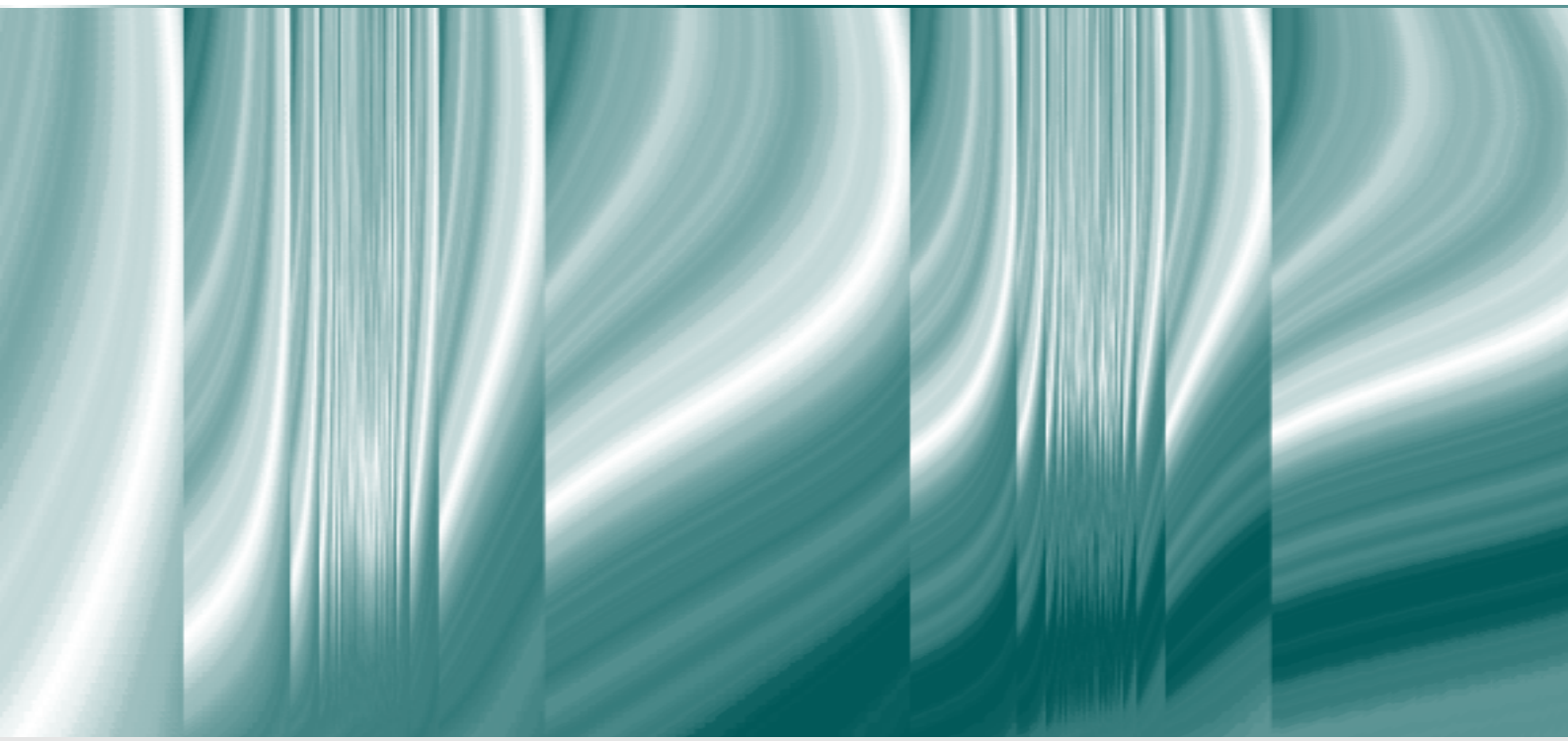
BANKA SLOVENIJE
EVROSISTEM

DELOVNI ZVEZKI BANKE SLOVENIJE/
BANKA SLOVENIJE WORKING PAPERS:

GLOBAL VALUE CHAIN INTEGRATION IN CESEE AND EURO AREA ECONOMIES



Mojca Lindič

3/2022

Title/*Naslov*: Global Value Chain Integration in CESEE and Euro Area Economies

No./*Številka*: 3/2022

Published by/*Izdajatelj*: BANKA SLOVENIJE
Slovenska 35
1505 Ljubljana
tel.: 01/+386 1 47 19 000
http://www.bsi.si
Electronic edition/*Elektronska izdaja*

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID 118815235
ISBN 978-961-6960-69-4 (PDF)

Global Value Chain Integration in CESEE and Euro Area Economies

Mojca Lindič*

Abstract

This paper studies and compares integration within the global value chains (GVCs) of Central, Eastern, and South-Eastern (CESEE) European countries that are EU members and the first twelve countries that entered the euro area (EA 12). In recent years, GVC participation was the highest among small economies, i.e. CESEE members of the euro area, despite the deterioration of their relative competitive positions due to higher wage growth. Meanwhile, the EA 12 participated in more technologically advanced sectors within GVCs than CESEE countries. The results suggest that between 2005 and 2015, GVC participation was positively correlated with changes in global demand, and negatively with country size and wage level. On the other hand, when reducing the sample only to CESEE countries, the results also indicate to positive linkages between GVC participation and FDI, which could be a result of technological spillovers. These findings imply the importance of FDI for countries undergoing the convergence process.

JEL codes: C33, F14, F40, F62
Keywords: CESEE, Global Value Chains, GVC Participation

* Bank of Slovenia, e-mail: Mojca.Lindic@bsi.si.

Acknowledgements: The author is very grateful to Tina Golob Šušteršič, PhD (IMAD) and Vanessa Gunnella, PhD (ECB) for their constructive insights on an earlier version of the manuscript, to Miha Breznikar, MSc and Ana Selan, MSc for their help and valuable contributions, and colleagues from the Analysis and Research Department of the Bank of Slovenia for their useful suggestions, which enriched the content of this paper.

The paper was completed before the 2021 edition of the TiVA database was released.

The views presented herein are solely the responsibility of the author and should not be interpreted as the views of the Bank of Slovenia.

Povzetek

Gradivo analizira in primerja integracijo držav CESEE (skupina vzhodnih in jugovzhodnih evropskih držav) in EA 12 (skupina prvih dvanajstih članic evrskega območja) znotraj globalnih proizvodnih verig. Opisne statistike kažejo, da se je v zadnjem obdobju med obravnavanimi skupinami držav zaradi relativno višje rasti plač najbolj poslabšal konkurenčni položaj CESEE držav, ki so članice evrskega območja (torej Estonije, Latvije, Litve, Slovaške in Slovenije). Kljub temu je bila odprtost in vpetost v globalne proizvodne verige med temi državami največja. Poleg tega opisne statistike kažejo tudi, da države EA 12 znotraj globalnih proizvodnih verig sodelujejo v tehnološko bolj zahtevnih sektorjih kot države CESEE.

Rezultati empirične analize kažejo, da je bila v obdobju med 2005 in 2015 vpetost v globalne proizvodne verige pozitivno korelirana s spremembami svetovnega povpraševanja in negativno z velikostjo države ter višino plač. Ko je empirična analiza zajemala le CESEE države, so postale statistično značilne in pozitivne tudi korelacije med vpetostjo v globalne proizvodne verige in neto tujimi investicijami, kar bi bila lahko posledica prenosa tehnologij in znanj znotraj globalnih proizvodnih verig. Ti zaključki potrjujejo pomembnost neto tujih investicij za države v procesu konvergence.

1 Introduction

With the aim of optimizing production processes, firms offshore and seek inputs abroad, which makes their production processes more fragmented. This has been especially evident in the last few decades with the decline in transportation and communication costs, decreased barriers to trade, and technological improvements (Gunnella, Fidora, and Schmitz, 2017). Because of such changes, production processes became more complex and divided among several countries. This increased linkages among firms, as they no longer traded only in finished products but increasingly also in intermediate goods (Cappariello et al., 2020). Consequently, trade in intermediate goods and services increased, while the gross value of exports further surpassed the value added originating in each exporting country. In turn, this has significantly changed the composition of international trade and had an important impact on official trade statistics. As a result, since studying net imports and exports is no longer a sufficient measure for analysing the effect of international trade on domestic economies, studying global value chains (GVCs) has gained importance (WTO, 2019).

This paper builds its analysis around Central, Eastern, and South-Eastern (CESEE) European countries, which are members of the European Union, and takes the first 12 countries that entered the euro area (EA 12) as a benchmark. The analysis focuses especially on studying: (i) how (dis)similar are the CESEE economies in terms of their trade and GVC integration, and their competitive stance with respect to EA 12; (ii) what role country characteristics and institutions play in terms of countries' GVC involvement; and (iii) whether there are any significant differences in the CESEE euro area and non-euro area members with respect to correlations between the GVC participation and countries' characteristics and institutions.

A value chain in general consists of interrelated activities within firms that are needed to transform goods to a final product. Since these activities are nowadays increasingly dispersed among firms, both foreign and domestic, they are considered as global (De Backer and Miroudot, 2013). The main advantages of GVCs are threefold. First, through participating in GVCs, countries can specialise in activities with higher comparative advantage and outsource those with lower comparative advantage to foreign countries. Second is the creation of job opportunities, especially in developing countries, while third is facilitating technological and innovation transfers from developed to developing countries (WTO, 2017). Because of this, GVC participation has a positive impact on a country's investment level and productivity, which in turn has a positive effect on GDP per capita (p.c.). In this respect, institutional factors, such as quality of infrastructure, also have an important role for determining GVC participation (Ignatenko, Raei, and Mircheva, 2019). Nevertheless, the benefits of participating in GVCs do not appear automatically, but rather rely heavily on the country's position within the GVCs (WTO, 2017).

The value of trade, in which production is split between at least two countries, accounts for more than two thirds of world trade (WTO, 2019). Before the onset of the global financial crisis, global GVC activity was increasing, with production processes becoming more fragmented and complex (Antràs and Chor, 2018). Among the important supply and demand hubs, China's role has been gaining importance, while the main hubs for complex GVC networks, i.e. where the production is shared by more than two countries, have remained the USA and Germany (WTO, 2019). In addition, although the global financial crisis slowed down involvement in GVCs, in general it has been increasing among euro area (EA) countries in recent decades. This process has been stimulated by the growth of the currency area and synchronised regulations within the European Union (EU), which serve to promote cross-border

production chains. As a result, euro area countries have been increasingly using imported intermediate inputs in the production of their exports, which has made them more integrated in GVCs than other large countries, such as, for example the USA or China (Gunnella, Fidora, and Schmitz, 2017). Nevertheless, the recent coronavirus pandemic has had significant negative effects on the world economy, where international trade is expected to be especially hindered as many GVCs became obstructed, if not broken, during the pandemic.

Going forward, being part of GVCs is especially important for small and open economies, which face a lack of natural resources and/or a large domestic market. In the context of the EU single market, GVCs present an important channel for technology and knowledge transfers among member states, which should in turn have a positive impact on EU productivity. In this respect, the technology embedded in imported inputs has proven to be an important aspect of technology diffusion. GVCs also have a significant influence on domestic prices and labour markets. With respect to the former, although the most important impacts on inflation within the euro area still come from domestic factors, the influence of foreign ones increased throughout the 2000s. This raises the importance of identifying sectors that have a greater propensity to be impacted by foreign influences, such as through import prices. Furthermore, GVCs impact countries' labour markets since they affect the tasks, labour costs, and demand for skills in a particular sector. The euro area has witnessed a decrease in the usage of low-skilled labour in recent years, where part of this shift in favour of high-skilled labour could be explained by the increased participation in GVCs. More specifically, studies show that the increased foreign value added in countries' exports has a positive bearing on the usage of high-skilled labour and hourly compensation. This could be due to imported inputs creating a positive stimulus for productivity growth via learning, variety, or quality factors (ECB, 2019).

The current analysis yields some interesting results. Descriptive statistics show that trade openness and global market shares have increased in almost all CESEE countries in the recent period, where the highest increase has been in countries that joined the euro area. These countries also participated the most in GVCs during this time, but were on average positioned further downstream. Furthermore, the highest discrepancy between wage and productivity growth, in favour of the latter, was found to be in CESEE countries that have not yet joined the euro area, causing these countries' competitive positions to increase the most with respect to other country groups. Empirical analysis, which was done for the period between 2005 and 2015 on the entire set of CESEE and EA 12 countries, suggests that smaller countries and those with lower wages have higher GVC participation, and that the latter is also enhanced during times of greater global demand. When splitting the sample into CESEE countries within and outside the euro area, country size and wage level remain significantly negative only for the CESEE non-EA countries. In addition, a share of FDI inward stock in GDP, a potential indication of technological spillovers, becomes statistically significant and positive, indicating its importance for GVC participation in CESEE countries. These results lead us to interesting findings, suggesting that a negative correlation between country size and GVC participation is in general more significant in bigger countries, while technological spillovers are in general more relevant for countries that are still undergoing the convergence process.

Since a small number of observations was one of the main drawbacks of the basic model, sensitivity analysis addressed this issue by applying a gravity-type regression model. On average, the results of the sensitivity analysis confirm the findings from the basic model and add some additional insights on the linkages between GVC participation and partner-specific regressors. The latter comprise bilateral trade costs and show that bilateral distance and a common colonial relationship have the most significant linkages with GVC participation.

The rest of this paper is structured as follows. The subsequent section introduces the topic and presents the descriptive statistics, while section 3 introduces the GVC framework. Furthermore, the empirical analysis is included in section 4, while section 5 presents the main findings and gives some policy implications. The literature is presented in section 6, followed by the appendices.

