequence of dynamics on a global level. There was a large decrease in coreness in *Food products, beverages and tobacco* (D10T12), which was also the highest relative change in coreness on both, global and European level. Comparing the changes in European coreness to global coreness we can see that some industries saw the opposite changes, namely *Food products, beverages and tobacco* (D10T12) with an increase on a European level, decrease on a global level and *Machinery and equipment* (D28) with a decrease on a European level and an increase on a global level.

Figure 3.8: Coreness by industry, European trade network, for Slovenia (2005, 2010, 2015)



Source: Authors' calculations based on TiVA (OECD) database.

Figure 3.9: Coreness by industry, global trade network, for Slovenia (2005, 2010 and 2015)



Source: Authors' calculations based on TiVA (OECD) database.

3.5. Conclusions

In this chapter, we portray the involvement of Slovenia in global value chains. Based on our results we conclude that Slovenia increased its GVC participation during the time period from 2005 to 2015. In the same time period, forward participation increased, while backward participation decreased. Furthermore, Slovenia as a country moved more upstream, meaning it started specializing in earlier phases of production and increasing the domestic value added sent to third countries. Most important trade partners for Slovenia remain the EU member states, despite there being a negative trend regarding the share of imported and exported VA. China has emerged as an important trade partner, with VA imported from China increasing substantially.

There was an overall increase in GVC participation in every industry during the time period from 2005 to 2015, with a significant drop during the financial crisis, followed by a fast rebound during the next two years.

The only two industries that moved downstream were the industries with the lowest GVC participation, that being *Total services* and *Wood and paper product industries*. In terms of coreness on a European and a global level, the changes were more significant on a global level as opposed to minor in the European market, where Slovenia is more deeply integrated.

To conclude, Slovenia exhibits above-average integration into GVCs compared to other CEECs. It was able to increase GVC participation while decreasing backward linkages and increasing forward ones, hence moving upstream the values chains. In order to benefit more from the global value chains, Slovenia should aim to keep highly educated and skilled workers and attract foreign capital in technology-intensive industries.

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Chapter 4
Hungary in Global Value Chains

Erzsebet Czakó[22], *Peter Vakhal*[23]

4.1. Introduction

Hungary has a central location in Central and Eastern Europe, which makes it transit country along the South East European corridor. In 1990 Hungary was one of the first countries that opened its borders for merchandise trade from Western Europe. In 1996 Hungary and other Visegrad countries (Poland, Czech Republic and Slovakia) signed a free trade agreement with the European Union, and since the EU accession in 2004, Hungary is the member of the customs union of the European Communities. Right after the EU accession in 2004 the most important EU achievement, the free movement of goods and persons, became a reality. From 2007 the psychical border and customs control between Hungary and the EU is ceased. According to estimations between 1992 and 1996 the reduction of tariff barriers resulted in a 1 billion US dollar decrease of burden.

During the transition to market economics Hungary was one of the countries that privatised formerly state-owned companies the fastest. Between 1990 and 1996 almost all large (usually loss-making) state-owned firm became private companies. That helped to reduce public debt and increase productivity rapidly. The net inflow of FDI in terms of the GDP was around 10% on average every year. In the 1990s, compared to other ex-socialist countries Hungary had a relatively high skilled labour force at much lower labour cost in comparison to developed countries. Besides, the

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government generously supported foreign direct investments (especially green fields).

In 1990 the Japanese car manufacturer Suzuki opened its plant in North Hungary which was followed the German brand Opel in Western Hungary. These two factories put the country on the value chain of the automotive industry. In 1993 Audi began production in Northwest Hungary and since then it has been permanently growing. In 2018 the number of employees was over 15.000. Since 2012 Mercedes-Benz began operation in Central Hungary. The presence of these manufacturers attracted other multinational companies (like Robert Bosch, ZF, Hankook etc.), directly supplying the industry with inputs. From 2004 Hungary gradually became a global host for shared service centres (SSC) for large transnational firms operating in the service sector (Morgan Stanley, Vodafone, IBM etc.).

After the change of the regime, Hungary's economy became export-led. Outbound trade including services amounts almost 90% of the GDP, which is one of the highest in the world. No doubt that the above-mentioned companies put Hungary on the map of global value chains, and nowadays the country turns out to be one of the biggest assembling factories in Europe. The price for that was lag in competitiveness that caused labour costs to almost freeze for many years, implying loss in productivity and growing risk of external business environment dependency. In this chapter, we'll go through the GVC indicators concerning Hungary that will show the pros and cons of deep GVC integration.

4.2. Trade in value added patterns in Hungary

Hungary has a backward participation in the global value chains, that is, it imports more value added than exports (Figure 4.1). It implies that it is relatively positioned at the end of the GVC, closer to the ultimate consumer. More than half of the exported domestic value added comes from the manufacturing industry, mainly from chemical, automotive and chemical industry and these also provide the largest export share.

Hungary's export was rocketing after the financial crises both in nominal and in per GDP term. At the same time, the domestic value-added content did not emerge, and it is still one of the lowest in Europe (around 50%). Most probably this is due to the multinational companies settled in Hungary who attracted their – also multinational – suppliers because there was not enough local capacity. Intermediate goods are still imported, many times the assembly is the only source of domestic value-added. Another specific factor that Hungary is lack of energy raw materials.

Due to its special characteristics, services, agriculture and mining are operating with much higher domestic value-added share compared to manufacturing. At the same time, the latter produce more value-added in absolute terms, though it is much dependent on imports. One can conclude that the higher the gross export of industry, the lower is the value-added. The three largest industries (chemical, machinery and automotive industry) give 50% of the gross export, though it contains domestic value-added only in 37%. This value is one of the lowest in Europe.

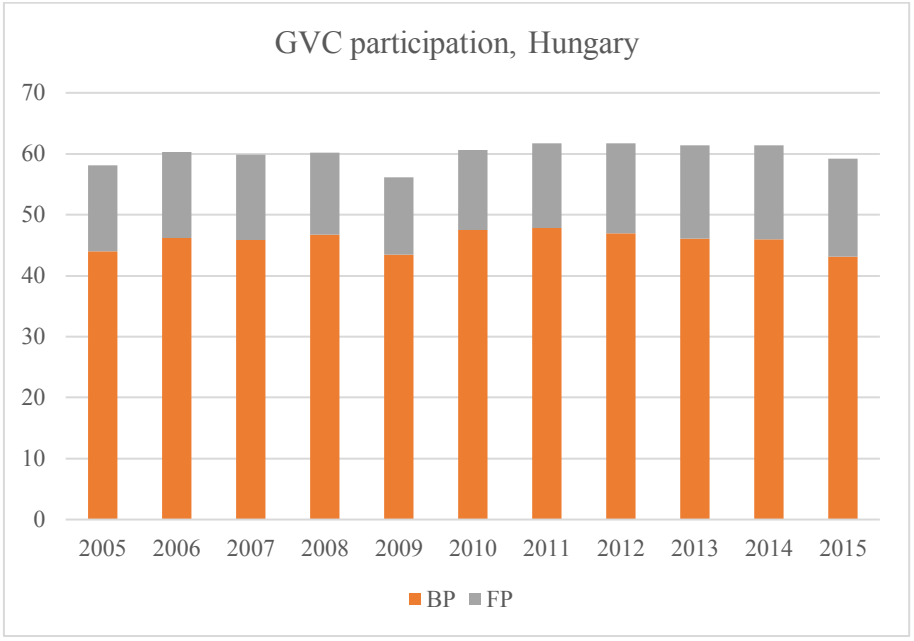
Food and beverage industry, which traditionally relies on domestic inputs, contains Hungarian value-added in 60% of gross export only. Compared to other Visegrad countries, this value is very low and it is mainly due to the privatisation of local food suppliers in the 1990s. Hungary lost its competitive position on the international food market as it ceased production of some crucial products (like sugar). 1/3 of the total value added in the local food industry is from Germany, Poland and Slovakia.

Manufacturing industry imports value-added mainly from Germany, Russia and China. These 3 countries give half of the total domestic value-added. Germany is the top supplier in almost all industries, while Russia is the main one in the chemical, and China in the electronics industries. Germany provides 16% of the foreign value added in the Hungarian export, thus it is the largest value-added import partner. It is then followed by Russia (energy raw materials) and Austria. Hungary exports its domestic value-added mainly into Germany, Italy and Great Britain. The main source of that value added is the Hungarian automotive industry.

4.3. The participation of Hungary in Global Value Chains

As mentioned before Hungary's backward integration in the global value chain the much higher than the forward (Figure 4.1). Despite the rapid increase in exports, the participation rate did not change significantly. The backward participation rate was around 40% in 2015 which was the highest in the investigated countries.

Figure 4.1: GVC participation in Hungary 2000-2015

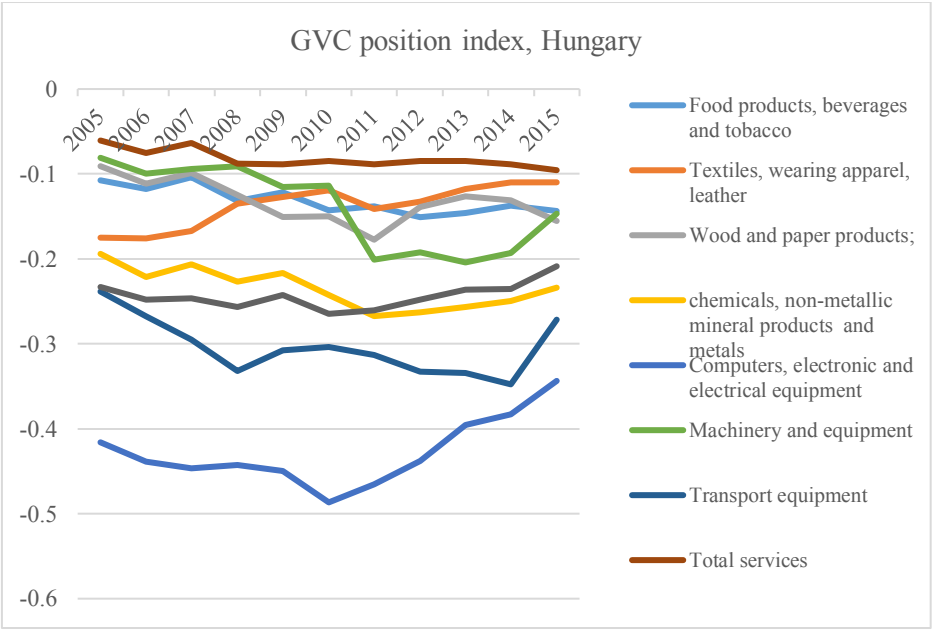


Source: Authors' calculations based on TiVA (OECD) database.

According to Vakhal (2018), the main source of growth in the automotive industry between 2014 and 2018 in Hungary was the labour. As returns to scale is much higher in Hungary than in other European countries, it is easier to increase production by utilising more labour than capital. This implied a very low increase in productivity. In order to keep the competitiveness of the economy, labour costs kept low resulting one of the lowest wages in Europe.

Due to the lack of significant improvement in productivity industries could hardly upgrade along the GVC and the only way to ensure economic growth was to increase output by involving more inactive labour. Government measurements to achieve this was successful, now the employment is record high in Hungary, and there is a significant labour shortage in almost all industries.

Figure 4.2: GVC position by industries in Hungary



Source: Authors' calculations based on TiVA (OECD) database.