2 Descriptive Statistics

This study distinguishes between EU members from the CESEE area which are within and outside the euro area. Following Žuk et al. (2018), CESEE countries which are EU members were divided into two groups, where one consisted of euro area member states (i.e. Estonia, Latvia, Lithuania, Slovakia, and Slovenia), while the other of non-euro area member states (i.e. Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania). The list of countries is presented in Table 1. Although Žuk et al. (2018) also included a group of "Western Balkan" states into the definition of CESEE countries (i.e. Albania, North Macedonia, Montenegro, Serbia, Bosnia and Herzegovina, and Kosovo), these have been excluded from the current analysis due to less reliable and limited data. Finally, in order to compare the results to euro area countries, a group of the first twelve states that entered the euro area was added to the analysis (i.e. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain).

Table 1: List of CESEE countries

Euro area	**Non-euro area**
Estonia	Bulgaria
Latvia	Croatia
Lithuania	Czech Republic
Slovakia	Hungary
Slovenia	Poland
	Romania

Note: The list of CESEE countries was compiled by following Žuk et al. (2018).

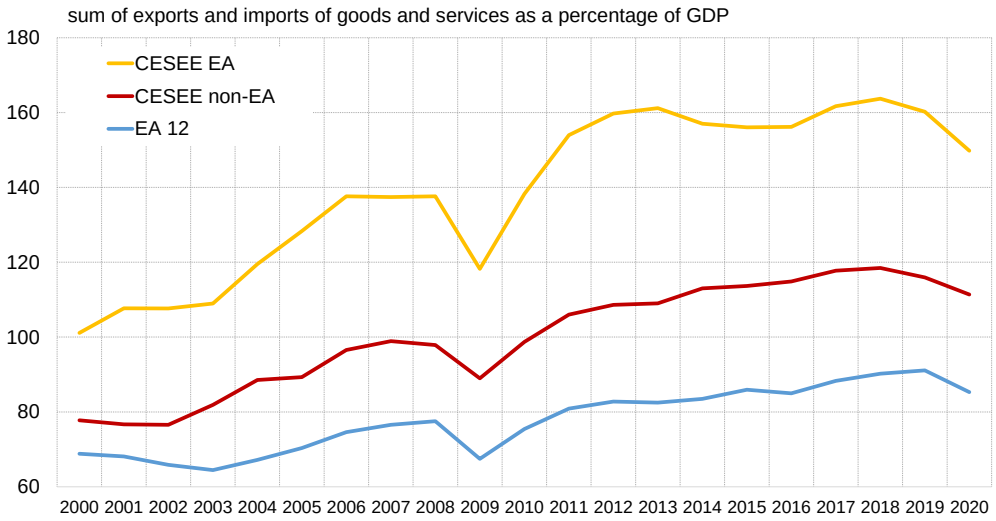
The CESEE countries share some common features. During the 1990s, they transitioned from command economies to market economies. In addition, many of them are small and open countries, located near larger EU economies and having strong relationships with them. As of 2000, these countries also underwent the process of real convergence towards the EU average, with the European Single Market playing an important role during this period (Žuk et al., 2018). Through the Single Market, member states have access to a larger market, which enhances trade flows among them and creates economic benefits (Veld, 2019). In addition, the Single Market also equips member states with common rules and standards, which decreases information asymmetries among countries, and in turn fosters trade and integration within GVCs (Blind et al., 2018).

The benefits of the Single Market and CESEE countries' convergence towards advanced EU economies are also visible in descriptive statistics. Trade openness, which shows the significance of international trade for a particular country, has increased through the vast majority of the CESEE countries since 2000, where CESEE countries that have joined the euro area experienced the fastest growth.[1] The share of imports and exports in the CESEE countries' GDP that are members of the euro area has been higher than 100% since 2000, which indicates the importance of international trade for these countries. In

[1] Trade openness is the indicator that shows the share of exports and imports in a country's GDP.

addition, the trade openness of the CESEE EA accelerated especially in the first years after EU accession, and after the onset of global financial crisis. Similar trends are also visible within the rest of the CESEE countries, albeit at a lower scale. The findings on the importance of international trade for CESEE countries served as an important motivation for implementing a more in-depth analysis on the GVC integration of these countries.

Figure 1: Trade openness

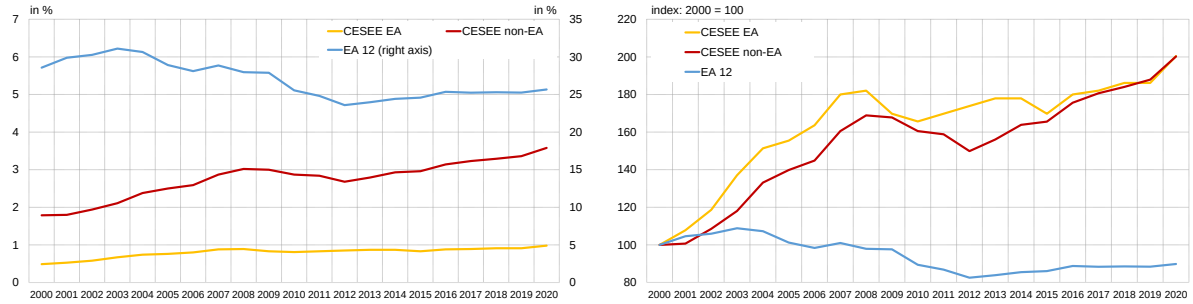


Source: Eurostat, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

In addition, CESEE countries have experienced a significant growth of their exports' shares in global exports, albeit this share has remained minor.[2] In the two decades between 2000 and 2020, CESEE countries doubled their share in global exports from 2.3% to 4.6%, which suggests their capability to compete in global markets has enhanced. Within the group, euro area members improved their share from 0.5% to 1.0%, while the non-euro area members' share increased from 1.8% to 3.6% (Figure 2). A disproportionate increase in CESEE countries' export market share, compared to the EA 12 average, is visible on the right side of Figure 2. Traditionally, the EU has been the main trading partner of CESEE countries, which on average represented 70% of their merchandise exports. Nevertheless, these countries have broadened their export networks and increased intra-regional trade in recent years amid their increased competitiveness in international markets (Žuk et al., 2018).

[2] The global export market shares are calculated as the share of the country group's exports in global exports.

Figure 2: Global export market share



Source: Eurostat, WITS, author's calculations.

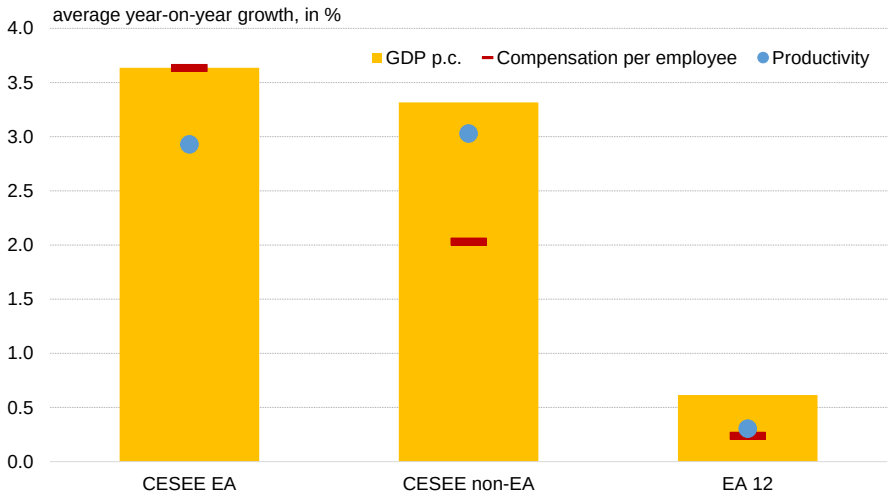
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Finally, between 2000 and 2020, growth in GDP p.c., labour productivity, and wage level – measured as compensation per employee – was substantially higher in CESEE countries, compared to the EA 12, which enabled the abovementioned convergence towards more developed EU member states. According to Žuk et al. (2018), the main drivers of productivity growth in CESEE countries were (i) enhanced institutional quality, which was especially improved during the EU accession process; (ii) favourable levels of human capital, measured for example by educational attainment of the workforce; and (iii) the abovementioned increases in trade openness and external competitiveness. With respect to the latter, Belka et al. (2016), and Bas and Strauss-Kahn (2014) suggest that international engagement increases productivity levels through several channels. First, through enhanced competition, which forces firms to be more cost-effective and innovative. Second, by having access to a larger market and a large variety of intermediate inputs, firms can take advantage of increasing returns to scale and can decrease production costs. Also, by having access to higher varieties of intermediate inputs, firms can enhance the customisation and quality of their products, and in turn improve the complementarity of their products on final markets. Finally, by sharing and transferring technologies and knowledge, embedded in intermediate imports. In addition, firms can increase their productivity by offshoring the least productive production processes and specialising in the most productive tasks (Grossman and Rossi-Hansberg, 2008). In terms of innovation, Žuk et al. (2018) claim there remains room for improvement among CESEE countries. By investing in capital, labour, and innovation, these countries can shift their production processes from relatively labour-intensive to more technologically advanced. In this respect, technological transfers, transmitted within GVCs and through FDI, play an important role. Furthermore, FDI also enables the exchange of good managerial practices and know-how (Belka et al., 2016). This was confirmed in the ESPON (2018) report, which shows that the intra-European FDI presents a significant factor for productivity increases. The report also concludes that, in 2018, most EA 12 members were net FDI investors, while all CESEE countries were net FDI receivers, suggesting that technological transfers were on average transmitted from EA 12 to CESEE countries.

On the other hand, while the GDP p.c. growth of CESEE countries was especially high before the onset of the global financial crisis, it deteriorated afterwards, which hindered these countries from moving closer to the EU average. Similarly, the productivity growth of CESEE countries was also clearly lower in the post-crisis period. Based on Chiacchio, Gradeva, and Lopez-Garcia (2018), this can be strongly linked to the GVC integration of these countries. Namely, firms in these countries have lately been

subject to lower technological transmissions from parent firms located in the rest of the EU, after the latter experienced lower productivity growth. Moreover, technological transfers were also limited due to the worldwide halt in the GVC participation growth in recent years. Finally, even though productivity growth was similar in both CESEE country groups, wage growth was much higher in CESEE euro area members. Consequently, their relative competitive position deteriorated compared to the rest of the CESEE countries and with respect to the EA 12. Nevertheless, as the convergence process within the CESEE group is still ongoing, the GDP p.c. and average wage levels of the CESEE group remain significantly lower than in the EA 12.

Figure 3: GDP, productivity, and wage growth in the period between 2000 and 2020



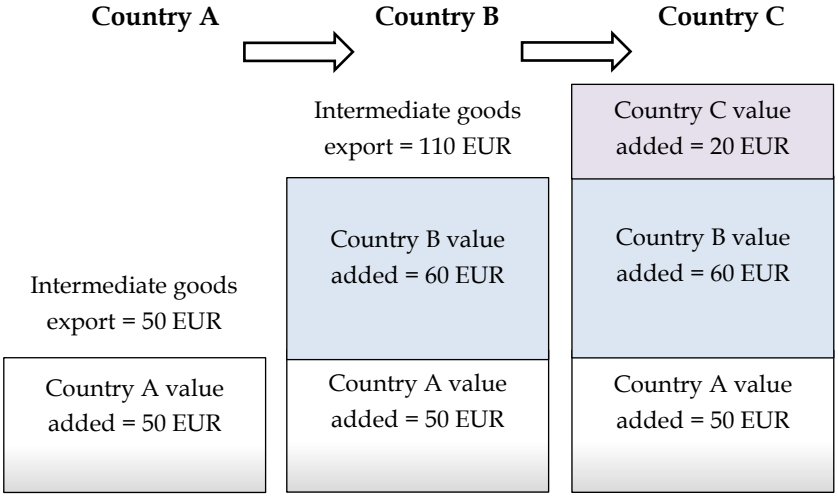
Source: Eurostat, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain. Compensation per employee has been HICP deflated.

3 GVC Framework

The rise of GVCs had a significant impact on the world economy, where complex GVCs were among the leading factors for global GDP growth between 1995 and the start of global financial crisis. Although the crisis has affected global trade patterns and hampered GVC growth, the latter has gained some momentum (WTO, 2019 and 2017). Nevertheless, according to recent indicators, trends have reversed again significantly due to the coronavirus outbreak.

The significance of GVCs is masked if it is analysed only by official trade and GDP data. In this respect, it is important to bear in mind that official trade and production data cannot distinguish which GDP and final goods production falls into GVC and non-GVC activities. Accordingly, since production is nowadays broken down into many stages, GVC analysis helps interpret bilateral trade balances, which can no longer be fully distinguished by analysing only net imports and exports (WTO, 2019 and 2017). In this respect, the GVC framework connects official trade statistics, presented in gross value terms, and national accounts, presented in value added terms (Aslam, Novta, and Rodrigues-Bastos, 2017). The drawback of the official trade statistics, which includes intermediate and final products, is that it double counts the value of intermediate products (Koopman, Wang, and Wei, 2014). A schematic representation of this issue is depicted in Figure 4.

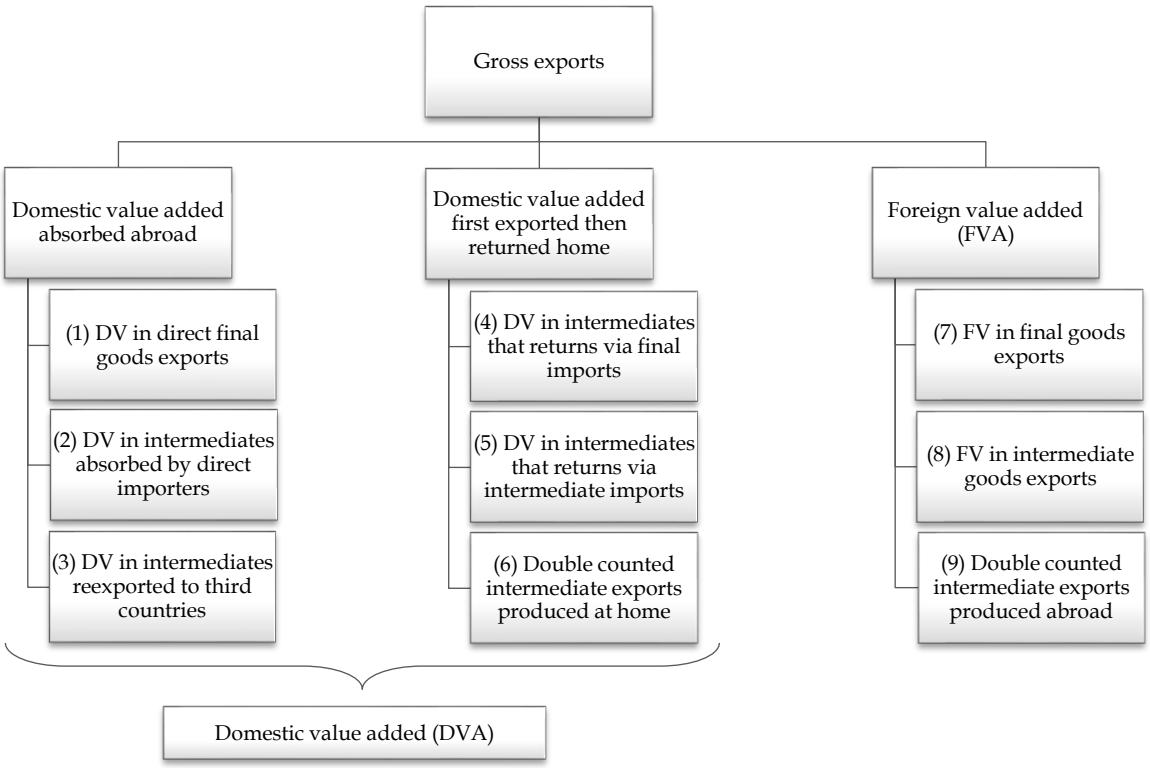
Figure 4: Schematic representation of a global value chain



Source: Based on Rausch (2020).

Going forward, since official trade statistics are calculated in gross terms where an intermediate product can be accounted for several times along the value chain, the role of the final producer seems to be overvalued, while that of firms providing intermediate products is undervalued (De Backer and Miroudot, 2013). In Figure 5, gross exports within the GVC framework are divided into several components, where the multiple value-added components are calculated by source as in Koopman, Wang, and Wei (2014).

Figure 5: Decomposition of gross exports



Source: Based on Aslam, Novta, and Rodrigues-Bastos (2017), and WTO (2017).
Notes: DV denotes domestic value; FV denotes foreign value; DVA denotes domestic value added; FVA denotes foreign value added.

An additional explanation of the terms in Figure 5 is given below (following Aslam, Novta, and Rodrigues-Bastos, 2017, and Koopman, Wang, and Wei, 2014):

1. Sum of terms 1–6: DVA, stands for domestic value added or the domestic content of gross exports.
2. Sum of terms 1–3: value-added exports, which can be broken down into direct value added exports (sum of the terms 1 and 2), and indirect value added exports (term 3, denoted also as IV in the literature).
3. Term 3 shows the domestic value added of intermediates re-exported to third countries and presents the likely length of the GVC. That is, if the country's intermediate inputs are later re-exported to third countries, it participates in longer value chains.
4. Sum of terms 4–6: domestic content in intermediate exports that finally returns home. These terms include goods that return to the origin country via imports, as well as a double counting item.
5. Sum of terms 7–9: FVA, foreign value added.

3.1 Data

The GVC analysis in this study uses the Trade in Value Added (TiVA) dataset, which is provided by the OECD and considers a country's value added in the production of goods and services. The dataset is among others available at the level of exporting sector, country, and sector origins of the value added.

The 2018 edition includes information for 64 economies in the period between 2005 and 2015 (TiVA, 2019). As presented in Figure 6, the data is organised as a system of industry-by-industry global input-output tables. The concepts are based on the 2008 System of national accounts (2008 SNA) and use a sector list based on ISIC Rev. 4. (OECD, 2019).

Figure 6: Basic structure of the OECD's Inter-Country Input-Output system

		Intermediate Consumption			Final Demand			G.O.
		Country 1	…	Country N	Country 1	…	Country N	
		Ind. 1 … Ind. K	…	Ind. 1 … Ind. K	FD 1 … FD F	…	FD 1 … FD F	
Country 1	Ind. 1 ⋮ Ind. K	Z^{11}	…	Z^{1N}	Y^{11}	…	Y^{1N}	X^{1}
⋮	⋮	…	⋱	⋮	⋮	⋱	⋮	⋮
Country N	Ind. 1 ⋮ Ind. K	Z^{N1}	…	Z^{NN}	Y^{N1}	…	Y^{NN}	X^{N}
Value Added		W^{1}	…	W^{N}	Taxes less subsidies on final products			
Gross Output		X^{1}	…	X^{N}				

Source: Based on OECD (2019).

Notes: W: value added at basic prices (plus taxes less subsidies on intermediate products), so that total value added equals total final demand at basic prices; X: gross output at basic prices; Z: intermediate consumption at basic prices; Y: final demand; G.O.: Gross Output.

Following OECD (2019), this paragraph presents the main indicators through a less technical approach. First, total gross exports of the reporting country *c* for a sector *s* are calculated by summing the exports of intermediate goods and services, and exports of final demand goods and services (Figure 7). The indicator is reported by sector and by partner country in USD million. Although the gross exports in TiVA are consistent with the national accounts' estimates of total exports, the latter are valued at purchaser's prices, while the former are valued at basic prices. Because of this, the total exports of services in the TiVA might be significantly higher than the total exports of services in the national accounts' statistics. Second, the foreign value added content of gross exports (i.e. FVA) takes into account the value of imported intermediate goods and services in the reporting country *c* sector's exports, in USD million. Foreign value added, which was previously exported by the reporting country *c* and later re-imported by the same country, is also embodied in this measure (Figure 8). Finally, domestic value added embodied in foreign exports measures the reporting country *c*'s domestic value added in partner countries' *p* gross exports of sector *s*. The measure is in USD million (Figure 9) (OECD, 2019).

Figure 7: Illustrative diagram of country *c*'s total gross exports

VA origin	Exports	Imports	Final Demand
all countries	country *c*	country *p*	
all sectors	sector *s*		

Legend:
Indicator dimension
Measured attribute

Source: Based on OECD (2019).
Notes: Country *c* denotes reporting country; country *p* denotes partner country.

Figure 8: Illustrative diagram of country *c*'s foreign value added content of gross exports

VA origin	Exports	Imports	Final Demand
∑ country ≠ *c*	country *c*		
all sectors	sector *s*		

Legend:
Indicator dimension
Measured attribute

Source: Based on OECD (2019).
Notes: Country *c* denotes reporting country; country *p* denotes partner country.

Figure 9: Illustrative diagram of country *c*'s domestic value added embodied in foreign exports

VA origin	Exports	Imports	Final Demand
country *c*	∑ country ≠ *c*		
country = *c*			
	sector *s*		

Legend:
Indicator dimension
Measured attribute

Source: Based on OECD (2019).
Notes: Country *c* denotes reporting country; country *p* denotes partner country.

3.2 Measures of GVC Integration

Since changes in bilateral trade balances cannot be fully captured by analysing official trade data, previous studies introduced new measures in order to capture countries' involvement in GVCs. One of them is vertical specialisation, the notion presented by Hummels, Ishii, and Yi (2001), which entails the following three characteristics. First, the production of goods is divided into several different stages. Second, the value added in a particular stage of production is provided by at least two countries. Third, the imported inputs are used in a production stage and are later exported by at least one country. GVC integration measures can be considered from the perspective of the value added origin, exporters, importers, and final consumers, and each with a country and sector dimension.
Countries' position and participation within GVCs is derived by considering the following measures (Koopman, Wang, and Wei, 2014):

- FVA (from the import perspective, backward or downstream participation): the imported intermediate input content of exports. It approximates the imported intermediates that are used to generate exports and therefore presents the foreign value added embedded in inputs that are used in the production of later exported outputs.
- IV (from the export perspective, forward or upstream participation): trade flows within the domestic value-added component, which are exported to other countries. It measures the value added of intermediate goods that are used as inputs in the foreign country's production and are later exported further by the foreign country.

The GVC participation is calculated as the sum of FVA and IV in the share of exports (Aslam, Novta, and Rodrigues-Bastos, 2017):

$$GVC_{Participation} = \frac{FVA+IV}{Gross\ Exports} \quad (1)$$

The GVC participation measure defines the extent of a country's involvement in GVCs and shows the importance of the global supply chain for that country (Koopman, Wang, and Wei, 2014). If a country has a higher value for the GVC participation measure, this indicates a greater GVC involvement of the country (Aslam, Novta, and Rodrigues-Bastos, 2017).

Koopman, Wang, and Wei (2014) developed an additional measure, which positions the country within GVCs and shows its relative downstream or upstream position in comparison with other countries. The position index is calculated 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 (Aslam, Novta, and Rodrigues-Bastos, 2017):

$$GVC_{Position} = \ln\left(1 + \frac{IV}{Gross\ Exports}\right) - \ln\left(1 + \frac{FVA}{Gross\ Exports}\right) \quad (2)$$

A country with a larger position index is positioned relatively more upstream in GVCs (i.e. the country's numerator tends to be large). This means it contributes more value added to other countries' exports than other countries contribute to its exports. The country achieves that by producing inputs for other countries, either by providing raw materials (e.g. Russia) and manufactured intermediates (e.g. Japan) (Koopman, Wang, and Wei, 2014), and/or intangibles at the start of the production process (e.g. research and development, and design) (Taglioni and Winkler, 2016, and De Backer and Miroudot, 2013). Therefore, with a higher share of a country's IV in gross exports than its share of FVA in gross exports, the country lies upstream in GVCs with a positive GVC position index, indicating that a relatively high share of its value added in re-exported intermediate products is being shifted further down the value chain (Gunnella, Fidora, and Schmitz, 2017).

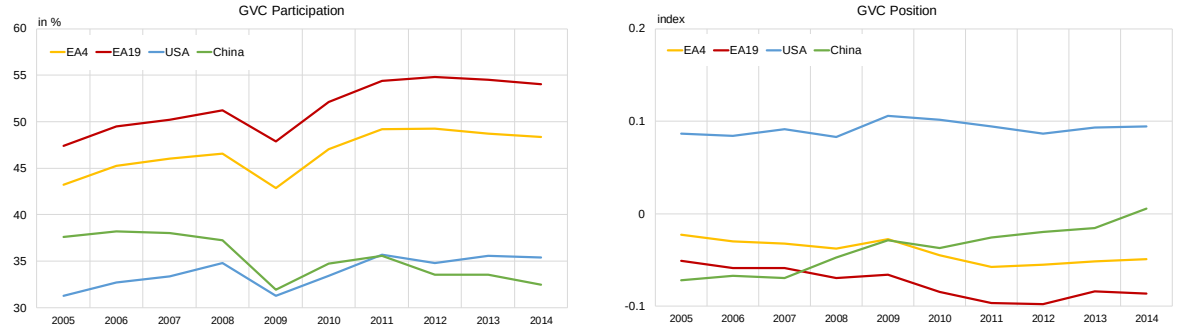
On the other hand, a downstream position of a country is denoted by a negative GVC position index, indicating that the country uses relatively higher share of foreign value added in its exports, i.e. its FVA share is higher than its IV share in gross exports. If the country lies downstream in GVCs, it uses a relatively larger share of imported foreign components to produce export goods (Koopman, Wang, and Wei, 2014). This means the country is involved in the assembly of processed products or provides customer services (De Backer and Miroudot, 2013).

To explain the GVC position index, Koopman, Wang, and Wei (2014) give an example of Japan and China, where Japan specializes in providing manufacturing components to Chinese firms. The GVC position index would therefore take on a low value for the latter and a high value for the former. In addition, by considering the distribution of IV's and FVA's shares in a country's gross exports, one can deduce the GVC position. For example, a higher (lower) share of FVA in the country's gross exports would indicate a relatively lower (higher) GVC position of this country compared to other countries. Although two countries can be positioned similarly within GVCs, their GVC participation measure could be very different, and vice versa. Consequently, Koopman, Wang, and Wei (2014) recommend the parallel use of both measures, i.e. the GVC position and the GVC participation.

3.3 Testing Data Sensibility

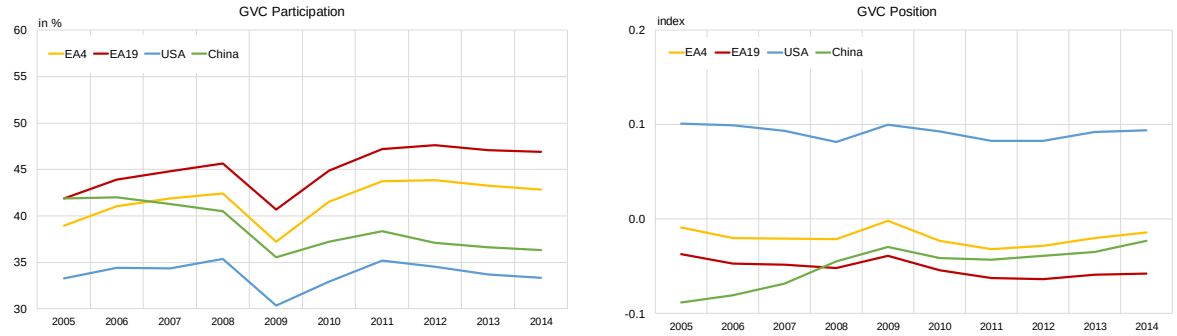
Before conducting the analysis, the data reliability of the TiVA dataset was tested in order to increase the sensibility of the results. For that reason, the GVC participation and the GVC position measures were calculated by using the TiVA dataset and later compared with the study by Gunnella, Fidora, and Schmitz (2017), which used the WIOD dataset.[3] The results of the latter study are presented in Figure 10, while results of the TiVA dataset are presented in Figure 11. The figures compare the results for the USA, China, the euro area, and four biggest euro area countries (i.e. France, Germany, Italy, and Spain). In order to enhance comparability of the results, the figures refer to a common time span of 2005–2014.