Figure 4.2 above represents the situation well. Between 2005 and 2015 there was no industry in the manufacturing branch in Hungary that could achieve a positive balance of domestic and foreign value added per export. Even more, the three top exporter industries have the lowest position index within manufacturing. This also means an unfavourable balance of trade. Current account has been traditionally positive in Hungary, though nowadays the surplus is due to services. Although the automotive industry is considered to be the most important economic branch in Hungary it mainly due to its large output and rapidly growing export. At the same time, its backward linkage ratio is very high, which means its multiplier

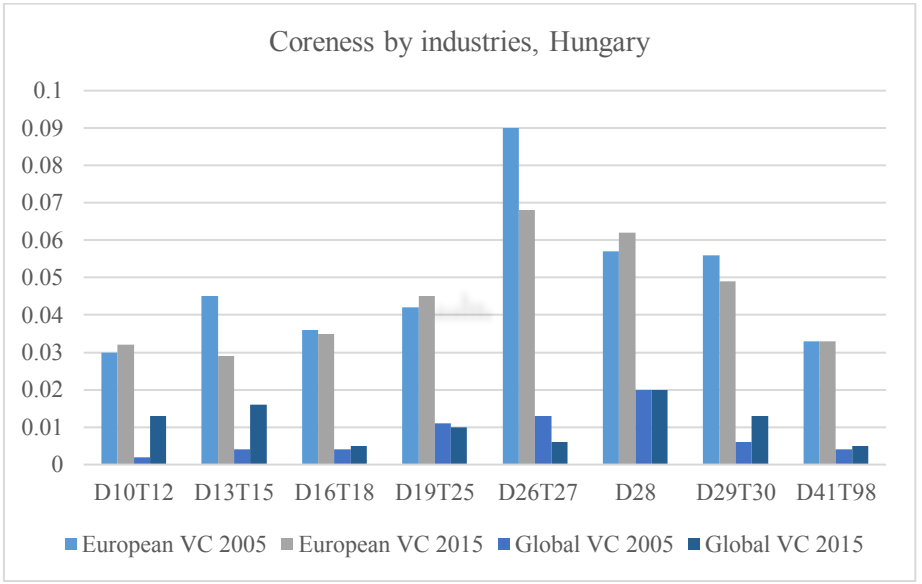
effect is much lower than one would expect based on the output. Koppány (2017) estimated that services have a much higher multiplier effect in the Hungarian economy than the manufacturing industry. Even more, agriculture and mining have higher value-added multipliers. Within the manufacturing industry printing and service activities related to printing (NACE18) possess three times higher multiplier than the automotive industry. This implies that the deep embeddedness in global value chains does not necessarily give more economic power to the production of the involved industries. If the competitive advantage of an industry is low labour costs then in the long run the national economy will not gain an advantage of GVC integration.

4.4. Coreness of Hungary in global and European trade network

Although Hungary has an extremely high export/GDP ratio, and it has a geographically favourable position in the region, the trade relation of the country is not diverse. The main trading partner is Germany which takes almost a third of the total merchandise export. Altogether 6 countries constitute more than 50% of total export and all of them is European. China has only 2.9% share in the Hungarian export, while Romania has 5.4%.

This is due to the specialisation of export products which means that most probably Hungary is only on the automotive industry value chain. In comparison, Poland could join the food value chain and has some interests in service value chain, too. Although, Hungarian domestic value-added in the automotive industry can reach many destinations one must not forget that the GVC position is negative, which makes Hungary a relatively small actor in that particular value chain.

Figure 4.3: Coreness by Hungarian industries in the European and global value chains



Source: Authors' calculations based on TiVA (OECD) database.

4.5. Conclusions

This chapter went through the CEE value chains in view of the Hungarian economy. Hungary had a rapid export growth since the 1990s right after the change of the political system. Opening to the market economy, accessing to the EU and abolishing almost all trade barriers with the most important trading partner attracted a significant amount of FDI inflow to the country. Large global automotive brands settled in Hungary employing more than 30.000 employees directly. Due to its large output, the export is depending on the automotive industry.

Since 1990 the comparative advantage of Hungary gradually shifted to low labour cost from skilled labour. Although significant measurements were taken by the government in the past years, Hungarian wages are still one of the lowest in the EU. Low wages resulted in lagging innovation, productivity and competitiveness. At the same time, Hungary integrated

deeper into the global value chains by decreasing the ratio of the inactive population.

The lack of development in productivity implied increased backward linkage in all manufacturing industries and causing severe negative GVC position values. Today it is the service sector that balances the forward and backward participation and produces current account surplus. Business services have two times higher multiplier effect on average than the manufacturing industry because the latter imports more foreign value-added than export domestic value-added. The specialisation of the Hungarian export on the automotive industry provides Hungary with a small role in the European and global value chain. Although it is one of the most open countries in the world, it couldn't upgrade in the GVC in the past years.

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Chapter 5
Poland in Global Value Chains

Michał Zdziarski[24]

5.1. Introduction

The global value chain (GVC) concept was developed to acknowledge the importance of supplier and buyer networks to value creation and competitiveness. GVC role in value creation is critical, as "55% of the value of each product an average manufacturing firm produces in the US, and 69% in Japan, are purchased from outside" (Dyer and Singh 1998, 660). It is estimated that the share of intermediary goods and services in the world trade accounts for as much as 60% (Gunnella, Fidora and Schmitz 2017). The value chain denotes "the process by which technology is combined with material and labour inputs, and then processed inputs are assembled, marketed, and distributed. A single firm may consist of only one link in this process, or it may be extensively vertically integrated, such as steel firms that carry out operations that range from mining ore to fabricating final goods" (Kogut 1985, 15). Firms from different sectors and industries may contribute to value created in the same value chain, which requires a perspective beyond the traditional firm, sector and country levels (Giuliani, Pietrobeli and Rabellotti 2005). Value creation in GVCs occurs in upstream and downstream activities, which are often globally dispersed. Dispersion of the value chain in global markets and variation in network structures of the value chains are becoming increasingly important in International Business research (Zdziarski, Srai and Rezk, 2017). We observe the dominant unit of analyses of the global rivalry is evolving from firm-versus-firm competition towards the competition of supply chains and interconnected networks of firms competing against other in globally dispersed value chains (Craighead, Hult and Ketchen 2009). Therefore

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understanding competitive position in the global value chains, and consequences of the embeddedness in the GVC networks becomes increasingly important. Focusing on global value chains rather than firm to firm rivalry brings variety of research problems that include: "network shape and structure, ownership, levels of vertical and horizontal integration, relationships and inter-dependencies between network partners, unit operations (manufacturing processes, optimum sequence, platforms, sub-assembly, modularity, complexity, flexibility, etc.), product offering (product, spares, through-life support and services)" (Srai and Gregory 2008, 393–394). While these multi-level approach is challenging for researchers due to difficulties in operationalisation and scarcity of data, the evidence clearly indicates the need to increase our knowledge on GVC, as 60% of global trade, amounting to over $20 trillion, consists of trade in intermediate goods and services at various stages of global value chains (UNCTAD 2013).

In this chapter, we focus on the involvement of Poland in GVCs both on an industry and aggregate level during the time period from 2005 to 2015. In this period Poland was the largest country measured by the size of its economy and population, among the set of countries from Central and Eastern Europe that were subject of analysis in international research project reviewed in this publication. The data sources in this chapter are OECD TiVA database, Economic Complexity Laboratory Ranking and Eurostat. The theoretical grounding for the chapter is a framework of GVC participation proposed by Koopman, Powers, Wang & Wei (2010) and Koopman, Wang & Wei (2014) that traces the value added in exports of a country by domestic and foreign sources, as well as by geographical origin of the final demand that activated them.

5.2. Poland in Global Value Chains in the 2005-2015 period

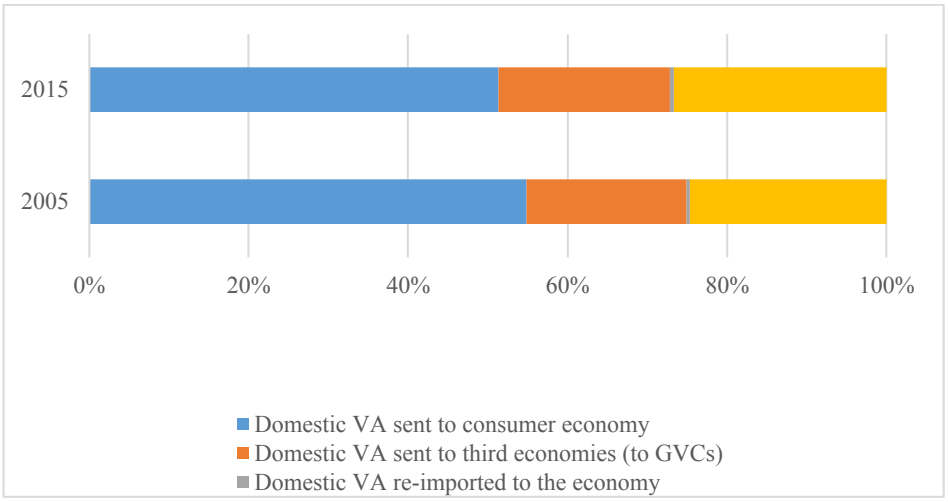
Many enterprises operating from Poland are well integrated into international value chains as evidenced by statistical data on value added

published by the Organization for Economic Cooperation and Development (OECD) and the World Trade Organization (WTO). This is also supported by a relatively high position of Poland in economic complexity index rankings that aim to capture the value of knowledge embedded in exports depending on industrial mix of an economy (Hidalgo & Hausmann. 2009). In the analysed period from 2005-2015 Poland kept its position of 24th most complex among world economies, ahead of each of BRIC countries (Russia, Brazil, India and China), yet below several neighbouring countries from Central and Eastern Europe including the Czech Republic, Slovenia, Slovakia, and Lithuania. The key finding of the "TRADE IN VALUE ADDED: POLAND" report from OECD was that "Poland has integrated significantly into global value chains (GVCs) in the last two decades with the foreign content of exports doubling between 1995 (16.1%) and 2011 (32.3%)"[25]. The share of foreign value added in the exports has increased from 24.7% to 26,6% between 2005-2015 as more recent data from OECD TiVA (2018) database indicates. Based on these results one can claim high levels of participation in international value chains. We also observe a rising value added generated in Poland that accounts for other countries' exports.

According to the WTO data for Poland total domestic value added (hereinafter DVA) sent to third economies rose by approximately 7.3 percentage points from 2005 to 2015 (Figure 5.1). The measure reflects how domestic industries (upstream in a value-chain) are connected to consumers in other countries, even where no direct trade relationship exists. The indicator, therefore, illustrates the full upstream impact of final demand in foreign markets to domestic output. It can be interpreted as 'exports of value added'.