Figure 10: GVC participation and GVC position (WIOD dataset, ECB calculation)



Source: Gunnella, Fidora, and Schmitz (2017).
Notes: EA4: four largest euro area countries (i.e. France, Germany, Italy, and Spain); EA19: euro area.

Figure 11: GVC participation and GVC position (TiVA dataset)



Source: TiVA dataset, author's calculations.
Notes: EA4: four largest euro area countries (i.e. France, Germany, Italy, and Spain); EA19: euro area.

Although the values of both measures, the GVC participation and the GVC position, vary between the two datasets, their movements are in general consistent. The highest discrepancies in both measures are seen for China. In this respect, it is important to mention that previous studies already pointed out there might be some problems when using data for which the official supply-use tables do not exist, including China (Aslam, Novta, and Rodrigues-Bastos, 2017).

When using a macro (i.e. Input-Output) approach for measuring GVCs, some caveats have to be taken into account. First, for constructing a global input-output table, various data sources have to be combined, which can sometimes be deficient or even unavailable. Therefore, data providers of the

[3] WIOD stands for "World Input-Output Tables". The 2016 release covers 43 countries for the period 2000–2014 and is provided by the European Commission, Research Directorate General (WIOD, 2020).

global input-output tables have to make use of laborious cleaning, and different evaluation methods and assumptions when building the datasets. Consequently, due to data availability issues, global input-output tables are usually available only for recent decades, which makes it challenging to extend the analysis to a preceding period. In addition, datasets are also usually disaggregated at a broader level in terms of sectors or products, or provide only limited information on bilateral trade information, which makes it harder to conduct a more in-depth analysis. Finally, these data do not differentiate between the usage of domestically produced and imported inputs, nor between the usages of imported inputs across different firms. Some of these issues could be resolved by using micro-approaches for measuring GVC integration (Johnson, 2017).

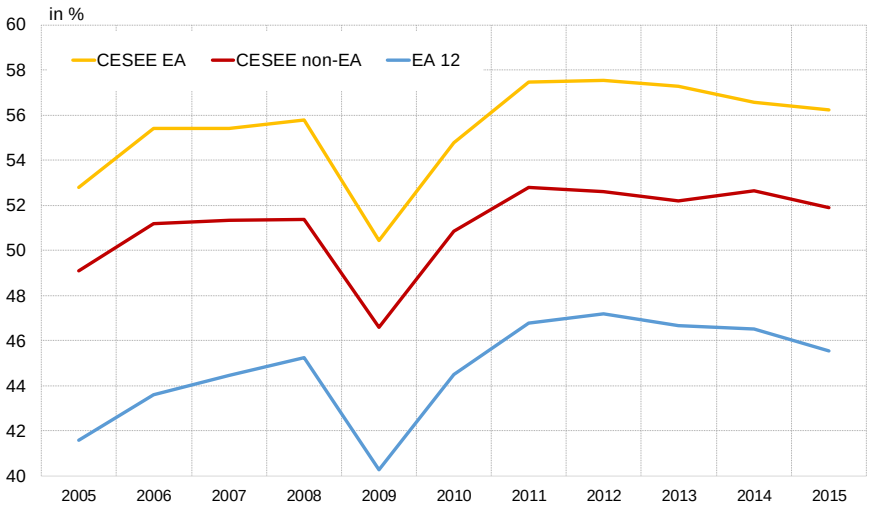
3.4 Descriptive Statistics on GVCs

Descriptive statistics on GVCs confirm the abovementioned expectations that countries with higher trade openness are relatively more integrated in GVCs. Among the sampled country groups, the highest degree of the GVC participation is seen for CESEE members of the euro area, followed by CESEE non-euro area members and the EA 12. Gunnella, Fidora, and Schmitz (2017) also find that smaller countries are relatively more integrated into GVCs. Their results are presented in Figure 10, which shows that the GVC participation in the euro area is higher than in the USA or China. The authors link this result to the intra-euro area trade, which is fostered by the common regulatory framework established within the European Single Market and the currency area. Damjanović and Banerjee (2018) reach similar conclusions and explain that larger economies, especially those that have access to natural resources, can take advantage of economies of scale and rely less on foreign suppliers than smaller and more open economies.

The participation in GVCs of the selected country groups has intensified between 2005, the first available year in the analysis, and 2015, the latest available year (Figure 12). Between the two years, the GVC participation has increased within all country groups, with the highest increase in the EA 12 group and the lowest in the CESEE non-euro area group. In addition, increases in GVC participation were hampered after the onset of the economic crisis, which is especially evident from 2011 onwards. According to Gunnella, Fidora, and Schmitz (2017), one of the reasons for the slowdown was onshoring, which relocated production processes closer to the demand markets and thus shortened GVCs. Firms undertook onshoring due to (i) increasing labour costs in developing countries, which worsened their competitive position; (ii) protectionist measures, which elevated trade costs; and/or (iii) robotisation, which prompted the re-opening of production in developed countries. In addition, a significant factor might also be an increase in demand for services, which are more difficult to trade internationally than goods.

Current developments within international trade are not yet captured in the TiVA database. In the last few years, GVC participation has been first hindered by the USA-China trade war, before being significantly obstructed by the onset of the coronavirus pandemic (UNCTAD, 2020). In addition, the pandemic is expected to limit global demand and supply, as well as financial channels (UNIDO, 2020). Thus, several factors have contributed to a slowdown in GVC participation in the recent period; rising global protectionism, the increased unpredictability of transport costs, declining FDI flows, and rising labour costs in emerging economies (Cigna, Gunnella, and Quaglietti, 2022).

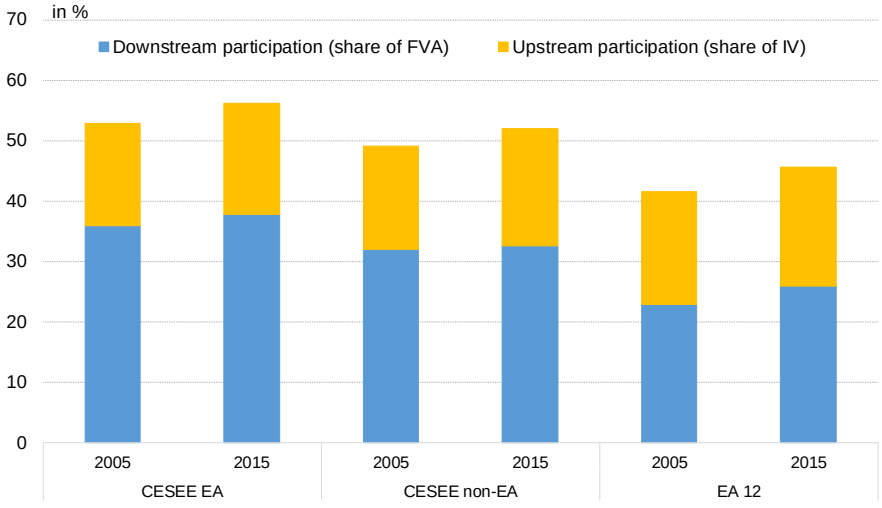
Figure 12: GVC participation



Source: TiVA, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

At the beginning and the end of the observation period, CESEE EA countries had the highest share of foreign value added in their exports, indicating this country group would have the most downstream GVC position among selected country groups. In contrast, the most upstream GVC position among selected country groups is expected for EA 12 countries. Supplementary discussion of the findings will be provided later in the segment which presents the results of the GVC position indices.

Figure 13: GVC participation breakdown for the years 2005 and 2015

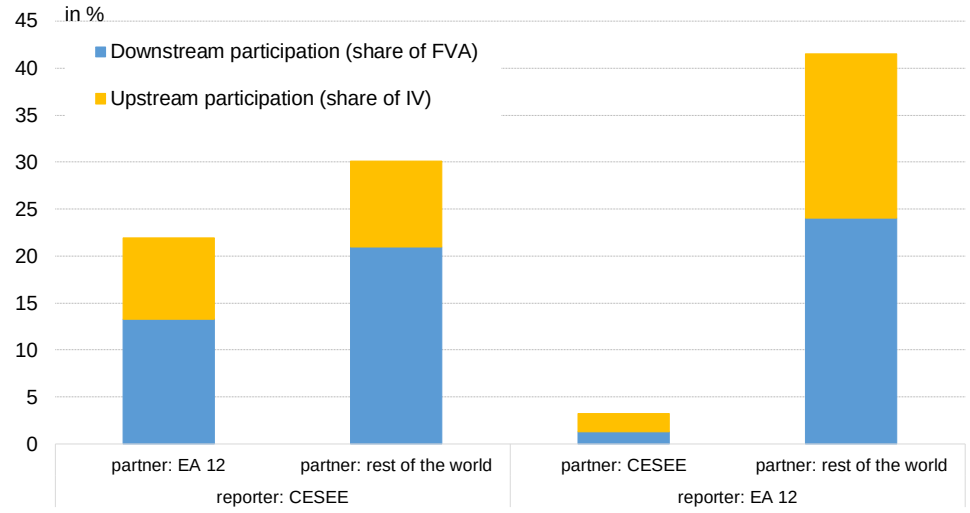


Source: TiVA, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

For brevity, the following charts provide only the main country groups' averages over the entire sample. Since Figure 13 shows that the proportions of the FVA and IV shares in total exports remained approximately the same throughout the observation period, only the average of the entire period is shown in the subsequent figures. Also on account of conciseness, the following figures show only the CESEE average. Figures containing both end years and both CESEE groups of countries are included in Appendix A.

Based on bilateral GVC participation statistics, EA 12 countries represent an important GVC partner for the CESEE group. GVC participation for each reporting country group in Figure 14 is broken down by partners of interest, i.e. the remaining country group and the rest of the world. Within the CESEE group, more than 40% of the GVC participation is based on integration with EA 12 countries. This is in line with the aforementioned conclusions of Žuk et al. (2018), who found that EU countries are the main trading partner of the CESEE group. On the other hand, GVC participation of the EA 12 group is less dependent on integration with the CESEE group as the proportionate share is lower than 10%. In this respect, the study by Amador, Cappariello, and Stehrer (2014) shows that, for a particular euro area country, its most important partners within GVCs are other euro area members. Moreover, and especially due to its size and specialisation in the production of transport equipment, Germany plays a pivotal role in the euro area's GVC integration. Concerning countries outside the euro area, China has been gaining importance as an input provider to these countries in the recent period.

Figure 14: GVC participation breakdown by reporting and partner country groups (2005–2015 average)



Source: TiVA, author's calculations.

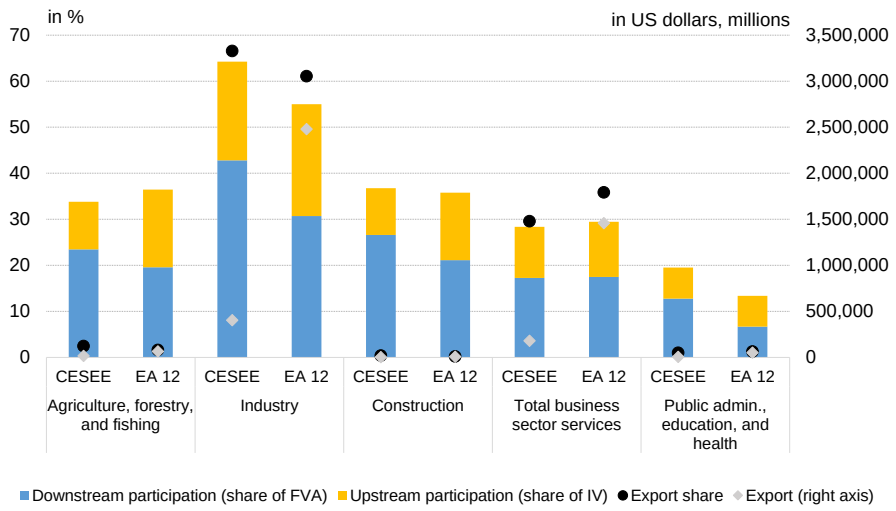
Notes: CESEE: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Since integration within GVCs can vary between sectors and countries, this analysis also aims to examine any possible differences in GVC participation across sectors in the CESEE and EA 12 countries. In general, services sectors are involved in more forward linkages, i.e. upstream participation, which means that a relatively higher value added from these sectors is embedded in foreign exports. In contrast, manufacturing sectors use relatively more foreign inputs in their production processes. In this respect, the largest suppliers in the world tend to be electrical and machinery sectors in China and Germany, whereas the highest value added is created in the financial and business services of the USA and Germany (Ignatenko, Raei, and Mircheva, 2019). Furthermore, previous studies found that

integration within GVCs is especially important for high-tech sectors (WTO, 2019). Considering Europe as a whole, GVC integration as well as employment is mostly concentrated in the manufacturing, transport and communications, and wholesale and retail sectors. Within manufacturing, GVC participation is the highest in machinery and equipment, followed by motor vehicles and manufacturing of chemicals and metal products (Huidrom et al., 2019).

The results show that GVC participation is the highest in the industry sector, which is in line with the aforementioned analyses (see for example Ignatenko, Raei, and Mircheva, 2019, and Huidrom et al., 2019).[4] Some conclusions are consistent for the CESEE and EA 12 groups of countries. First, between 2005 and 2015, GVC participation has increased in all sectors. Second, in the average of the observed period, export volume and export share were the highest in the industry sector, which also had the highest GVC participation. In contrast, GVC participation was the lowest in public administration, education, and health. Finally, since the share of downstream participation exceeded the share of upstream participation in all sectors, their GVC position measure is expected to be negative and hence to be located downstream within GVCs. In addition, all sectors are positioned more upstream within GVCs in the EA 12 group compared to the CESEE group. Nevertheless, there are also some inconsistencies between both country groups, mainly in terms of sectors' position within GVCs. In the average of the observed period, the most downstream positioned sector in the CESEE group was construction, while the most upstream sector was total business sector services. On the other hand, the latter was positioned the most downstream in the EA 12 group, while the most upstream was the public administration, education, and health sector.

Figure 15: GVC participation breakdown by sectors for the CESEE and EA 12 country group (2005–2015 average)



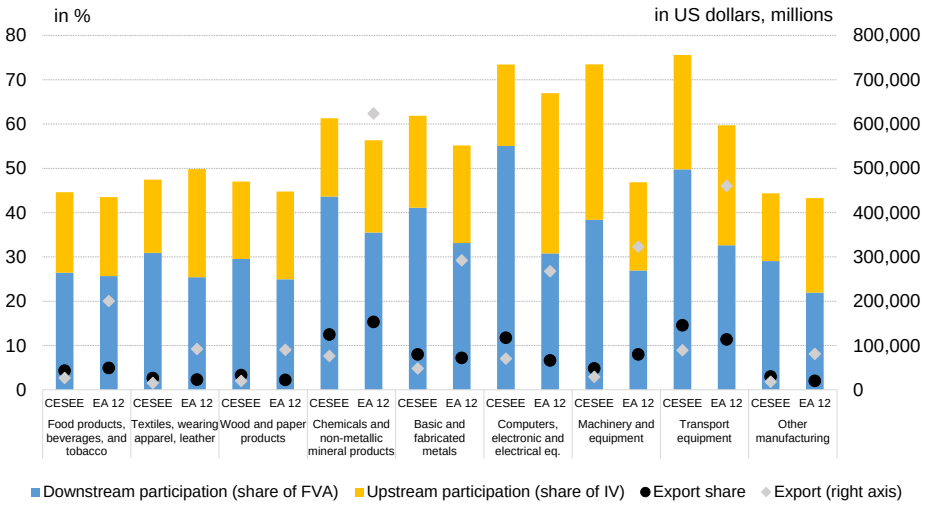
Source: TiVA, author's calculations.

Notes: CESEE: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

[4] This analysis divides sectors into five broad categories: 1) agriculture, forestry, and fishing; 2) industry, which combines mining, manufacturing, and utilities; 3) construction; 4) total business sector services; and 5) public administration, education, and health. The total business sector services combine distributive trade, transport, accommodation, and food services, information and communication, financial and insurance activities, real estate activities, and other business sector services.

Going forward, in contrast with results of aggregated sectors, inconsistencies of GVC participation between CESEE and EA 12 countries become much larger after disaggregating the manufacturing sector into subsectors. Since the analysis on aggregated sectors concluded that the highest GVC participation was within the industry sector, which is largely comprised of the manufacturing sector, the following part studies GVC participation within the manufacturing sector in greater detail, focusing on the average of the observed period. Within the CESEE country group, GVC participation was the highest in the transport equipment subsector, while it also reached above 70% in the subsectors of machinery and equipment, and computers, electronic and electrical equipment. The transport equipment subsector is important for these countries as many of them participate in car assembly activities (see for example Huidrom et al., 2019, and De Backer and Miroudot, 2013). In addition, when comparing downstream and upstream participation shares between subsectors, the share of downstream participation was greater than half in all manufacturing subsectors within the CESEE group, indicating their downstream GVC position. The most upstream subsector within the CESEE group was machinery and equipment, while the most downstream was computers, electronic and electrical equipment. On the other hand, by approaching 67%, the GVC participation within the EA 12 group was the highest in the subsector of computers, electronic and electrical equipment. In contrast to the CESEE country group, this subsector was positioned the most upstream within the EA 12 group, while the most downstream was chemicals and non-metallic mineral products. Furthermore, all manufacturing subsectors within the EA 12 group were positioned more upstream than within the CESEE group. Finally, considering Eurostat's high-tech classification of manufacturing industries (Eurostat, 2019), the highest export share and GVC participation of the EA 12 was in more technologically advanced sectors compared to the CESEE group.

Figure 16: GVC participation breakdown within manufacturing sector for the CESEE and EA 12 country group (2005–2015 average)



Source: TiVA, author's calculations.
Notes: CESEE: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

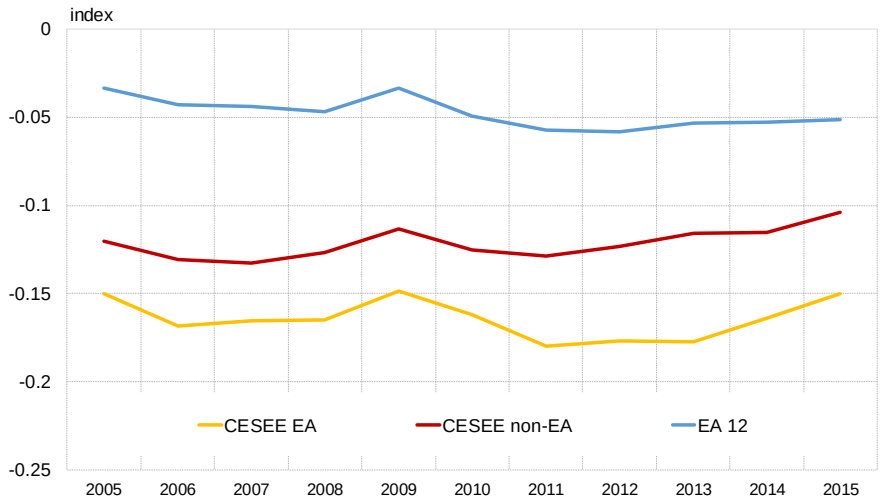
The descriptive statistics' analysis has so far offered some interesting takeaways. Particularly noteworthy are the findings that all manufacturing subsectors within CESEE countries were on average positioned more downstream within GVCs compared to within the EA 12, and that the highest export shares and GVC participation of the CESEE were in technologically less advanced manufacturing

subsectors than seen with the EA 12. Combined with the fact that the EA 12 country group is a very important partner for CESEE countries in terms of their GVC participation, this could indicate that GVC integration with the EA 12 would represent an important source of technology transfers for CESEE countries.

The final part of the descriptive statistics' section focuses on GVC position indices. As in the case of GVC participation, the position of sectors within GVCs can also vary significantly between countries and sectors, where some sectors may be positioned upstream in some countries while downstream in others. On a global scale, the top three upstream sectors in 2009 were renting of machinery equipment and other business services, mining and quarrying, and basic metals and fabricated metal products. On the other hand, the three most downstream sectors were transport equipment, electrical and optical equipment, and basic metals and fabricated metal products (ECB, 2019). Interestingly, basic metals and fabricated metal products was the third most downstream and upstream sector in the global production network, where it was listed as upstream for Germany, but downstream for China. Following Koopman, Wang, and Wei (2014), this indicates that, within this sector, German firms are in general providing components for foreign firms' production processes, whereas Chinese firms are in general using foreign components in their production processes.

This study analyses GVC position indices only at the country level and confirms preliminary predictions that all considered country groups are located downstream within GVCs. Negative GVC position indices for the entire observation period in Figure 17 indicate that all three country groups use more foreign inputs in their export production than they supply intermediate products to other countries. The figure also confirms that the more integrated and open the countries are, the more downstream their GVC position is. Parallel conclusions were obtained by Gunnella, Fidora, and Schmitz (2017) who noted that these countries mostly participate in assembly activities within the pan-European contribution to GVCs. Nevertheless, a lower GVC position does not necessarily contribute negatively to GDP, and vice versa, since a higher share of domestic value added in gross exports might not necessarily point to a higher exported total value added and higher GDP. If a country uses inferior domestic inputs in its production, instead of importing them from abroad, this will likely result in fewer gross exports and lower total value added exports. The data even show that the share of domestic value added in exports tends to decrease over time, owing to more disaggregated production processes (WTO, 2019). Backward participation therefore enables countries to specialise in sectors with higher comparative advantages, to improve the cost effectiveness of their tasks, and to gain from the technology and knowledge that is embodied in imported inputs (OECD, 2017).

Figure 17: GVC position



Source: TiVA, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

4 Empirical Analysis

The empirical analysis will study in more detail the questions that remained open in the earlier part of the analysis, especially those regarding the correlations between various determinants and institutional factors, and GVC participation. As noted above, the main motivation for implementing regression analysis was to further analyse the GVC integration of CESEE and EA 12 countries, and to search for possible differences among these countries.

4.1 Basic Model

In the basic model, a pooled OLS model with cluster-robust standard errors was applied. With respect to the latter, the standard errors were corrected for clustering on the country level. A similar approach was, for example, also taken by the ECB (2019) and Ignatenko, Raei, and Mircheva (2019).

$$\begin{aligned} \text{GVC\_part}_{it} = \alpha &+ \beta_1 \text{Population}_{it} + \beta_2 \text{FDI}_{it} + \beta_3 \text{R\&D}_{it} + \beta_4 \text{Skill share}_{it} \\ &+ \beta_5 \text{Global demand}_{it} + \beta_6 \text{GDP p. c.}_{it} + \beta_7 \text{Manufacturing}_{it} + \beta_8 \text{Wages}_{it} \\ &+ \beta_9 \text{Location}_{it} + u_{it} \end{aligned} \qquad (3)$$

for years $t = 1, \dots, T$ and countries $i = 1, \dots, N$.

The dependent variable (GVC_part_{it}) is the GVC participation measure. Based on related studies, the following control variables were included in the analysis, which will be presented in more detail in the following paragraphs: size of the country (Population_{it}), foreign direct investments (FDI_{it}), research and development ($\text{R\&D}_{it}$), share of the tertiary educated in total employment (Skill share_{it}), global demand conditions ($\text{Global demand}_{it}$), GDP per capita ($\text{GDP p. c.}_{it}$), value added of manufacturing sector ($\text{Manufacturing}_{it}$), wage level ($\text{Wages}_{it}$), and location ($\text{Location}_{it}$).

First, size of the country, measured with the number of inhabitants, was included in order to consider a country's market size. Previous studies find mixed results on the correlation between a country's size and GVC participation. For example, Van der Marel (2015) finds a negative relationship between the two variables, while the ECB (2019) finds a positive one. The results might be mixed since, according to Kowalski et al. (2015), backward and forward integration within GVCs have contrary linkages with market size. In other words, since larger countries have more domestic intermediates at their disposal, country size is negatively linked to backward engagement within GVCs and positively to forward engagement within GVCs. As a result, since descriptive statistics showed the sampled countries are relatively more involved in backward linkages within GVCs, a negative correlation is expected between the two variables, especially in the case of larger countries.

Second, FDI inward stock and R&D expenditure were included in order to take into account technological spillovers and the innovative abilities of countries, where both variables were measured as a share of GDP, with the aim of allowing for country size. In addition, the FDI variable is reported as stock in order to allow for the entire FDI stock and not only newly formed stock. Technology can be transferred within GVCs from parent to host firms through backward and forward linkages. The former originates from firms using intermediate inputs from their parent firms and thus having access to embedded technologies. In contrast, by providing intermediate inputs to parent firms through forward linkages, firms are exposed to quality checks which have positive effects on their products' quality (Chiacchio, Gradeva, and Lopez-Garcia, 2018). Positive linkages between GVC integration and FDI were also confirmed by Kowalski et al. (2015), Kersan-Škabić (2019), and Adarov and Stehrer (2019), where the latter study concludes that backward participation especially enables inward FDI, while outward FDI is enabled by forward participation. In addition, studies indicate that EA 12 countries might present a significant source of technological diffusion in CESEE countries. For instance, the UNCTAD statistics on FDI inflows by geographical origin show that between 2001 and 2012, CESEE countries on average received more than a half of their total FDI inflows from EA 12 countries (UNCTAD Bilateral FDI Statistics, 2019). Moreover, the ESPON (2018) report shows that the majority of EA 12 countries continued to be net FDI investors of intra-European FDI flows in 2018, while CESEE countries were listed as net FDI receivers (ESPON, 2018). In the light of past studies, positive linkages are expected between FDI and GVC integration. Finally, with respect to R&D activities and GVC participation, the former are located upstream within GVCs, provide intermediate inputs to firms, and diffuse technology between parent and host firms (ECB, 2019, Taglioni and Winkler, 2016, and De Backer and Miroudot, 2013). In turn, R&D activities are expected to have a positive bearing on backward GVC participation due to the last two factors, while their upstream position is expected to be positively associated with forward GVC participation.

Third, studies show that GVC integration usually favours skilled workers. In order to control for labour force characteristics, the share of tertiary educated in total employment was included as one of the regressors. Linkages between GVC participation and high-skilled workers were proven to be positive in the case of the relatively higher usage of imported inputs, i.e. backward participation, which could result in technological transfers within GVCs (ECB, 2019). This is because these favour high-skilled labour, especially in the case of GVC integration with high-income countries. On the other hand, since labour-intensive tasks are commonly offshored to low-income countries, GVC integration correlates negatively with low-skilled labour in the home country (OECD, 2017). Thus, skill upgrading is important for both firms and workers. With regard to firms, skilled workers can more easily adapt and apply new technologies (WTO, 2017), while workers are less at risk of losing their jobs if they invest in

upgrading their skills (OECD, 2017). Therefore, a positive correlation is expected between GVC participation and high-skilled labour.

Going further, the model also takes into account global demand conditions by considering foreign demand for the home country's products. The latter is proxied by the total value of domestic value added, embodied in foreign demand. As seen in the descriptive statistics, there was a significant downturn in GVC participation during the onset of the global financial crisis, when global demand dampened. As such, linkages between global demand conditions and GVC participation are expected to be positive.