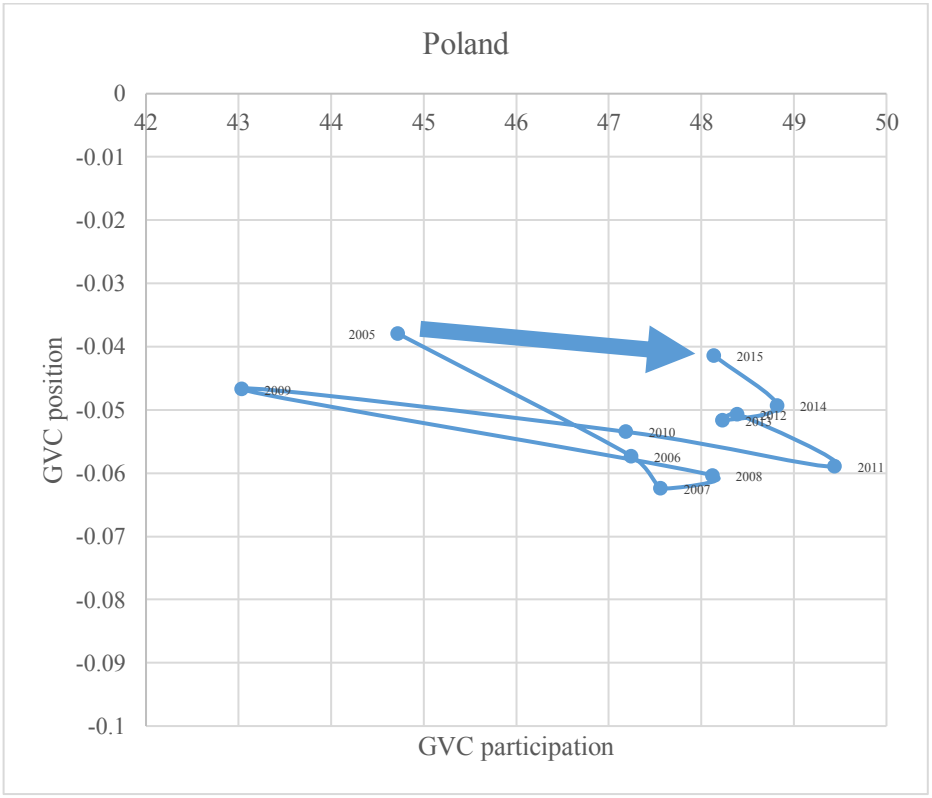
[25] https://www.oecd.org/sti/ind/tiva/CN_2015_Poland.pdf last access 07/07/2019

Figure 5.1: Value added components in total gross exports (2015 and 2005)



Source: Authors' calculations based on TiVA (OECD) database.

Figure 5.2: GVC position vs GVC participation for Poland (2005-2015)



Source: Authors' calculations based on TiVA (OECD) database.

Despite the decrease in the share of DVA sent to consumer economy by 6,5 percentage points, increase in DVA sent to third economies (to GVCs) rose by 7,3 percentage points, meaning there was an increase in total DVA in a share of total gross exports. This also shows the growing importance of forward participation in GVCs for Polish exports.

During the observed time period, Poland moved relatively more downstream, as can be seen in Figure 5.2, where we graphically depicted the relation between GVC participation index and GVC position index. The latter denotes relative upstreamness of a country and is calculated based on forward and backward participation indices based on the approach of Koopman, Powers, Wang & Wei (2010). The arrow represents a trend of changes during the observed period, from which we can conclude Poland moved more downstream and increased its GVC participation at the same time.

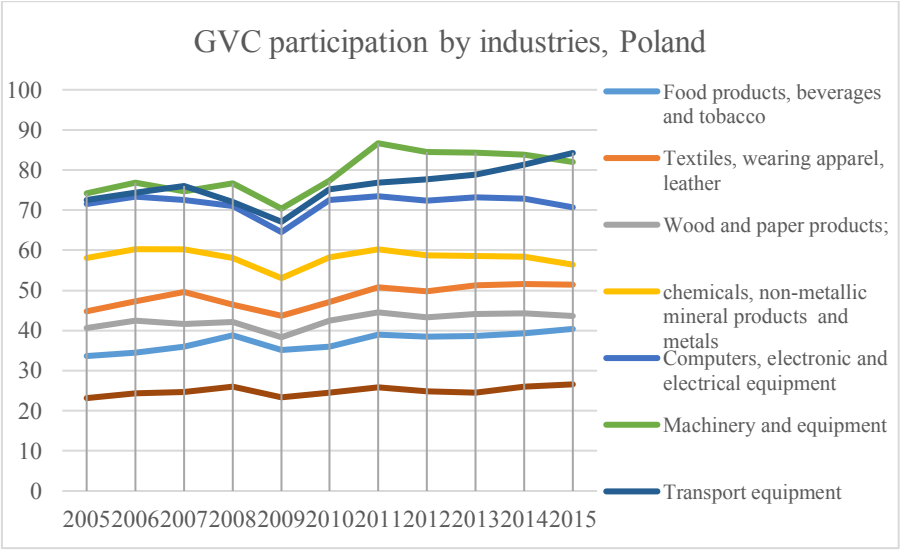
5.3. Industry Overview of the Participation in Global Value Chains

In Figure 5.3 we present GVC participation index by industry. For the purpose of analysis we chose the following industry classifications: Food products, beverages and tobacco (D10T12); Textiles, wearing apparel, leather (D13T15); Wood and paper products (D16T18); Chemicals, non-metallic mineral products and metals (D19T25); Computers, electronic and electrical equipment (D26T27); Machinery and equipment (D28); Transport equipment (D29T30); Total services (D41T98). For six out of eight industries there was a positive trend in GVC participation, with the highest growth being in transport equipment, machinery and equipment, textiles, wearing apparel and leather, and food products, beverages and tobacco industry. There has been noticeable decrease of Poland's participation during the financial crises followed by expansion of GVC participation since 2009. Machinery with the highest participation rate in GVC in 2009 expanded most dynamically, but later remained stagnant or slightly decreasing from 2011. In 2015 transport equipment industry took

over the first position among all analysed as ranked by the GVC participation.

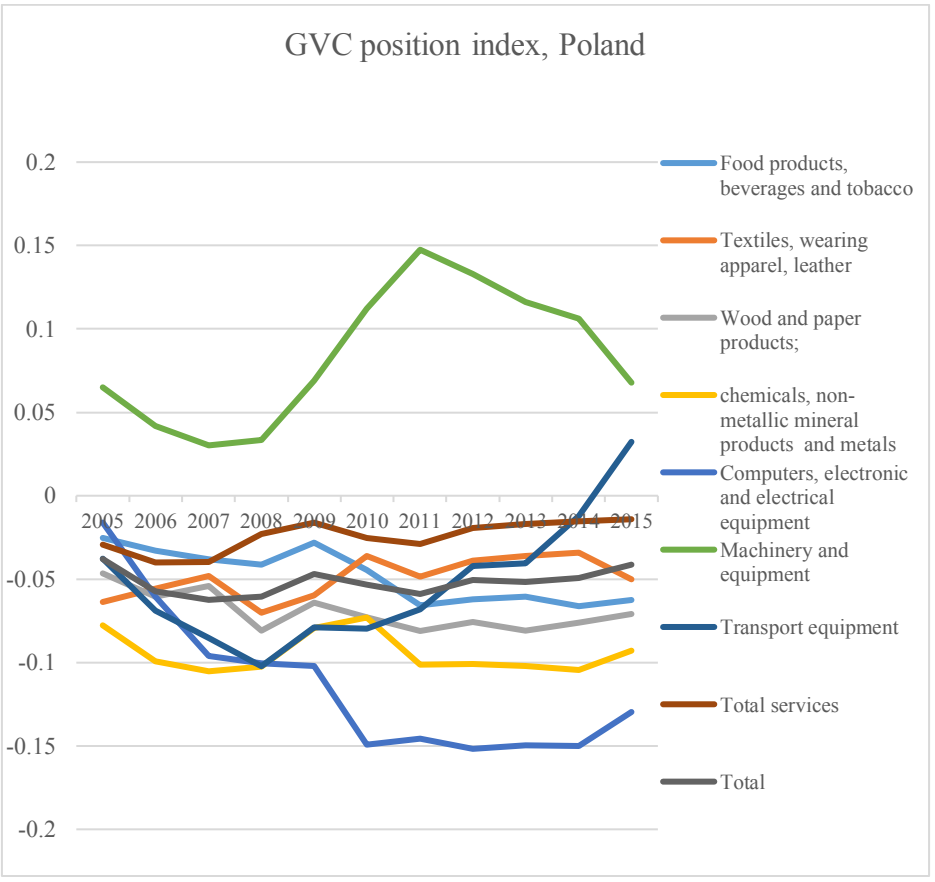
Changes in GVC position (Figure 5.4) describing the relative upstreamness of a country show only two industries with positive scores in the analysed period from 2005-2015. In the industry with the highest GVC participation in period from 2005-2015 – Machinery and equipment, we observed the move downstream until 2008, followed by a dynamic move upstream until 2011, followed by a fast decrease since then. In the industry of transport equipment which raised to the highest rank from all in terms of GVC participation, the upstream position has been increasing from 2008 to 2015. The highest downstream movement was for computers, electronics and electrical equipment.

Figure 5.3: GVC participation by industries between 2005-2015 for Poland



Source: Authors' calculations based on TiVA (OECD) database.

Figure 5.4: GVC position index by industries between 2005-2015 for Poland

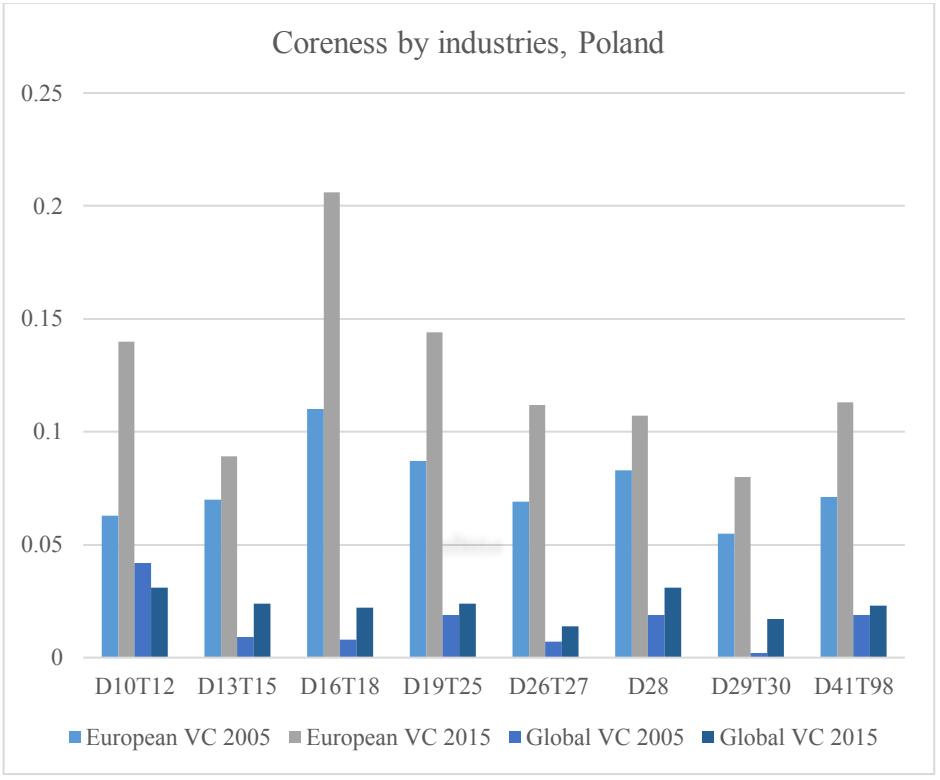


Source: Authors' calculations based on TiVA (OECD) database.

5.4. Coreness of Poland in global and European trade network

We calculated the index of network coreness based on the Borgatti & Everett (2000)' theoretical definitions (see Chapter 1) for the years in focus: 2005 and 2015. Results for global as well as European trade network by industry are graphically presented in Figure 5.5 below.

Figure 5.5: Coreness index by industries in Global and European VCs between 2005-2015 for Poland



Source: Authors' calculations based on TiVA (OECD) database.

Changes to coreness in European trade network were much more substantial from 2005-2015 in relative terms compared to those in the global trade network. For all industries but Food products, beverages and tobacco (D10T12) global coreness of the Polish industry position in the overall networks has strongly improved in the analysed decade. Even for Food products, beverages and tobacco the decrease in coreness on a global scale is parallel to substantial increase on a European level. Wood and paper products (D16T18) is most closer to the core of European trade network, while two industries: Machinery and equipment (D28) and Food products, beverages and tobacco (D10T12) have the highest coreness scores in the global trade network in 2015.

5.5. Conclusions

In this chapter, we portray the involvement of Poland in global value chains. Based on our results we conclude that Poland increased its GVC participation during the time period from 2005 to 2015, while the position in GVCs decreased after several expansion and downwards movements. Finally, Poland in the analysed period moved more downstream. Key trade partners for Poland remain the EU member states with Germany being the most crucial partner of all. Outside of EU the US and China stand out as increasingly important trade partners. The Polish economy is relatively complex with scores above the BRIC countries. There was an overall increase in GVC participation in most industries during the time period from 2005 to 2015, with a significant drop during the financial crisis, followed by a fast rebound during the next two years. The only two industries have decreased their participation in the analysed period are chemicals and computers. During the observed time period, Poland moved downstream but only slightly, while overall the GVC participation of Poland increased.

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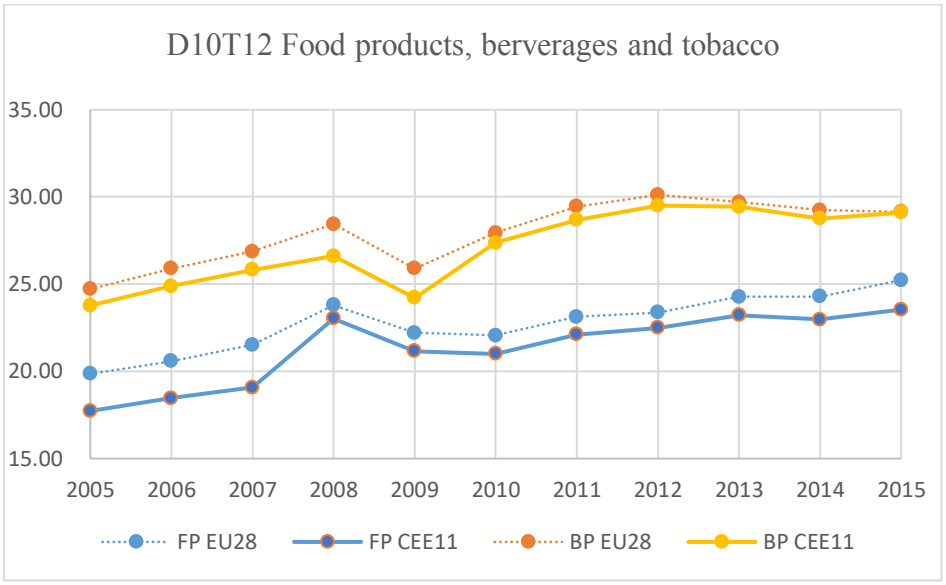
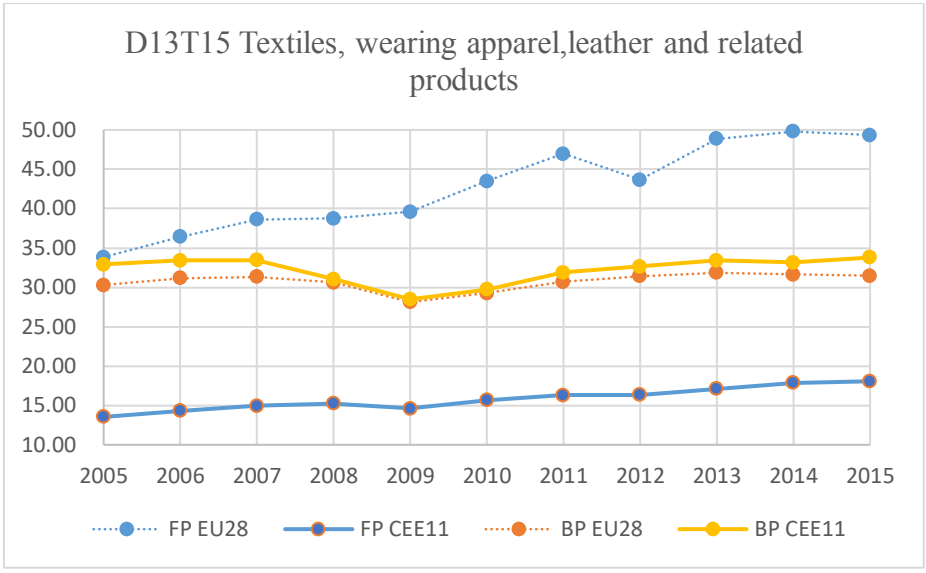
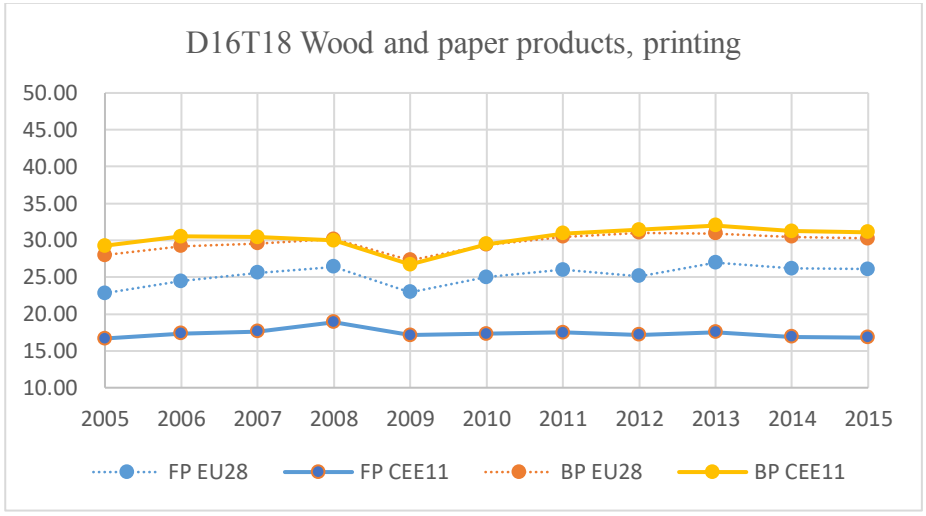
Appendices

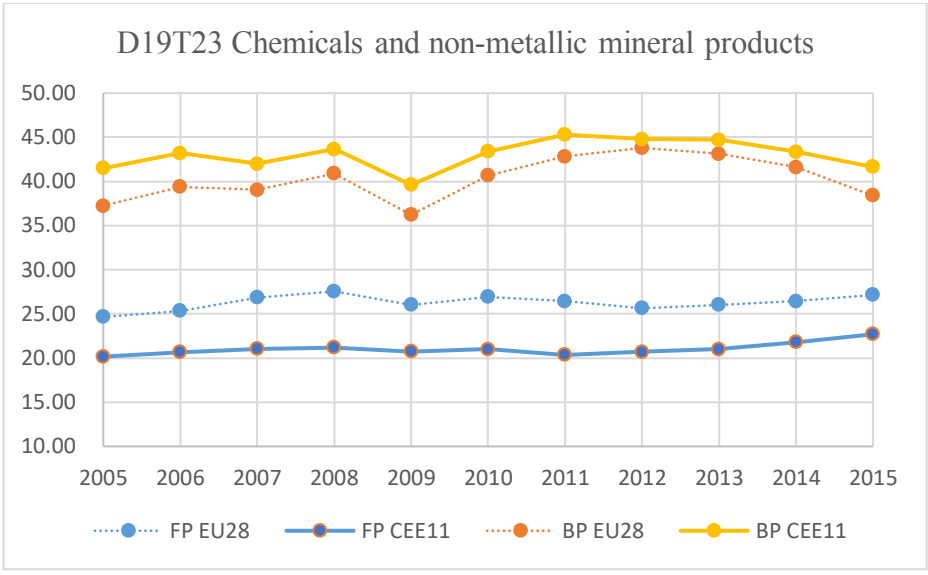
Appendix 1: Development of FP and BP in EU-28 and CEE-11 in selected industries

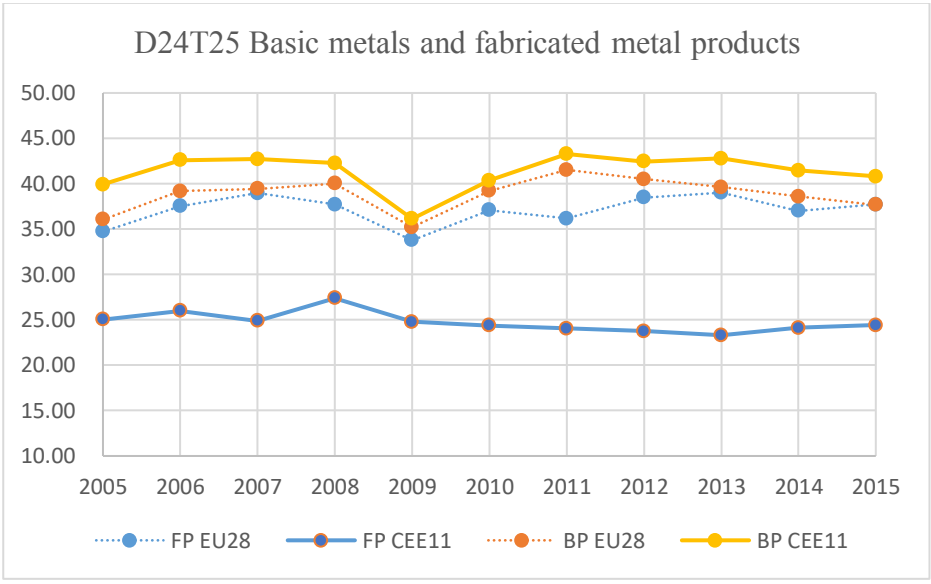
Figure A1.1: Average forward and backward participation of CEE-11 and EU-28, 2005-2015