In order to assess the country-specific institutional environment and growth developments, the analysis also takes into account GDP p.c. as an explanatory variable (see, for example, Taglioni and Winkler (2016) for further reference). Kowalski et al. (2015) find that a higher level of development is positively associated with both forward and backward engagement within GVC participation. This means that developed countries buy greater shares of their intermediate inputs abroad and that they also export more of their products abroad as intermediates. The positive relationship between GDP p.c. and GVC integration is also confirmed by ECB (2019), Huidrom et al. (2019), and WTO (2017). On the other hand, while also IMF (2015) finds a positive relationship between GDP p.c. and backward GVC participation, the relationship turns negative once a subsample of countries with lower GDP p.c. levels are taken into account.

Furthermore, according to the descriptive statistics and previous studies (see, for example, Huidrom et al. (2019), and Kowalski et al. (2015)), GVC participation is the highest in manufacturing sector. In this respect, since Kowalski et al. (2015) find that an increase in the share of manufacturing in GDP is positively associated with backward integration within GVCs, and since the descriptive statistics show the manufacturing sector had on average a higher share of backward integration within GVCs, one can expect positive linkages between the two regressors.

In addition, since low-wage destinations are relatively more attractive for GVCs (see for example WTO (2019) and OECD (2017)), especially in the case of labour-intensive tasks, GVC integration is expected to be negatively associated with the wage level.[5]

Finally, since countries tend to choose geographically closest trade partners, one of the important drivers of GVC participation is the location of the country. There are three main production hubs worldwide, the USA, China, and Germany, where the latter is the most important for European countries (WTO, 2017). In addition, Kowalski et al. (2015) find that firms buy fewer intermediate products abroad if they are located further away from the main hub economies. Accordingly, the last regressor captures distance to the German hub by measuring the bilateral distance between the German capital and that of a particular country, anticipating negative linkages between the two variables.

The GVC participation measure was regressed on a set of the abovementioned control variables, using a panel dataset, which included the period between 2005 and 2015. The model for a particular country group was estimated with and without time fixed effects. Control variables for the country size (Population_{it}), global demand conditions ($\text{Global demand}_{it}$), GDP per capita ($\text{GDP p. c.}_{it}$), wages ($\text{Wages}_{it}$), and location ($\text{Location}_{it}$) were transformed into logarithms. In addition, since descriptive statistics indicated there are some institutional and economic differences between CESEE countries inside and outside the euro area, the empirical analysis was conducted separately for the two groups of countries. Finally, the analysis also checked for the possible autoregressive component of the GVC participation by estimating dynamic panel data models with the Arellano-Bond GMM estimator, and

[5] In this analysis, compensation per employee was used as a measure of the wage level.

found that the autoregressive coefficient is statistically insignificant. Therefore, only the results of the pooled OLS estimation are presented in this section.

An important caveat when discussing the regression results in Table 2 is that they in general demonstrate correlations between the variables, and thus do not necessarily imply causation. Furthermore, since the results for a particular country group generally remain consistent after allowing for time fixed effects, the following discussion will for brevity focus only on results which take into account time fixed effects.

The results for the entire set of countries (i.e. combined for the EA 12 and CESEE) indicate that population and wage level are negatively correlated with GVC participation, while the global demand is positively correlated. These correlation signs are in line with expectations. First, the results confirm the presumption that bigger countries can more easily source intermediate inputs from domestic markets, and consequently integrate less intensively within backward linkages of GVCs. Since the latter are prevalent in this analysis' dataset, larger country size is negatively associated with higher GVC participation. This result is, for example, in line with the studies of Van der Marel (2015) and Kowalski et al. (2015), and ultimately also with this study's descriptive statistics, which show that the GVC participation level is higher for smaller and more open economies (Figure 11). Second, higher GVC integration is related to lower wages. This confirms the results of WTO (2019) and OECD (2017) that in the case of a relatively higher share of backward GVC participation and relatively more labour-intensive tasks, the wage increase can be associated with lower GVC integration as firms offshore to lower-cost countries in search of greater cost-effectiveness. Finally, GVC participation seems to be hindered in times of lower global demand, which is in line with developments during the global financial crisis.

When considering only CESEE countries, the results that are common for both euro and non-euro area members show that GVC participation is positively associated with FDI, global demand, and the share of manufacturing sector in GDP. These findings are in line with those drawn from the overall sample only for the global demand variable. On the other hand, a positive linkage between the share of manufacturing sector in GDP and GVC participation might be significant only within the CESEE group due to the relatively larger overall GVC participation of the manufacturing sector and due to a relatively higher share of backward participation within manufacturing in this country group. Just as important, this analysis confirms the abovementioned importance of FDI, which allow technological spillovers, for GVC participation within CESEE countries.

Furthermore, the positive linkage between GVC integration and R&D activities is the only relationship that is significant solely for the CESEE euro area group. This indicates that firms in this group have innovative capabilities and abilities to diffuse technology from parent firms. In this respect, Veugelers (2013) shows that foreign technology, labour, and capital are embodied in domestic exports through imported imports. Consequently, GVC integrated firms are more innovative in terms of introducing new process and product innovations, and invest more in R&D.

Finally, linkages within CESEE countries that are statistically significant only for the non-euro area group are the following. First, as in the case of the entire sample, GVC integration in CESEE non-euro area countries is negatively correlated with population size and wage level. Second, as the CESEE non-euro area group has the lowest GDP p.c. level among the sampled country groups, the result of the negative linkage between GDP p.c. and GVC participation could be explained by findings of the aforementioned IMF (2015) study, which finds a negative link between GVC integration and GDP p.c. for a group of countries with lower GDP p.c. levels. This may well indicate that a certain threshold of GDP p.c., i.e. a certain level of infrastructure and development of the country, is needed for the relationship between GVC integration and GDP p.c. to become positive.

Since most of the control variables maintain statistical significance and sign direction in regressions with time fixed effects included, this indicates the results are in general consistent within the three country groups. Nevertheless, due to the limited number of data observations, the interpretative power of the results in this part of the analysis is constrained by the low number of observations. The analysis will address this issue in the following subsection.

Table 2: Factors associated with countries' GVC participation, estimation period: from 2005 to 2015 (basic model)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total	Total	CESEE EA	CESEE EA	CESEE non-EA	CESEE non-EA
Population	-0.323***	-0.343***	-0.297**	-0.172	-0.953*	-0.741***
	(0.087)	(0.105)	(0.105)	(0.112)	(0.397)	(0.161)
FDI	0.000	-0.000	0.002**	0.003**	0.002*	0.003***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R&D	0.045	0.053	0.070***	0.064**	0.038	0.124
	(0.032)	(0.036)	(0.011)	(0.020)	(0.125)	(0.069)
Skill share	-0.001	-0.001	-0.005**	-0.003	0.003	0.005
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.003)
Global demand	0.428***	0.502***	0.244***	0.190***	0.387***	0.524***
	(0.089)	(0.141)	(0.044)	(0.026)	(0.032)	(0.044)
GDP p.c.	-0.015	-0.096	-0.114	-0.055	-1.554*	-1.000**
	(0.149)	(0.195)	(0.077)	(0.119)	(0.661)	(0.292)
Manufacturing	-0.079	-0.126	0.202***	0.159***	0.554	0.318*
	(0.068)	(0.074)	(0.034)	(0.033)	(0.316)	(0.132)
Wages	-0.379*	-0.338*	-0.252***	-0.157	-0.184	-0.112*
	(0.184)	(0.195)	(0.024)	(0.088)	(0.094)	(0.051)
Location	0.000	0.000	0.000	0.000	-0.001*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	4.344***	4.749***	2.962	0.527	21.358*	12.656**
	(1.175)	(1.523)	(2.083)	(2.011)	(8.538)	(4.036)
Time fixed effects	No	Yes	No	Yes	No	Yes
Observations	253	253	55	55	66	66
Number of countries	23	23	5	5	6	6
R-squared	0.718	0.754	0.953	0.971	0.905	0.976

Source: TiVA database, Eurostat, UNCTAD FDI, WB, WITS.

Notes: Cluster robust standard errors in parentheses (clustered on the country level). *** p<0.01, ** p<0.05, * p<0.1. The explanation of the variables used in the model corresponds to the model in equation (3). Empirical analysis was done for the entire set of countries, i.e. CESEE EA + CESEE non-EA + EA 12 (Total), and separately for CESEE members of the euro area (CESEE EA) and CESEE countries outside the euro area (CESEE non-EA).

4.2 Sensitivity Analysis

In order to tackle the small sample problem and increase the interpretive power of the previous section, the sensitivity analysis applies a bilateral gravity model with fixed effects. Since gravity models have proven to be quite effective in clarifying bilateral trade flows, the use of this type of model has also

emerged when studying GVCs (Anderson, 2011). In this respect, Tinta (2017) shows that two main groups of factors have a significant bearing on GVC integration. The first are non-policy or structural factors, such as market size, development level, degree of industrialisation, and trade costs, while second are policy factors, such as trade performance indicators.

The gravity model emerged in the 1960s by applying a law of physics to the international trade framework. In the model, trade flows between two countries are proportional to the economic size and distance between the two partners (Baldwin and Taglioni, 2006). In traditional gravity models that use official trade statistics, i.e. do not control for GVCs, the dependent variable of interest is usually the value of bilateral exports for each country pair (UN, 2015). The sensitivity analysis in this study takes into account two different dependent variables. First, the gravity model uses the logged value of backward integration (i.e. FVA) as a dependent variable, which measures a foreign country's value added, as embodied in the reporting country's exports. The motivation for using FVA as a dependent variable is mainly based on descriptive statistics, showing the relative importance of FVA versus IV, especially in CESEE countries. As a consequence, it was important to study the country-pair characteristics influencing FVA in further detail. As an additional sensitivity check, this analysis also uses a measure for the total GVC as a dependent variable, calculated as the logged value of the sum of backward integration (i.e. FVA) and forward integration (i.e. IV). A similar approach was, for example, also used by Ignatenko, Raei, and Mircheva (2019), Tinta (2017), and Guilhoto, Siroën, and Yücer (2015).

$$\begin{aligned} \mathrm{FVA}_{ijt}/(\mathrm{FVA}_{ijt} + \mathrm{IV}_{ijt}) &= \alpha + \beta_1 \mathrm{Population}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \mathrm{R\&D}_{it} + \beta_4 \mathrm{Global\ demand}_{it} \\ &+ \beta_5 \mathrm{GDP\ p.c.}_{it} + \beta_6 \mathrm{Manufacturing}_{it} + \beta_7 \mathrm{Wages}_{it} + \beta_8 \mathrm{Distance}_{ij} \\ &+ \beta_9 \mathrm{Colony}_{ij} + \beta_{10} \mathrm{Language}_{ij} + \beta_{11} \mathrm{Common\ country}_{ij} + \beta_{12} \mathrm{Currency}_{ij} \\ &+ v_{ijt} \end{aligned} \quad (4)$$

for years $t = 1, \dots, T$, reporting countries $i = 1, \dots, N$, and partner countries $j = 1, \dots, M$.

For brevity and in order to effectively address the small sample problem, gravity models in sensitivity analysis take into account only those control variables that were statistically significant in the estimated models in the previous subsection (i.e. population, FDI, R&D, global demand, GDP p.c., manufacturing share, and wages), and additional explanatory variables that are traditionally used in gravity models and expected to impact bilateral trade costs (Baldwin and Taglioni, 2006). The latter comprise the distance between both trading partners ($\mathrm{Distance}_{ij}$), calculated as a logarithm of the simple distance between the most populated cities, and several dummy variables, which include previous or current colonial relationship (Colony_{ij}), common official language ($\mathrm{Language}_{ij}$), being part of the same country in the past ($\mathrm{Common\ country}_{ij}$), and having a common currency ($\mathrm{Currency}_{ij}$). These additional control variables were obtained from the CEPII Database (2020), described in Head, Mayer, and Ries (2010).[6] Following Baldwin and Taglioni (2006), time fixed effects and clustered standard errors at the level of each country pair were used in order to reduce the omitted variable problem. Besides increasing the interpretive strength of the model, an important reason for implementing a gravity model was thus reducing the omitted variable problem and including additional regressors in the sensitivity analysis. In this respect, bilateral trade costs are expected to be lower in the case of common cultural, legal, and historical familiarities between trade partners, i.e. in the case of lower distance between the two trade

[6] The CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) is the leading French institute for research on the world economy.

partners, common colonial relationship, shared official language, if countries were ever part of the common country, or in the case of common currency (Martínez-Galán and Fontoura, 2019).

Table 3: Factors associated with countries' GVC participation, estimation period: from 2005 to 2015, (sensitivity analysis)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total	Total	CESEE EA	CESEE EA	CESEE non-EA	CESEE non-EA
Population	-0.574***	-0.162	0.480	0.176	-1.316**	-0.845
	(0.178)	(0.168)	(0.804)	(0.765)	(0.625)	(0.596)
FDI	0.002*	0.001	0.010**	0.005	0.006**	0.005**
	(0.001)	(0.001)	(0.004)	(0.004)	(0.003)	(0.002)
R&D	0.115	0.120*	0.251***	0.173***	0.391***	0.315***
	(0.077)	(0.072)	(0.066)	(0.057)	(0.110)	(0.105)
Global demand	1.716***	1.425***	1.633***	1.417***	2.177***	1.857***
	(0.210)	(0.198)	(0.225)	(0.178)	(0.327)	(0.309)
GDP p.c.	-0.563	-0.029	1.366	0.702	-2.198**	-1.629*
	(0.355)	(0.333)	(1.045)	(1.021)	(1.012)	(0.963)
Manufacturing	-0.056	-0.172	-0.579	-0.360	0.354	0.225
	(0.178)	(0.167)	(0.612)	(0.584)	(0.422)	(0.400)
Wages	-0.352	-0.440*	-0.352	-0.388*	0.054	-0.058
	(0.262)	(0.249)	(0.220)	(0.200)	(0.456)	(0.433)
Distance	-0.377***	-0.449***	-0.570***	-0.623***	-0.431***	-0.533***
	(0.040)	(0.037)	(0.072)	(0.073)	(0.068)	(0.064)
Colony	0.936***	0.761***	2.380***	2.076***	1.598***	1.441***
	(0.279)	(0.254)	(0.542)	(0.427)	(0.454)	(0.459)
Language	0.591***	0.610***				
	(0.224)	(0.203)				
Common country	0.170	0.217	-0.351	-0.110	-0.031	-0.039
	(0.234)	(0.214)	(0.475)	(0.438)	(0.365)	(0.341)
Currency	0.333***	0.437***	0.229	0.317		
	(0.110)	(0.101)	(0.203)	(0.196)		
Constant	7.363***	1.842	-19.883	-7.648	22.068**	16.148
	(2.663)	(2.510)	(15.794)	(15.191)	(10.890)	(10.401)
Dependent variable	FVA	FVA+IV	FVA	FVA+IV	FVA	FVA+IV
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,209	15,418	3,315	3,376	3,956	3,982
R-squared	0.504	0.553	0.451	0.440	0.394	0.429

Source: TiVA database, CEPII, Eurostat, UNCTAD FDI, WB, WITS.