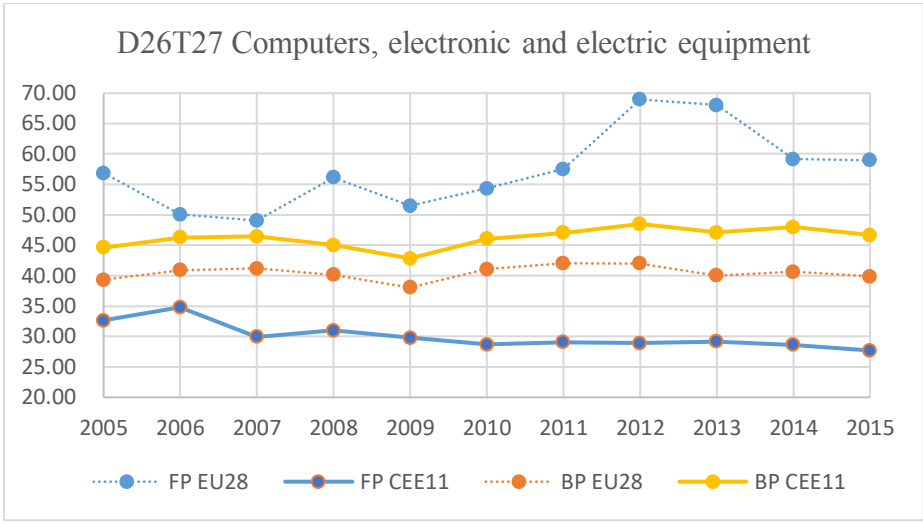


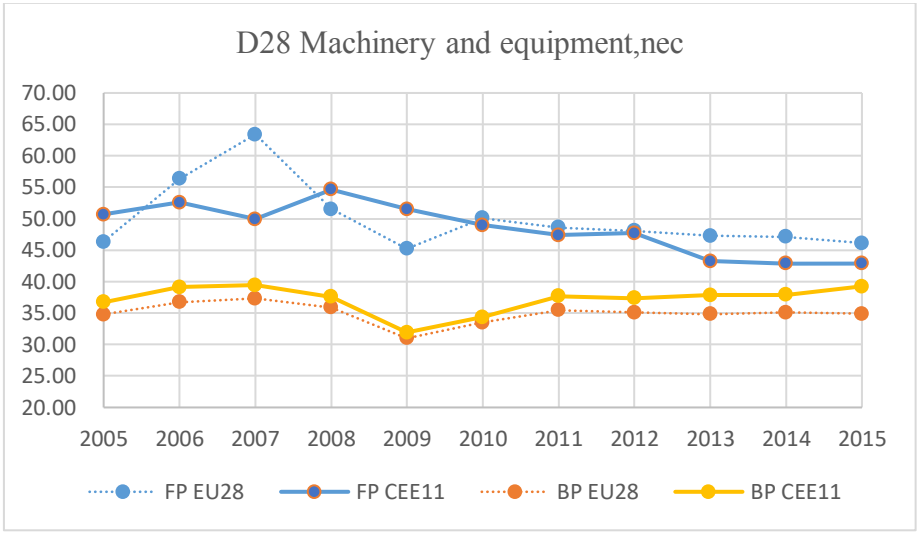

D13T15 Textiles, wearing apparel,leather and related products
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11

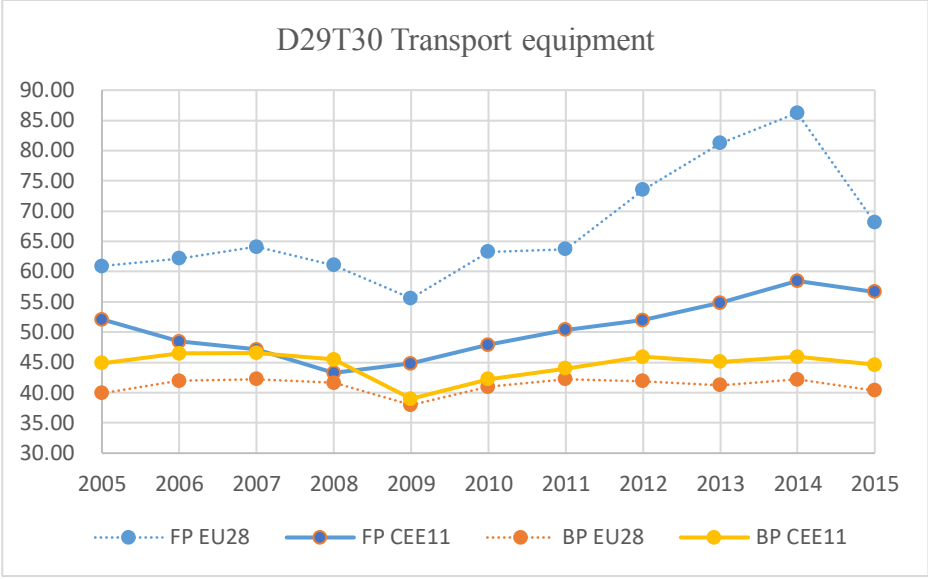

D16T18 Wood and paper products, printing
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11


D19T23 Chemicals and non-metallic mineral products
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11


D24T25 Basic metals and fabricated metal products
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11


D26T27 Computers, electronic and electric equipment
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11


D28 Machinery and equipment,nec
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
FP EU28
FP CEE11
BP EU28
BP CEE11



Source: Authors' calculations based on TiVA (OECD) database.

Appendix 2: Centrality measures in global exports of VA network by industries, in 2005, 2010 and 2015

Food products, beverages and tobacco

	2005							
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	164.600	195.300	-30.700	77.000	66.000	0.014	0.005	1.359
CZE	962.500	896.200	66.300	64.000	64.000	0.096	0.044	3.242
EST	96.300	135.600	-39.300	79.000	68.000	0.004	0.004	0.290
HRV	407.900	285.900	122.000	66.000	66.000	0.044	0.012	1.845
HUN	744.100	736.200	7.900	65.000	65.000	0.075	0.040	2.248
LTU	246.900	249.700	-2.800	70.000	67.000	0.015	0.008	1.177
LVA	121.400	186.600	-65.200	74.000	69.000	0.004	0.006	0.688
POL	1765.200	1325.200	440.000	64.000	64.000	0.201	0.056	3.242
ROU	431.600	534.500	-102.900	65.000	65.000	0.039	0.008	2.248
SVK	315.100	479.900	-164.800	66.000	64.000	0.025	0.016	2.597
SVN	137.300	244.700	-107.400	71.000	67.000	0.013	0.012	0.961

CHN	8263.900	5359.800	2904.100	63.000	63.000	-0.508	-0.355	8.018
DEU	12382.400	12788.200	-405.800	63.000	63.000	0.982	0.402	8.018
JAP	3514.000	11202.100	-7688.100	63.000	63.000	-0.277	-0.867	8.018
USA	9853.900	23071.400	-13217.500	63.000	63.000	-0.684	-1.000	8.018

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	395.600	474.400	-78.800	65.000	65.000	0.023	0.033	0.982
CZE	1410.900	1521.300	-110.400	64.000	64.000	0.125	0.146	1.297
EST	161.800	216.300	-54.500	69.000	66.000	0.003	0.014	0.458
HRV	466.600	325.600	141.000	64.000	65.000	0.039	0.029	1.120
HUN	1011.800	1007.500	4.300	64.000	64.000	0.077	0.101	1.297
LTU	517.200	431.400	85.800	65.000	65.000	0.029	0.030	0.723
LVA	242.600	294.400	-51.800	66.000	66.000	0.004	0.018	0.475
POL	3501.200	2647.100	854.100	63.000	64.000	0.327	0.242	1.983
ROU	660.700	861.800	-201.100	65.000	64.000	0.048	0.071	1.024
SVK	433.200	649.100	-215.900	67.000	64.000	0.030	0.042	0.693
SVN	169.800	367.100	-197.300	68.000	67.000	0.012	0.036	0.243

CHN	17267.000	12198.000	5069.000	63.000	63.000	-0.263	-0.539	5.829
DEU	16003.400	15294.300	709.100	63.000	63.000	1.000	0.892	5.829
JAP	4716.600	12909.101	-8192.501	63.000	63.000	-0.146	-0.851	5.829
USA	15512.600	28248.199	-12735.599	63.000	63.000	-0.514	-1.000	5.829

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	518.300	558.400	-40.100	66.000	64.000	0.029	0.042	0.810
CZE	1394.600	1729.100	-334.500	65.000	64.000	0.106	0.164	0.882
EST	210.000	283.500	-73.500	66.000	65.000	0.005	0.017	0.633
HRV	549.700	380.300	169.400	66.000	65.000	0.043	0.038	0.574
HUN	994.900	1022.100	-27.200	65.000	64.000	0.075	0.101	0.882
LTU	710.000	554.000	156.000	65.000	64.000	0.041	0.042	0.882
LVA	226.300	361.300	-135.000	66.000	66.000	0.005	0.021	0.596
POL	4635.300	3024.500	1610.800	63.000	64.000	0.409	0.277	2.032
ROU	873.900	1084.800	-210.900	64.000	64.000	0.060	0.097	1.327
SVK	436.000	882.900	-446.900	67.000	64.000	0.028	0.070	0.616
SVN	205.600	391.700	-186.100	67.000	66.000	0.013	0.035	0.504

CH	26529.50	25890.50		63.00	63.00	-	-	
N	0	0	639.000	0	0	0.148	0.414	4.535
DE	17785.80	16304.89		63.00	63.00			
U	1	9	1480.902	0	0	1.000	0.923	4.535
		14553.00		63.00	63.00	-	-	
JAP	5059.000	0	-9494.000	0	0	0.097	0.611	4.535
	21893.29	40345.89	-	63.00	63.00	-	-	
USA	9	8	18452.599	0	0	0.337	0.719	4.535

Textiles, wearing apparel, leather

2005								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	371.100	124.000	247.100	66.000	71.000	0.061	0.013	2.311
CZE	830.500	664.600	165.900	64.000	64.000	0.112	0.067	7.000
EST	170.400	101.200	69.200	73.000	75.000	0.008	0.006	0.291
HRV	275.300	301.400	-26.100	71.000	70.000	0.049	0.026	1.914
HUN	589.500	551.100	38.400	65.000	68.000	0.090	0.068	3.204
LTU	357.200	110.100	247.100	68.000	74.000	0.031	0.012	1.629
LVA	152.000	147.800	4.200	77.000	76.000	0.009	0.012	0.433
POL	1312.900	997.300	315.600	64.000	64.000	0.156	0.081	6.749
ROU	1836.400	715.600	1120.800	64.000	67.000	0.347	0.102	4.711
SVK	513.600	385.600	128.000	66.000	65.000	0.065	0.037	5.246
SVN	378.200	248.900	129.300	66.000	69.000	0.052	0.024	2.054
CHN	47781.699	3246.300	44535.399	63.000	63.000	-1.000	-0.091	9.476
DEU	3770.800	9684.700	-5913.900	63.000	63.000	0.322	0.540	9.476
JAP	2756.500	11802.500	-9046.000	63.000	63.000	-0.289	-0.233	9.476
USA	3791.400	43998.301	-40206.901	63.000	63.000	-0.120	-1.000	9.476

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	554.500	125.000	429.500	66.000	67.000	0.098	0.015	0.694
CZE	851.000	1035.900	-184.900	64.000	67.000	0.141	0.073	3.697
EST	133.900	150.600	-16.700	76.000	73.000	0.007	0.009	0.350
HRV	251.300	315.200	-63.900	68.000	70.000	0.045	0.029	1.121

HUN	473.500	528.300	-54.800	66.000	67.000	0.060	0.067	3.875
LTU	293.700	166.400	127.300	68.000	70.000	0.028	0.019	1.881
LVA	109.100	171.200	-62.100	77.000	74.000	0.005	0.019	0.400
POL	1486.100	2302.100	-816.000	64.000	63.000	0.182	0.125	8.130
ROU	2102.800	892.500	1210.300	63.000	68.000	0.433	0.150	5.496
SVK	656.700	632.500	24.200	66.000	64.000	0.087	0.031	4.849
SVN	255.100	323.600	-68.500	66.000	71.000	0.038	0.025	1.627

CHN	99373.898	5584.500	93789.398	63.000	64.000	-1.000	-0.052	6.999
DEU	3722.200	12568.300	-8846.100	63.000	63.000	0.348	0.592	9.102
JAP	2948.100	16084.601	-13136.501	63.000	64.000	-0.428	-0.216	6.999
USA	3645.400	52655.699	-49010.299	63.000	63.000	-0.152	-1.000	9.102

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	594.300	156.300	438.000	66.000	75.000	0.086	0.013	0.808
CZE	856.600	1315.700	-459.100	65.000	67.000	0.110	0.064	2.875
EST	172.100	181.800	-9.700	70.000	73.000	0.006	0.007	0.342
HRV	271.600	455.600	-184.000	67.000	71.000	0.036	0.050	1.260
HUN	434.600	642.100	-207.500	66.000	67.000	0.049	0.053	5.444
LTU	359.700	217.000	142.700	67.000	71.000	0.027	0.018	2.246
LVA	93.500	217.900	-124.400	75.000	72.000	0.005	0.014	0.317
POL	1733.200	2879.800	-1146.600	64.000	66.000	0.178	0.098	4.845
ROU	2028.900	1181.200	847.700	63.000	68.000	0.284	0.141	3.965
SVK	561.300	949.400	-388.100	65.000	66.000	0.057	0.034	4.255
SVN	218.500	323.500	-105.000	68.000	70.000	0.025	0.015	1.160

CHN	131047.602	11781.700	119265.902	63.000	63.000	-0.388	-0.030	13.033
DEU	3872.800	14096.899	-10224.099	63.000	63.000	0.295	0.439	13.033
JAP	2487.100	19432.701	-16945.601	63.000	64.000	-0.208	-0.179	9.019
USA	3200.900	69075.602	-65874.702	63.000	63.000	-0.111	-1.000	13.033

Wood and paper products

2005								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	95.000	173.400	-78.400	67.000	71.000	0.009	0.021	1.140
CZE	1180.800	864.800	316.000	64.000	65.000	0.166	0.125	4.447
EST	274.200	110.000	164.200	67.000	78.000	0.031	0.009	0.290
HRV	191.700	285.900	-94.200	68.000	69.000	0.026	0.036	1.230
HUN	509.500	786.300	-276.800	64.000	65.000	0.068	0.104	4.447
LTU	251.000	155.100	95.900	68.000	73.000	0.027	0.016	0.590
LVA	315.800	130.200	185.600	67.000	77.000	0.038	0.012	0.311
POL	2077.800	1507.700	570.100	63.000	65.000	0.301	0.222	5.157
ROU	550.900	567.200	-16.300	64.000	66.000	0.058	0.079	3.962
SVK	527.300	390.600	136.700	65.000	66.000	0.069	0.048	3.527
SVN	403.900	233.700	170.200	64.000	72.000	0.051	0.033	1.470
CHN	10006.400	7509.700	2496.700	63.000	63.000	-0.056	-0.097	15.478
DEU	13932.399	9992.100	3940.299	63.000	63.000	1.000	0.855	15.478
JAP	8431.800	8346.300	85.500	63.000	63.000	-0.040	-0.175	15.478
USA	15444.601	34518.398	-19073.797	63.000	63.000	-0.229	-0.578	15.478

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	159.700	260.600	-100.900	67.000	68.000	0.015	0.029	1.195
CZE	1580.900	1162.500	418.400	64.000	65.000	0.252	0.146	2.555
EST	422.900	122.700	300.200	65.000	77.000	0.048	0.010	0.437
HRV	224.800	244.100	-19.300	68.000	67.000	0.032	0.031	1.032
HUN	657.100	690.900	-33.800	64.000	65.000	0.083	0.086	2.555
LTU	378.600	175.900	202.700	66.000	70.000	0.047	0.018	1.010
LVA	412.400	117.200	295.200	65.000	76.000	0.049	0.011	0.500
POL	3031.400	2207.100	824.300	63.000	64.000	0.452	0.291	5.078
ROU	1015.700	726.700	289.000	64.000	65.000	0.101	0.095	2.555
SVK	870.800	506.800	364.000	64.000	65.000	0.128	0.053	2.555
SVN	419.600	272.800	146.800	64.000	69.000	0.057	0.036	1.608

CHN	20819.600	14053.600	6766.000	63.000	63.000	-0.103	-0.201	11.953
DEU	13919.100	11126.400	2792.700	63.000	64.000	1.000	0.844	5.078
JAP	8996.100	8705.500	290.600	63.000	63.000	-0.090	-0.221	11.953
USA	17828.000	27390.199	-9562.199	63.000	63.000	-0.311	-0.438	11.953

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	221.400	246.400	-25.000	66.000	69.000	0.020	0.035	1.382
CZE	1559.100	984.500	574.600	63.000	65.000	0.276	0.162	4.003
EST	557.900	134.000	423.900	65.000	75.000	0.057	0.012	0.388
HRV	282.100	217.000	65.100	66.000	70.000	0.039	0.034	0.821
HUN	627.600	649.000	-21.400	65.000	67.000	0.090	0.104	2.157
LTU	488.800	232.100	256.700	65.000	71.000	0.059	0.032	1.592
LVA	530.900	144.500	386.400	64.000	77.000	0.061	0.015	0.900
POL	3802.700	2115.700	1687.000	63.000	64.000	0.655	0.338	6.334
ROU	818.500	711.900	106.600	64.000	65.000	0.071	0.117	3.312
SVK	829.400	521.200	308.200	65.000	67.000	0.140	0.072	1.939
SVN	442.700	249.400	193.300	65.000	72.000	0.067	0.039	0.721

CHN	30455.000	23247.301	7207.699	63.000	63.000	-0.079	-0.191	13.209
DEU	12558.300	10356.800	2201.500	63.000	64.000	1.000	0.982	6.334
JAP	6785.500	8837.800	-2052.300	63.000	63.000	-0.071	-0.231	13.209
USA	19761.500	30921.801	-11160.301	63.000	63.000	-0.225	-0.345	13.209

Chemicals. non-metallic mineral products and metals

2005								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	707.300	1512.500	-805.200	65.000	63.000	0.010	0.031	1.104
CZE	8090.700	6809.400	1281.300	63.000	63.000	0.183	0.160	1.411
EST	328.900	773.300	-444.400	66.000	66.000	0.003	0.011	0.231
HRV	575.800	1976.100	-1400.300	64.000	64.000	0.011	0.046	0.923
HUN	4650.300	5524.500	-874.200	63.000	64.000	0.097	0.130	0.910
LTU	986.400	1337.200	-350.800	64.000	65.000	0.009	0.025	0.447

LVA	203.400	927.600	-724.200	68.000	66.000	0.002	0.016	0.140
POL	8654.700	12035.800	-3381.100	63.000	63.000	0.191	0.285	1.411
ROU	2406.600	4250.000	-1843.400	63.000	64.000	0.035	0.099	0.910
SVK	3404.100	3199.600	204.500	63.000	64.000	0.070	0.069	0.910
SVN	2239.900	1801.900	438.000	64.000	65.000	0.044	0.048	0.447

CHN	89272.898	57974.098	31298.800	63.000	63.000	-0.529	-0.505	1.411
DEU	111060.000	61514.598	49545.402	63.000	63.000	1.000	0.797	1.411
JAP	79535.000	50117.301	29417.699	63.000	63.000	-0.656	-0.475	1.411
USA	97476.102	208788.703	-111312.601	63.000	63.000	-0.236	-0.809	1.411

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	1194.000	2235.300	-1041.300	63.000	65.000	0.017	0.044	0.389
CZE	9803.500	9426.500	377.000	63.000	63.000	0.210	0.181	1.013
EST	544.600	854.200	-309.600	65.000	67.000	0.005	0.012	0.124
HRV	770.800	1799.900	-1029.100	64.000	64.000	0.014	0.035	0.454
HUN	6436.200	5559.800	876.400	63.000	64.000	0.119	0.116	0.582
LTU	1406.300	1413.000	-6.700	63.000	65.000	0.020	0.025	0.389
LVA	344.800	965.300	-620.500	66.000	66.000	0.004	0.016	0.123
POL	13552.899	19246.500	-5693.601	63.000	63.000	0.281	0.382	1.013
ROU	2507.400	6632.700	-4125.300	63.000	63.000	0.040	0.132	1.013
SVK	4775.000	3941.300	833.700	63.000	63.000	0.097	0.063	1.013
SVN	2683.500	2068.100	615.400	64.000	66.000	0.052	0.044	0.155

CHN	195655.500	115480.695	80174.805	63.000	63.000	-0.363	-0.349	1.013
DEU	125846.695	82826.102	43020.593	63.000	63.000	1.000	0.800	1.013
JAP	112408.297	63177.199	49231.098	63.000	63.000	-0.715	-0.313	1.013
USA	141341.000	229888.906	-88547.906	63.000	63.000	-0.201	-0.482	1.013

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	1756.700	2784.400	-1027.700	63.000	64.000	0.027	0.058	0.602
CZE	11351.399	8635.899	2715.500	63.000	64.000	0.241	0.190	0.602
EST	639.200	1072.700	-433.500	66.000	64.000	0.006	0.017	0.251
HRV	838.800	1660.900	-822.100	65.000	64.000	0.015	0.039	0.304
HUN	6764.500	5896.700	867.800	63.000	64.000	0.124	0.140	0.602

LTU	1587.300	1855.700	-268.400	63.000	65.000	0.020	0.038	0.433
LVA	379.000	1130.600	-751.600	64.000	67.000	0.004	0.020	0.140
POL	18157.900	20087.299	-1929.399	63.000	63.000	0.371	0.421	1.352
ROU	4468.800	7319.200	-2850.400	63.000	64.000	0.080	0.179	0.602
SVK	5253.500	4889.100	364.400	63.000	64.000	0.109	0.097	0.602
SVN	3120.400	1842.500	1277.900	63.000	65.000	0.060	0.041	0.433

CHN	285444.188	163610.594	121833.594	63.000	63.000	-0.283	-0.274	1.352
DEU	135129.594	81692.500	53437.094	63.000	63.000	1.000	0.919	1.352
JAP	89604.000	71908.898	17695.102	63.000	63.000	-0.519	-0.342	1.352
USA	173057.406	294664.094	-121606.688	63.000	63.000	-0.130	-0.514	1.352

Computers. electronic and electrical equipment

	2005							
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	80.700	491.900	-411.200	70.000	69.000	0.005	0.025	1.638
CZE	2752.300	2984.300	-232.000	63.000	66.000	0.192	0.130	4.845
EST	180.100	477.800	-297.700	68.000	72.000	0.007	0.018	1.242
HRV	171.400	705.400	-534.000	67.000	71.000	0.011	0.036	0.751
HUN	4608.700	2749.100	1859.600	63.000	67.000	0.286	0.119	4.193
LTU	209.300	452.300	-243.000	69.000	74.000	0.006	0.022	0.926
LVA	35.500	352.000	-316.500	93.000	74.000	0.001	0.019	0.039
POL	2006.300	4301.500	-2295.200	63.000	66.000	0.126	0.185	4.845
ROU	1016.900	1761.200	-744.300	64.000	67.000	0.071	0.103	4.776
SVK	810.700	1266.900	-456.200	64.000	67.000	0.055	0.052	3.425
SVN	619.000	685.900	-66.900	64.000	70.000	0.039	0.044	1.604

CHN	66183.898	40734.301	25449.597	63.000	64.000	-0.254	-0.191	14.462
DEU	35159.500	18198.400	16961.100	63.000	63.000	1.000	0.583	16.487
JAP	61157.602	26867.100	34290.502	63.000	63.000	-0.554	-0.131	16.487
USA	51881.801	109903.797	-58021.996	63.000	63.000	-0.065	-0.132	16.487