Notes: Cluster robust standard errors in parentheses (clustered at each country panel). *** p<0.01, ** p<0.05, * p<0.1. The explanation of the variables used in the model corresponds to the model in equation (4). Empirical analysis was done for the entire set of countries, i.e. CESEE EA + CESEE non-EA + EA 12 (Total), and separately for CESEE members of the euro area (CESEE EA) and CESEE countries outside the euro area (CESEE non-EA).

In general, the results of the gravity model are consistent with both the findings of the basic model and conclusions of previous studies. An important caveat when comparing the results of the basic model and sensitivity analysis is that certain discrepancies between the two are expected due to a different model specifications and a different set of variables. Nevertheless, the signs and statistical significance of the variables that are common between the two models are predominantly consistent. The biggest discrepancy is in the regressor the share of manufacturing sector in GDP, which was significantly positive in the basic model for CESEE countries but became insignificant in the sensitivity analysis. Furthermore, with respect to regressors that account for bilateral trade costs, the most significant for GVC participation appear to be lower distance and common colonial relationship between the two trade partners, which are significant for all three groups of countries. In addition, while having been part of the same country is not significant for any of the three country groups, having a common official language and currency is only positively significant for the entire set of countries. Last but not least, it is important to emphasize that variation within an individual variable is likely to have a significant impact on the statistical significance of these results, as it was lower within the last three variables (i.e. Language_{ij}, $\text{Common country}_{ij}$, and Currency_{ij}).

To sum up, the empirical analysis in this section provides some interesting conclusions. First, the basic model shows that, when considering the entire sample, GVC participation is positively associated with changes in global demand, and negatively with country size and wage level. Furthermore, when considering only CESEE countries, GVC participation is positively associated with FDI, which could be a result of technological spillovers through FDI. When comparing the results between the three country groups, they suggest that linkages between GVC participation and country size are relatively more important for larger countries, while FDI, which could indicate technology and knowledge transfers within GVCs, are relatively more important for countries within the convergence process. In addition, these findings are largely confirmed in the sensitivity analysis, which also reveals significant linkages of bilateral distance and common colonial relationship between two partner countries and GVC participation. Nevertheless, further analysis would be needed in order to make these conclusions generalizable for other countries. These findings will be discussed in further detail in the following section.

5 Conclusions and Policy Implications

International integration and participation in global value chains (GVCs) has become very important in recent decades, and enabled firms to reduce their operating costs by offshoring and outsourcing. The main drivers for increasing GVC participation have been the opening of emerging economies, reduction of trade barriers, and technological progress, which decreased transportation, communication, and transaction costs. Production processes have thus become more fragmented and broken down across multiple countries. In addition, participation in GVCs is particularly important for small and open economies, which are unable to exploit economies of scale in their own markets.

This study analyses the GVC engagement of Central, Eastern, and South-Eastern European countries (CESEE) and the first twelve euro area member states (EA 12). The main purpose of the study was (i) to analyse the international engagement, competitive stance, and GVC integration of CESEE and EA 12 countries, (ii) to empirically analyse correlations between various institutional factors and the GVC involvement, as well as (iii) to empirically analyse whether there are any significant differences in these correlations between CESEE euro area and CESEE non-euro area members.

Descriptive statistics show that trade openness and integration within GVCs was the highest among CESEE countries. Since the productivity growth of the CESEE countries that are part of the euro area lagged behind their wage growth, these countries have deteriorated their competitive position towards the rest of CESEE and EA 12 in the recent period. Nevertheless, the CESEE EA countries on average experienced the highest growth in trade openness and were the most integrated in GVCs. On the other hand, GVC participation measures in EA 12 were higher in more technologically advanced sectors than within the CESEE group, which suggests that the latter group participated in more supportive and labour-intensive production processes, while higher value-added activities were still carried out in relatively more developed EA 12 countries.

The empirical analysis was done for the period between 2005 and 2015, using the pooled OLS model, where the results suggest that, within the entire dataset, the GVC participation is positively correlated with global demand, and negatively with country size and wage level. When differentiating between CESEE EA and non-EA countries, the correlation of global demand with GVC participation retains its sign and statistical significance, while correlations between country size and wages with GVC participation remain significantly negative only in the case of CESEE non-EA group. As CESEE non-EA countries are on average almost six-times bigger than CESEE euro area members, this finding could indicate that the negative correlation between country size and GVC participation is more relevant for bigger countries. In contrast, the measure of technological spillovers, i.e. FDI, becomes significant and positive within the CESEE EA and CESEE non-EA group. The positive correlation between GVC participation and the FDI indicates the importance of technological diffusion for GVC integration within CESEE countries, which are still undergoing the convergence process. An especially interesting result in this respect is that FDI and GVC participation were positively correlated only within the CESEE countries. In addition, differences with regard to members inside and outside the euro area within the CESEE group also reveals some variations in correlations between the two country groups, which could be due to their different size and level of economic development.

With the aim of tackling the small number of observations and gaining additional interpretive power, an empirical estimation of the gravity-type regression models was included in the sensitivity analysis. The results of the basic and sensitivity analyses are in general consistent, where the gravity model also allows for evaluating partner-specific factors, which account for bilateral trade costs. In this respect, bilateral distance and common colonial relationship between trading partners appear to have the most significant linkages with GVC participation.

Countries' integration within GVCs is also important to study in view of policy implications. Based on the descriptive statistics and regression results, GVC participation is especially important for small and open economies as it facilitates the transfer of knowledge and technology through imported inputs, which is even more pronounced and elevated within the EU Single Market. By studying the types and origins of imported inputs, and their participation and position within GVCs, policy-makers can assess which skills and occupations are most sought after by firms and can consequently adjust their country's active labour market policies. For example, if the GVC participation is concentrated mostly in less technologically advanced sectors, policy-makers can adjust their policies accordingly in order to promote activities in sectors with higher value added. Finally, this study's findings are also important for future policy implications, especially in terms of CESEE convergence towards EA 12. Although descriptive statistics in this analysis point to the ongoing convergence process within CESEE countries, their GVC participation still consists of less technologically advanced sectors compared to the EA 12. Therefore, in order to continue with the convergence process, further structural changes will be needed

in these countries with the aim of transitioning to even more technology- and knowledge-based economies.

Going forward, the available data does not yet enable analysing the ongoing changes in international trade patterns due to the USA-China trade disputes and the coronavirus outbreak. Nevertheless, taking into account this study's conclusions on the importance of FDI flows between CESEE countries and EA 12, and the fact that these flows might be heavily obstructed by the pandemic, CESEE countries' convergence towards more developed EA member states might also be hindered. At the same time, the current unfortunate circumstances could also present a stimulus for CESEE countries to increase their own technological capacity and R&D.

The main contributions of this study are the inclusion of various institutional factors in the analysis, and differentiation between CESEE EA and CESEE non-EA country groups. In this respect, as in Taglioni and Winkler (2016), the empirical analysis controls for several economic and social drivers, with the latter, for example, being the skill share and wages, and the former GDP p.c., global demand conditions, FDI, and R&D. On the other hand, the main limitation of the current analysis is the relatively short observation period, resulting in a small number of observations, especially when splitting the sample into CESEE EA and CESEE non-EA countries. Consequently, the model does not enable the inclusion of numerous control variables without losing significant degrees of freedom. Although this drawback was somewhat mitigated in the sensitivity analysis, future analyses could address this issue in more detail. Another drawback is data availability, which is on average not accessible on a sectoral level. Using firm- or sector-level data would enable estimating causalities at the micro level and considering firm and sectoral variation (Taglioni and Winkler, 2016). This drawback could be overcome in the future when additional data is available. Moreover, future analysis could also disentangle GVC participation into forward and backward linkages, empirically analyse correlations between various institutional factors and the GVC position, and exploit additional bilateral time-varying regressors in the gravity specification. Finally, although the analysis already tested for any potential endogeneity problem by estimating the dynamic panel data models with the GMM estimator and found a statistically insignificant autoregressive coefficient, additional sensitivity analysis could address this matter further, and also include additional models, such as fractional response models, in order to enhance the sensitivity of the results.

6 Literature

1. Adarov, A. and Stehrer, R. (2019). Implications of Foreign Direct Investment, Capital Formation and its Structure for Global Value Chains. *The Vienna Institute for International Economic Studies working papers*, Paper No. 170. Available at: https://wiiw.ac.at/implications-of-foreign-direct-investment-capital-formation-and-its-structure-for-global-value-chains-dlp-5103.pdf
2. Amador, J., Cappariello, R. and Stehrer. R. (2014). Global Value Chains: a view from the Euro Area. *Bank of Portugal Working Papers*. Paper No. 12. Available at: https://www.bportugal.pt/sites/default/files/anexos/papers/wp201412.pdf
3. Anderson, J. E. (2011). The Gravity Model. *Annual Review of Economics*, 3, 133–160.
4. Antràs, P. and Chor, D. (2018). On the Measurement of Upstreamness and Downstreamness in Global Value Chains. *World Trade Evolution: Growth, Productivity and Employment*. Taylor & Francis Group, 126–194.
5. Aslam, A., Novta, N., and Rodrigues-Bastos, F. (2017). Calculating trade in value added. *IMF working paper*, Paper No. WP/17/178. Available at: https://www.imf.org/en/Publications/WP/Issues/2017/07/31/Calculating-Trade-in-Value-Added-45114
6. Baldwin, R. and Taglioni, D. (2006). Gravity for Dummies and Dummies for Gravity Equations. *NBER Working Paper Series*, Paper No. 12516. Available at: https://www.nber.org/papers/w12516
7. Bas, M. and Strauss-Kahn, V. (2014). Does importing more inputs raise exports? Firm-level evidence from France. *Review of World Economics*, 150 (2), 241–275.
8. Belka, M., Nowotny, E., Samecki, P, and Ritzberger-Grünwald, D. (2016). *Boosting European Competitiveness: The Role of CESEE Countries*. Edward Elgar Publishing, published in association with Oesterreichische Nationalbank, 1–213.
9. Blind, K., Mangelsdorf, A., Niebel, C., and Ramel, F. (2018). Standards in the global value chains of the European Single Market. *Review of International Political Economy*, 25 (1), 28–48.
10. Cappariello, R., Gunnella, V., Franco-Bedoya, S., and Ottaviano G. (2020). Rising protectionism and global value chains: quantifying the general equilibrium effects. *ECB Working Paper Series*, Paper No. 2360.
11. CEPII Database (2020). Available at: http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=8
12. Chiacchio, F., Gradeva, K., and Lopez-Garcia, P. (2018). The post-crisis TFP growth slowdown in CEE countries: exploring the role of Global Value Chains. *ECB Working Paper Series*, Paper No. 2143.
13. Cigna, S., Gunnella, V., and Quaglietti, L. (2022). Global value chains: measurement, trends and drivers. *ECB Occasional Paper Series*, Paper No. 289.
14. Damjanović, M. and Banerjee, B. (2018). Structure and Competitiveness of the Slovenian Economy in the World of Increasing Production Fragmentation. *The Bank of Slovenia Working Paper*, Paper No. 2/2018. Available at: https://bankaslovenije.blob.core.windows.net/publication-files/gdggAhfihwjiidh_wp_2_2018.pdf
15. De Backer, K. and Miroudot, S. (2013). Mapping Global Value Chains. *OECD Trade Policy Papers*, Paper No. 159.