2010								
	OutDegree	**InDegree**	**DegreeDiff**	**OutClose**	**InClose**	**OutEigen**	**InEigan**	**Betweenness**
BGR	276.400	806.100	-529.700	66.000	72.000	0.014	0.049	2.086
CZE	4869.800	4877.900	-8.100	63.000	65.000	0.336	0.157	6.167
EST	320.700	360.000	-39.300	66.000	76.000	0.006	0.012	0.786
HRV	280.400	596.100	-315.700	66.000	71.000	0.016	0.026	1.051
HUN	3234.300	2424.800	809.500	63.000	68.000	0.172	0.097	4.220
LTU	165.200	382.500	-217.300	68.000	74.000	0.005	0.018	0.794
LVA	69.800	232.200	-162.400	77.000	76.000	0.001	0.010	0.020
POL	3872.400	7017.500	-3145.100	63.000	64.000	0.221	0.223	6.739
ROU	3974.500	2650.600	1323.900	63.000	67.000	0.231	0.149	4.561
SVK	1516.200	1951.600	-435.400	64.000	67.000	0.092	0.065	3.402
SVN	791.000	701.300	89.700	64.000	72.000	0.048	0.042	1.188
CHN	130565.000	79825.898	50739.102	63.000	63.000	-0.185	-0.124	12.150
DEU	51065.301	36113.102	14952.199	63.000	64.000	1.000	0.655	6.739
JAP	61401.301	30181.199	31220.102	63.000	63.000	-0.732	-0.142	12.150
USA	59328.801	116092.602	-56763.801	63.000	63.000	-0.095	-0.206	12.150

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	395.000	847.100	-452.100	65.000	70.000	0.022	0.064	1.635
CZE	4724.600	4469.100	255.500	63.000	64.000	0.317	0.171	5.127
EST	411.800	425.200	-13.400	66.000	74.000	0.006	0.017	0.372
HRV	221.400	557.100	-335.700	65.000	74.000	0.014	0.042	0.738
HUN	3263.800	2922.500	341.300	63.000	65.000	0.200	0.185	4.579
LTU	224.000	526.400	-302.400	67.000	72.000	0.007	0.034	1.009
LVA	159.200	281.300	-122.100	69.000	75.000	0.003	0.016	0.402
POL	4464.400	7745.700	-3281.300	63.000	64.000	0.287	0.326	5.127
ROU	2352.600	2485.400	-132.800	63.000	66.000	0.162	0.198	3.695
SVK	1525.200	2033.800	-508.600	64.000	66.000	0.103	0.077	3.122
SVN	805.200	584.300	220.900	65.000	72.000	0.051	0.037	0.990
CHN	187211.500	133530.203	53681.297	63.000	63.000	-0.092	-0.092	9.453
DEU	53764.602	33137.602	20627.000	63.000	64.000	1.000	0.754	5.127
JAP	48651.602	37507.801	11143.801	63.000	63.000	-0.527	-0.137	9.453
USA	74684.203	149208.594	-74524.391	63.000	63.000	-0.052	-0.283	9.453

Machinery and equipment

2005								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	105.900	460.800	-354.900	68.000	74.000	0.010	0.042	2.050
CZE	1714.500	1707.100	7.400	64.000	66.000	0.178	0.163	10.763
EST	66.700	239.800	-173.100	85.000	80.000	0.002	0.016	0.739
HRV	91.200	513.200	-422.000	75.000	77.000	0.009	0.048	0.651
HUN	909.100	1950.600	-1041.500	64.000	70.000	0.102	0.180	5.933
LTU	35.100	325.700	-290.600	83.000	77.000	0.001	0.028	1.181
LVA	26.800	246.200	-219.400	98.000	78.000	0.001	0.021	0.346
POL	1448.300	3250.300	-1802.000	64.000	68.000	0.122	0.321	7.327
ROU	566.900	1301.800	-734.900	65.000	68.000	0.045	0.137	7.351
SVK	453.900	772.400	-318.500	66.000	71.000	0.051	0.070	5.359
SVN	337.500	344.500	-7.000	66.000	77.000	0.032	0.035	1.568
CHN	16593.199	21076.801	-4483.602	63.000	65.000	-0.302	-0.309	18.063
DEU	48514.301	12985.300	35529.001	63.000	64.000	1.000	0.550	19.528
JAP	38950.000	9558.700	29391.300	63.000	63.000	-0.662	-0.367	31.228
USA	33949.699	42473.301	-8523.602	63.000	63.000	-0.196	-0.687	31.228

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	228.400	612.900	-384.500	65.000	72.000	0.016	0.048	3.062
CZE	2725.500	2151.300	574.200	63.000	67.000	0.225	0.129	6.477
EST	71.300	182.200	-110.900	74.000	82.000	0.002	0.008	0.460
HRV	110.200	469.700	-359.500	70.000	74.000	0.009	0.029	0.722
HUN	2481.900	1742.400	739.500	63.000	68.000	0.195	0.123	5.931
LTU	99.700	236.100	-136.400	72.000	79.000	0.004	0.016	1.177
LVA	40.900	163.900	-123.000	86.000	81.000	0.001	0.011	0.175
POL	2472.200	4709.800	-2237.600	63.000	65.000	0.182	0.307	8.327
ROU	961.300	1921.000	-959.700	64.000	67.000	0.063	0.156	6.173
SVK	806.400	1004.300	-197.900	63.000	68.000	0.066	0.057	5.839
SVN	421.200	421.600	-0.400	64.000	74.000	0.033	0.033	1.968

CHN	38303.602	46336.402	-8032.800	63.000	63.000	-0.163	-0.119	19.170
DEU	60394.602	15795.200	44599.402	63.000	64.000	1.000	0.436	12.666
JAP	50615.102	10763.400	39851.702	63.000	63.000	-0.597	-0.228	19.170
USA	42948.199	39859.602	3088.597	63.000	63.000	-0.187	-0.573	19.170

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	345.500	836.000	-490.500	65.000	68.000	0.020	0.065	4.082
CZE	2923.600	2893.300	30.300	63.000	65.000	0.194	0.183	6.241
EST	113.800	267.800	-154.000	70.000	78.000	0.002	0.012	0.318
HRV	152.400	422.700	-270.300	68.000	76.000	0.009	0.032	0.566
HUN	2627.800	2118.900	508.900	63.000	67.000	0.163	0.147	5.294
LTU	141.200	411.800	-270.600	68.000	72.000	0.005	0.029	2.105
LVA	59.000	281.100	-222.100	75.000	78.000	0.002	0.018	0.487
POL	2845.400	5371.900	-2526.500	63.000	65.000	0.173	0.318	6.241
ROU	1098.300	2262.900	-1164.600	63.000	66.000	0.063	0.176	5.806
SVK	966.700	1508.000	-541.300	65.000	67.000	0.071	0.089	3.817
SVN	444.400	344.600	99.800	65.000	76.000	0.030	0.024	0.929

CHN	56017.898	52876.602	3141.296	63.000	63.000	-0.103	-0.096	14.774
DEU	66733.203	15162.900	51570.303	63.000	64.000	1.000	0.453	10.466
JAP	45081.102	13888.800	31192.302	63.000	63.000	-0.354	-0.247	14.774
USA	42432.301	60317.602	-17885.301	63.000	63.000	-0.133	-0.646	14.774

Transport equipment

2005								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	34.700	615.600	-580.900	88.000	73.000	0.002	0.032	3.968
CZE	4486.600	1937.600	2549.000	63.000	71.000	0.237	0.095	8.892
EST	47.000	179.600	-132.600	91.000	84.000	0.001	0.007	0.350
HRV	184.500	651.500	-467.000	72.000	79.000	0.006	0.040	1.710
HUN	2732.100	1750.300	981.800	64.000	73.000	0.176	0.099	6.847
LTU	103.500	339.500	-236.000	72.000	79.000	0.005	0.010	2.329
LVA	23.900	226.400	-202.500	98.000	81.000	0.000	0.009	0.428
POL	3215.400	2413.700	801.700	64.000	69.000	0.163	0.126	10.309

ROU	805.400	1106.000	-300.600	64.000	76.000	0.040	0.059	4.342
SVK	1269.500	721.900	547.600	64.000	76.000	0.068	0.034	3.959
SVN	447.600	522.600	-75.000	69.000	80.000	0.028	0.037	1.275

CHN	10251.400	10631.500	-380.100	63.000	66.000	-0.109	0.010	14.643
DEU	58528.898	22180.701	36348.197	63.000	65.000	1.000	0.656	19.632
JAP	57233.801	8298.100	48935.701	63.000	64.000	-0.448	-0.152	27.656
USA	51430.301	87275.102	-35844.801	63.000	63.000	-0.255	-0.632	37.156

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	124.200	397.800	-273.600	71.000	78.000	0.005	0.015	1.216
CZE	7712.800	2435.700	5277.100	63.000	71.000	0.377	0.090	5.547
EST	112.000	165.200	-53.200	78.000	82.000	0.002	0.005	0.741
HRV	268.800	442.800	-174.000	67.000	79.000	0.005	0.016	1.800
HUN	4002.400	1180.300	2822.100	63.000	75.000	0.197	0.054	3.371
LTU	103.300	232.000	-128.700	74.000	79.000	0.002	0.007	0.832
LVA	34.900	127.800	-92.900	89.000	85.000	0.001	0.001	0.114
POL	5008.100	6129.700	-1121.600	63.000	68.000	0.217	0.201	7.790
ROU	2557.000	1044.200	1512.800	64.000	75.000	0.129	0.046	2.912
SVK	3387.300	1101.500	2285.800	63.000	69.000	0.138	0.041	15.166
SVN	665.500	635.300	30.200	64.000	78.000	0.041	0.031	1.707

CHN	24735.000	30164.000	-5429.000	63.000	66.000	0.203	0.188	17.614
DEU	75074.398	30311.600	44762.798	63.000	64.000	1.000	0.564	30.024
JAP	66460.703	8282.500	58178.203	63.000	66.000	-0.641	-0.126	17.614
USA	52670.199	79133.602	-26463.403	63.000	64.000	-0.445	-0.737	29.107

2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	225.300	733.200	-507.900	66.000	75.000	0.008	0.027	1.330
CZE	8603.500	3420.600	5182.900	63.000	70.000	0.322	0.116	4.801
EST	130.300	328.000	-197.700	70.000	78.000	0.002	0.009	0.642
HRV	135.100	501.600	-366.500	71.000	79.000	0.003	0.019	0.063
HUN	7734.900	2168.000	5566.900	63.000	74.000	0.236	0.091	2.723

LTU	104.900	577.200	-472.300	70.000	75.000	0.002	0.018	6.305
LVA	51.600	281.300	-229.700	83.000	77.000	0.001	0.007	0.481
POL	7186.100	8209.000	-1022.900	63.000	65.000	0.241	0.251	15.333
ROU	2547.000	1956.600	590.400	63.000	73.000	0.092	0.082	3.204
SVK	4864.900	1574.400	3290.500	63.000	73.000	0.142	0.045	3.545
SVN	830.700	533.800	296.900	65.000	77.000	0.036	0.021	0.900

CHN	34721.699	57462.398	-22740.699	63.000	64.000	-0.151	-0.076	24.559
DEU	124951.297	24984.301	99966.996	63.000	64.000	1.000	0.498	23.786
JAP	72123.898	13299.399	58824.499	63.000	65.000	-0.438	-0.150	16.107
USA	72400.898	153917.094	-81516.196	63.000	63.000	-0.131	-0.829	30.661

Total services

	2005							
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	4133.700	5164.400	-1030.700	63.000	63.000	0.023	0.025	0.016
CZE	20093.000	21265.000	-1172.000	63.000	63.000	0.145	0.110	0.016
EST	2960.100	2798.000	162.100	63.000	63.000	0.007	0.008	0.016
HRV	6291.600	6520.200	-228.600	63.000	63.000	0.046	0.035	0.016
HUN	15473.000	18681.100	-3208.100	63.000	63.000	0.101	0.092	0.016
LTU	3574.600	4183.700	-609.100	63.000	63.000	0.014	0.016	0.016
LVA	2669.300	2977.900	-308.600	63.000	64.000	0.010	0.011	0.016
POL	35670.898	33886.301	1784.597	63.000	63.000	0.262	0.179	0.016
ROU	7658.500	13715.300	-6056.800	63.000	63.000	0.051	0.068	0.016
SVK	7950.800	8653.200	-702.400	63.000	63.000	0.051	0.041	0.016
SVN	5060.700	5568.800	-508.100	63.000	63.000	0.037	0.033	0.016