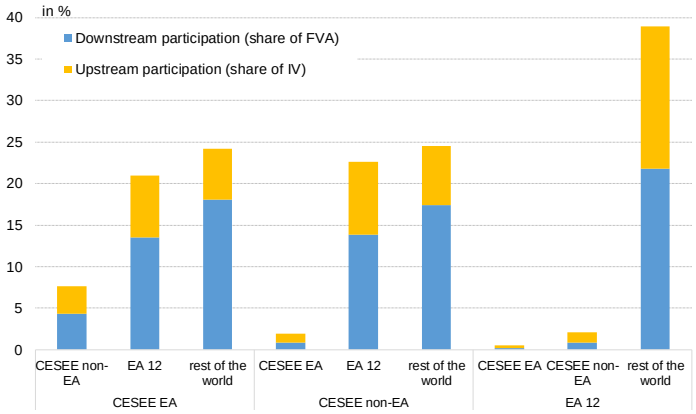
16. ECB (2019). The impact of global value chains on the euro area economy. *ECB Working Group on Global Value Chains, Occasional Paper Series*, Paper No 221. Available at: https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op221~38185e6936.en.pdf
17. ESPON (2018). The World in Europe, global FDI flows towards Europe, Intra-European FDI. Available at: https://www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/0/440/1525770844/espon-fdi-08-main-report-intra-european-fdi.pdf
18. Eurostat (2019). Glossary: High-tech classification of manufacturing industries. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries
19. Eurostat (2020). Database. Available at: https://ec.europa.eu/eurostat/data/database
20. Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, 98 (5), 1978–1997.
21. Guilhoto, J., Siroën, J.-M., and Yücer, A. (2015). The Gravity Model, Global Value Chain and the Brazilian States. *Dial Research Papers*, Paper No. DT/2015-02.
22. Gunnella, V., Fidora, M., and Schmitz, M. (2017). The impact of global value chains on the macroeconomic analysis of the euro area. *Economic Bulletin*, Issue 8. Available at: https://www.ecb.europa.eu/pub/pdf/ecbu/eb201708.en.pdf?098fecf8c32c2fc25cc6c334adde0f91
23. Head, K., Mayer, T., and Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of International Economics*, 81 (1), 1–14.
24. Huidrom, R., Jovanovic, N., Mulas-Granados, C., Papi, L., Raei, F., Stavrev, E., Wingender, P. (2019). Trade Tensions, Global Value Chains, and Spillovers: Insights for Europe. *International Monetary Fund, European Department Paper Series*, Paper No. 19/10.
25. Hummels, D., Ishii, J., and Yi, K.-M. (2001). The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics*, 54 (91), 75–96.
26. Ignatenko, A., Raei, F., and Mircheva, B. (2019). Global Value Chains: What are the Benefits and Why Do Countries Participate? *IMF working paper*, Paper No. WP/19/18.
27. IMF (2015). Sub-Saharan Africa: Navigating Headwinds. Regional Economic Outlook. Available at: https://www.imf.org/~/media/Websites/IMF/imported-flagship-issues/external/pubs/ft/reo/2015/afr/eng/pdf/_sreo0415pdf.ashx
28. Johnson, R. C. (2017). Measuring Global Value Chains, *NBER working paper series*, Paper No. 24027.
29. Kersan-Škabić, I. (2019). The drivers of global value chain (GVC) participation in EU member states. *Economic Research-Ekonomska Istraživanja*, 32 (1), 1204–1218.
30. Koopman, R., Wang, Z., and Wei, S.-J. (2014). Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review*, 104 (2), 459–494.
31. Kowalski, P., Lopez Gonzalez, J., Ragoussis, A., and Ugarte, C. (2015). Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-Related Policies. *OECD Trade Policy Papers*. Paper No. 179. Available at: https://www.die-gdi.de/uploads/media/OECD_Trade_Policy_Papers_179.pdf
32. Martínez-Galán, E. and Fontoura, M. P. (2019). Global value chains and inward foreign direct investment in the 2000s. *The World Economy*, 42, 175–196.
33. OECD (2019). Guide to OECD's Trade in Value Added (TiVA) Indicators, 2018 Edition. Available at: http://www.oecd.org/sti/ind/tiva/TiVA2018_Indicators_Guide.pdf
34. OECD (2017). Skills Outlook 2017: Skills and Global Value Chains. *OECD Publishing, Paris*. Available at: http://www.oecd.org/education/oecd-skills-outlook-2017-9789264273351-en.htm

35. Rausch, T. (2020). The Coronavirus challenges global value chains. Available at: https://ged-project.de/globalization/coronavirus-economic-impact/
36. Taglioni, D., and Winkler, D. (2016). Use of GVC Measures to Assess the Drivers and Impacts of GVC Participation. In book: *Making Global Value Chains Work for Development*, 117–143.
37. Tinta, A. A. (2017). The determinants of participation in global value chains: The case of ECOWAS. *Cogent Economics & Finance*, 5, 1–14.
38. TiVA Database (2019). Available at: https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm
39. UN (2015). Asia-Pacific Trade and Investment Report – Supporting Participation in Value Chains. Available at: https://www.unescap.org/sites/default/files/Full%20Report%20-%20APTIR%202015.pdf
40. UNCTAD (2020). Coronavirus outbreak has cost global value chains $50 billion in exports. Available at: https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2297
41. UNCTAD FDI (2020). Database on Foreign direct investment. Available at: https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96740
42. UNCTAD Bilateral FDI Statistics (2019). Available at: https://unctad.org/en/Pages/DIAE/FDI%20Statistics/FDI-Statistics-Bilateral.aspx
43. UNIDO (2020). Coronavirus: the economic impact. Available at: https://www.unido.org/stories/coronavirus-economic-impact
44. Van der Marel, E. (2015). Positioning on the Global Value Chain Map: Where do You Want to Be? *ECIPE Occasional Paper*, Paper No. 1.
45. Veld, J. in 't (2019). Quantifying the Economic Effects of the Single Market in a Structural Macromodel. European Commission, Directorate-General for Economic and Financial Affairs, *European Economy Discussion Papers*, Paper No. 094.
46. Veugelers, R. (2013). Innovative firms in Global Value Chains'. European Commission, Policy Brief No. 21. Available at: https://ec.europa.eu/research/innovation-union/pdf/expert-groups/i4g-reports/i4g_policy_brief__21_-_innovative_firms_global_value_chains.pdf
47. WIOD (2020). World Input-Output Database. Available at: http://www.wiod.org/home
48. WITS (2020). World Integrated Trade Solution database. Available at: https://wits.worldbank.org/CountryProfile/en/Country/WLD/Year/2018/TradeFlow/Export/Partner/by-country
49. WTO (2017). Measuring and Analyzing the Impact of GVCs on Economic Development. Global Value Chain Development Report. Available at: https://www.wto.org/english/res_e/publications_e/gvcd_report_17_e.htm
50. WTO (2019). Technological innovation, supply chain trade, and workers in a globalized world. Global Value Chain Development Report. Available at: https://www.wto.org/english/news_e/news19_e/publ_15apr19_e.htm
51. Žuk, P., Polgar, E. K., Savelin, L., del Hoyo, J. L. D., and König, P. (2018). Real convergence in central, eastern and south-eastern Europe. *Economic Bulletin*, Issue 3. Available at: https://www.ecb.europa.eu/pub/pdf/ecbu/eb201803.en.pdf

7 Appendices

7.1 Appendix A: Supplementary Figures

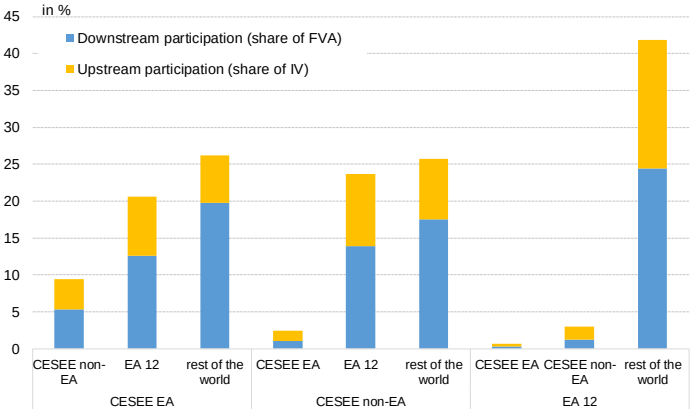
Figure A1: GVC participation breakdown by partner countries, for the year 2005



Source: TiVA, author's calculations.

Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

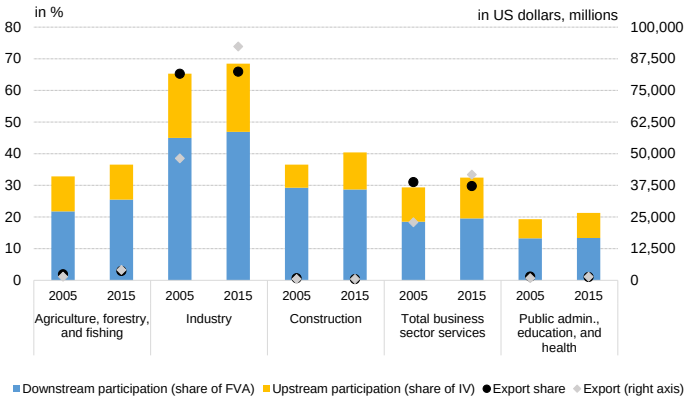
Figure A2: GVC participation breakdown by partner countries, for the year 2015



Source: TiVA, author's calculations.

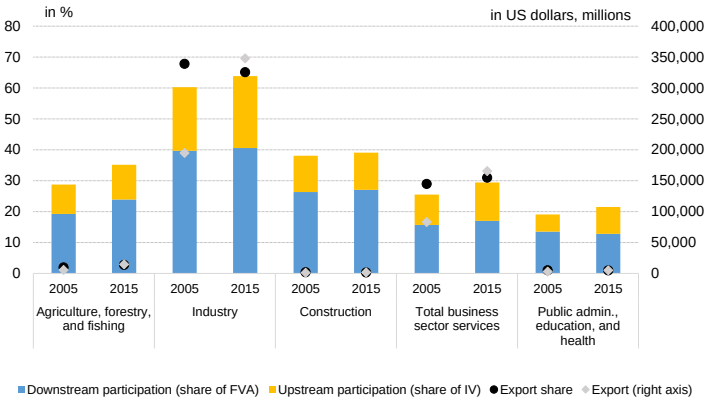
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia; CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania; EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Figure A3: GVC participation breakdown by sectors for the CESEE EA country group



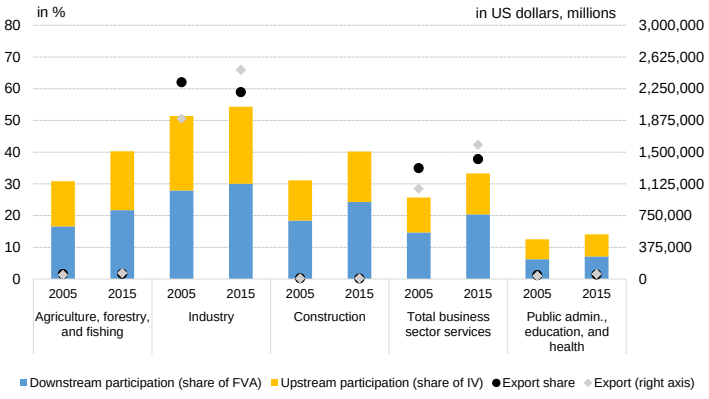
Source: TiVA, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia.

Figure A4: GVC participation breakdown by sectors for the CESEE non-EA country group



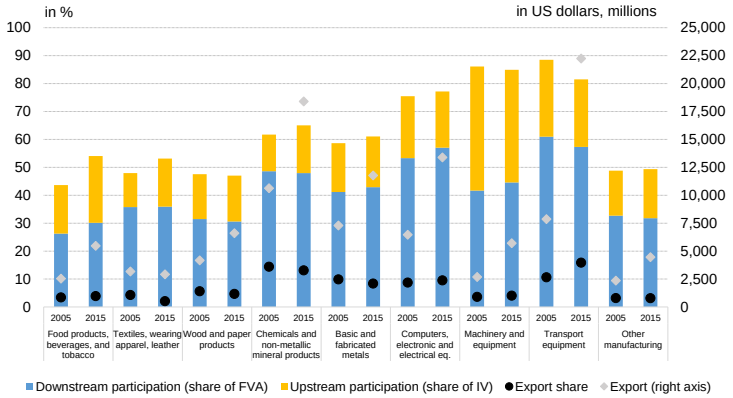
Source: TiVA, author's calculations.
Notes: CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania.

Figure A5: GVC participation breakdown by sectors for the EA 12 country group



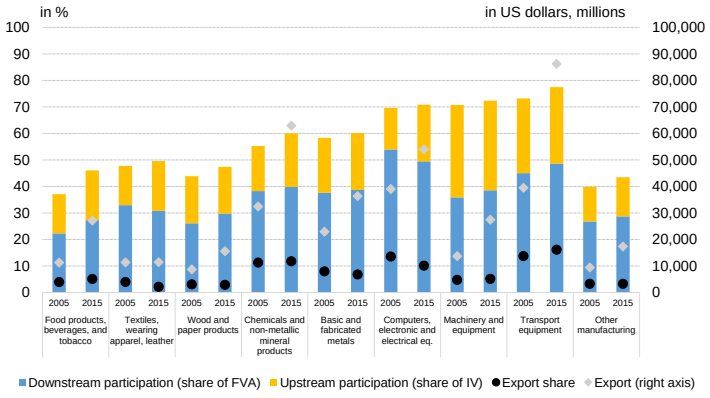
Source: TiVA, author's calculations.
Notes: EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Figure A6: GVC participation breakdown within manufacturing for the CESEE-EA country group



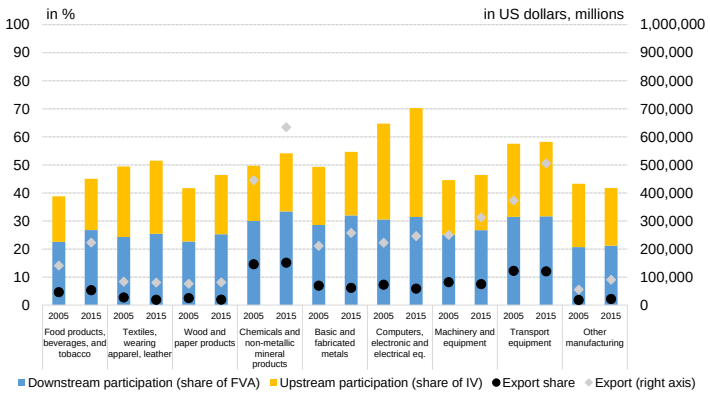
Source: TiVA, author's calculations.
Notes: CESEE EA: Estonia, Latvia, Lithuania, Slovakia, and Slovenia.

Figure A7: GVC participation breakdown within manufacturing for the CESEE non-EA country group



Source: TiVA, author's calculations.
Notes: CESEE non-EA: Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania.

Figure A8: GVC participation breakdown within manufacturing for the EA 12 country group



Source: TiVA, author's calculations.
Notes: EA 12: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.