CHN	119547.805	163284.797	-43736.992	63.000	63.000	-0.455	-0.475	0.016
DEU	318368.500	277132.000	41236.500	63.000	63.000	0.945	0.769	0.016
JAP	249810.594	204121.297	45689.297	63.000	63.000	-0.737	-0.594	0.016
USA	550709.000	663743.313	-113034.313	63.000	63.000	-0.566	-0.740	0.016

2010								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	7000.300	7318.000	-317.700	63.000	63.000	0.034	0.033	0.000
CZE	32261.000	32843.000	-582.000	63.000	63.000	0.206	0.142	0.000
EST	4364.000	3432.900	931.100	63.000	63.000	0.010	0.010	0.000
HRV	7414.600	6936.900	477.700	63.000	63.000	0.046	0.029	0.000
HUN	22388.400	21542.500	845.900	63.000	63.000	0.115	0.095	0.000
LTU	5920.600	5790.900	129.700	63.000	63.000	0.027	0.022	0.000
LVA	4077.600	3638.500	439.100	63.000	63.000	0.013	0.013	0.000
POL	62320.398	61453.898	866.500	63.000	63.000	0.393	0.287	0.000
ROU	12940.000	21392.699	-8452.699	63.000	63.000	0.074	0.106	0.000
SVK	14593.000	13678.600	914.400	63.000	63.000	0.085	0.054	0.000
SVN	7454.300	7174.000	280.300	63.000	63.000	0.045	0.036	0.000

CHN	270296.906	350366.688	-80069.782	63.000	63.000	-0.468	0.499	0.000
DEU	411395.813	363604.094	47791.719	63.000	63.000	1.000	0.863	0.000
JAP	296079.406	243600.406	52479.000	63.000	63.000	-0.682	-0.499	0.000
USA	767257.188	765132.375	2124.813	63.000	63.000	-0.546	-0.638	0.000

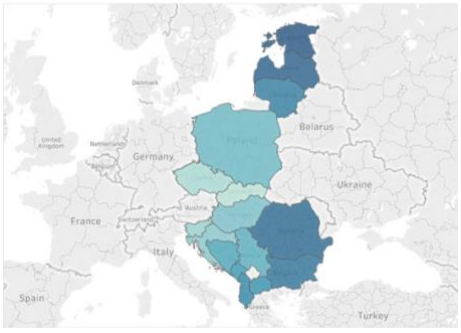
2015								
	OutDegree	InDegree	DegreeDiff	OutClose	InClose	OutEigen	InEigan	Betweenness
BGR	8560.000	8360.500	199.500	63.000	63.000	0.041	0.040	0.016
CZE	32030.400	31189.500	840.900	63.000	63.000	0.191	0.145	0.016
EST	5077.600	4292.900	784.700	63.000	63.000	0.012	0.014	0.016
HRV	7690.100	6154.900	1535.200	63.000	63.000	0.047	0.032	0.016
HUN	21679.301	21867.000	-187.699	63.000	63.000	0.106	0.111	0.016
LTU	7437.700	7150.300	287.400	63.000	63.000	0.033	0.029	0.016
LVA	4945.700	4099.900	845.800	63.000	63.000	0.016	0.015	0.016
POL	72482.797	62451.801	10030.996	63.000	63.000	0.440	0.291	0.016
ROU	21326.199	23080.199	-1754.000	63.000	63.000	0.129	0.129	0.016
SVK	15969.800	15105.800	864.000	63.000	63.000	0.086	0.063	0.016
SVN	7144.700	6221.700	923.000	63.000	63.000	0.040	0.030	0.016

CHN	523618.500	577763.313	-54144.813	63.000	63.000	-0.541	-0.527	0.016
DEU	419311.500	382589.594	36721.906	63.000	63.000	0.982	1.000	0.016
JAP	272694.594	282595.500	-9900.906	63.000	63.000	-0.575	-0.510	0.016
USA	975347.875	958006.500	17341.375	63.000	63.000	-0.334	-0.532	0.016

Appendix 3: CEECs' geographical centrality position in Europe across industries in 2015

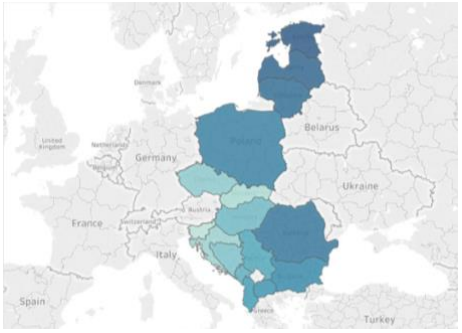
Food products, beverages and tobacco

D10T12 [rank] 1 16



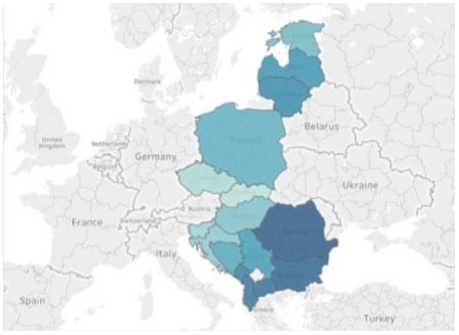
Textiles, wearing apparel, leather

D13T15 [rank]



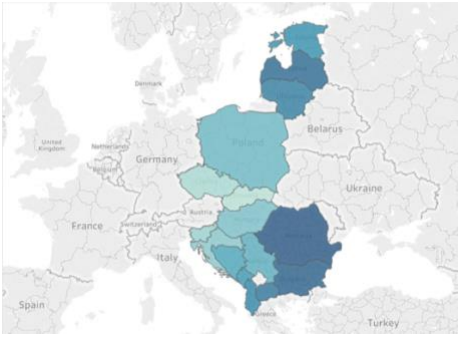
Wood and paper products; printing metallic mineral products

D16T18 [rank] 1 16

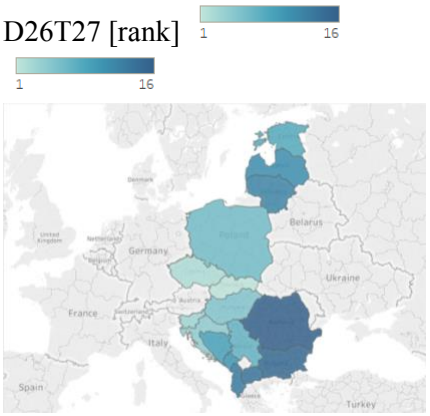


Chemicals and non-

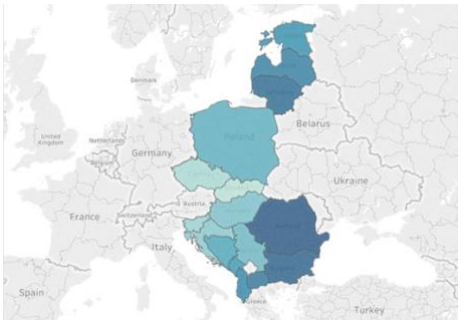
D19T23 [rank]



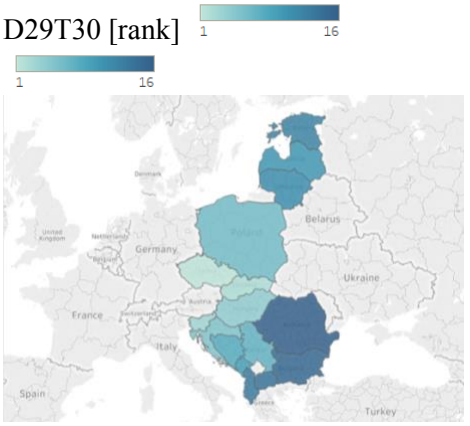
Computers, electronic and electrical equipment D26T27 [rank]



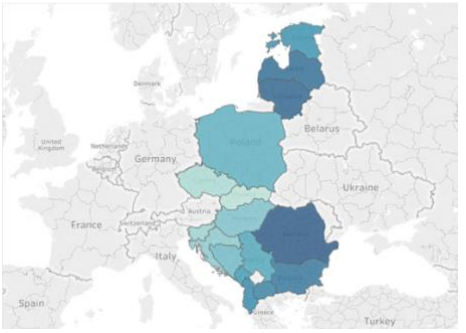
Machinery and equipment, nec D28 [rank]



Transport equipment including construction D29T30 [rank]



Total services, D41T98 [rank]



Source: Authors' calculation based on CEPII and Eurostat (2019) data.

Appendix 4: Foreign direct investment inflows to Serbia by sectors for the 2010-2018 period

Table A4.1: FDI inflows to Serbia by sectors for the period 2010-2018 (Mill. EUR)

Sectors	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agriculture, forestry and fisheries	19.8	30.9	9.2	65.8	-0.3	63.8	43.3	72.0	154.7
Mining	204.2	478.1	218.8	179.9	26.0	22.1	-33.0	102.5	402.3
Manufacturing industry	329.4	631.1	521.2	679.2	535.2	721.1	749.5	634.3	924.8
Electricity, gas, steam and air conditioning supply	6.0	2.9	3.8	9.0	9.9	12.8	15.0	52.2	10.2
Water supply: wastewater management, control of waste disposal and similar activities	3.8	6.0	5.9	12.1	17.7	17.9	13.6	11.1	21.6
Construction	35.3	91.6	19.4	67.1	162.7	264.5	272.9	406.8	457.1
Wholesale and retail trade: repair of motor vehicles and motorcycles	133.3	1019.2	194.1	300.0	224.8	208.5	138.2	312.3	317.7
Traffic and storage	21.2	65.9	17.4	70.8	-9.4	68.5	68.6	22.4	660.1
Services of accommodation and nutrition	5.2	15.0	26.7	-3.1	-1.9	7.0	2.9	16.3	9.4
Information and communication	-8.2	125.6	-480.0	28.5	46.8	108.1	120.7	197.9	-212.4
Financial activities and insurance activity	432.7	840.4	290.6	141.5	358.0	484.0	447.0	367.5	494.8
Real estate	-19.9	72.1	22.1	-55.7	24.7	57.6	124.5	221.7	132.0
Professional, scientific, innovation and technical activities	29.4	32.0	116.4	4.1	83.6	27.1	141.2	65.0	61.8
Administrative and support service activities	4.0	51.2	9.0	30.2	-9.6	14.3	11.8	39.4	21.2
Education	0.0	0.5	0.1	1.1	1.4	0.3	0.1	0.1	0.7
Health and social protection	0.0	0.1	0.1	0.1	0.1	-0.1	-0.2	2.1	0.4
Art; Entertainment and recreation	-3.9	2.4	-2.5	-1.4	-14.9	4.2	0.0	16.1	2.0
Other service activities	2.5	0.8	0.6	1.3	1.4	0.3	1.5	0.5	1.0
Unclassified	83.4	78.7	35.9	17.3	44.4	32.1	9.3	7.9	36.4
Total net increase of financial liabilities for FDI	**1278.4**	**3544.5**	**1008.8**	**1547.9**	**1500.5**	**2114.2**	**2126.9**	**2548.1**	**3495.8**

Source: National Bank of Serbia Data, *Republic of Serbia's Balance of Payments*, Internet: https://www.nbs.rs/internet/cirilica/80/platni_bilans.html, (accessed on 20.04.2019)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