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Linkages between services and manufacturing as a new channel for GVC development: evidence from CEE countries

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Abstract

The goal of the paper is to verify a causal relationship between forward linkages from domestic services to manufacturing and the participation/position of a country in global value chains (GVCs) in selected Central and Eastern European economies. We observed a strong polarisation pattern: the Baltic countries along with the Czech Republic strengthen their positions and participation in GVCs by having a strong relationship between the financial sector and manufacturing, while Poland, Hungary, and Slovakia have solid linkages between transportation services and manufacturing. We also discover that the reverse relationship is significant.

Keywords: CEE countries, forward linkages, GVCs, Granger causality, services

JEL classification: C22, C23, F14, L80

1. Introduction

Services play a special role in an economy, representing almost 70% of global GDP and more than 55% of global employment in advanced countries (World Bank 2016). The growing role of services is also observed in international trade because of their tradability and for two main reasons. The first is the so-called 'servicification' of manufacturing, which is the idea that value added by the service sector is becoming more important in manufacturing (Baldwin et al. 2015). The other is the rapid development of global value chains (GVCs), in which services provide the 'link' or the 'glue' at each point in the chain. UNCTAD (2013) finds evidence that the quality and cost of services determine the participation of a country in GVCs. At a macro scale, services are growing more than 60 percent faster than trade in goods, with almost 70 percent of world service imports today being intermediate services used in production organised in GVCs (McKinsley 2019).

So far, empirical studies have paid little attention to the increasing importance of services in GVC participation. Scholars interested in trade and GVCs focus on the determinants of participation in GVCs (Mehta 2018), the effects of GVCs on labour markets and wages in participating countries (Parteka and Wolszczak-Derlacz 2017), and the importance of establishing GVCs through the liberalisation of trade in services (Ishido 2017). Few researchers have considered participation in GVCs by offering services as a new opportunity for many countries to catch up with more developed ones (Hernández et al. 2014). They have focused on the role of services in GVCs and indicate skills and relative wages in service sectors as determinants of the participation of a country in GVCs (Sáez et al. 2014).

This paper aims to add something new to this debate. Our hypothesis is that the drivers of a country's participation in GVCs are not only factor endowments or costs in service sectors but also a specific domestic structure, i.e. strong linkages between service sectors and others (especially manufacturing). The objective of the paper is, therefore, to apply a panel Granger

causality test to verify our hypothesis about the existence of a causal relationship between forward linkages from domestic services to manufacturing and the participation and position of a country in GVCs in selected Central and Eastern European (CEE) economies — the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, and Slovakia — for the period 2000–2014. When considering forward linkages from services to manufacturing, domestic service sectors are regarded as suppliers of services that are subsequently used by domestic manufacturing sectors in their production processes. In forward linkages, relationships between sectors are analysed from the perspective of sellers[1]. In the CEE region, exporters are generally located further downstream than their euro-area partners (Iossifov 2014) but strengthening domestic service linkages with manufacturing can be an effective component of a comprehensive development strategy to achieve a more upstream position in GVCs.

Our study focuses on selected CEE countries, i.e. on seven first-wave accession countries that joined the EU on 1 May 2004. It is a specific group of countries, which should be separated from other countries, e.g. from the Eurozone, in economic analyses due to their own growth path during the transition period (large openness and massive FDI investments), changing nature of domestic economies of CEE countries in recent years (e.g. drivers of growth), and changing international trade dependencies (e.g. main trade partners) (ING 2019). In general, CEE economies are currently more domestic demand-driven than they were between 2008 and 2016 and they have a new, more diversified structure of global value chains (countries producing unique intermediate goods and consumer goods). CEE countries are no longer just a cog in the German manufacturing wheel as they have diversified away from the

[1] Even though backward linkages are not the topic of this paper, together with forward linkages they establish the full picture of intersectoral linkages in economies. Taking into account the relation between services and manufacturing, backward linkages are understood as manufacturing industries' activity in buying services that are needed for their production processes. In backward linkages, we analyse relationships between industries from the perspective of buyers.

industry towards services and, finally, are more shock resistant as compared to Western European countries (European Parliament 2020).

The paper is organised as follows. The next section outlines theoretical considerations on linkages between services and manufacturing in the literature on economics. Section 2 begins the empirical part of the paper by introducing the methodology used to measure a country's participation in GVCs and forward linkages as well as the panel Granger causality test. Section 3 describes the data used for the main analysis, section 4 presents the results, and the last section includes our conclusions.

2. Literature Review on Linkages between Services and Manufacturing

Many studies have been conducted to analyse sectoral linkages in the context of a national economy. The pioneering theoretical literature is mainly related to the Lewis dual economy model (1954) and Hirschman's theory of 'unbalanced growth' (1958), which are then developed by Leontief (1970), Stone (1973), Hewings (1982), and Defourny and Thorbecke (1984).

The relevance of intersectoral connectedness is shown in many empirical studies, and the empirical literature tends to stress links between agriculture and industry. Less attention is paid to models of the behaviour of services in this process, but certain alternative models now exist (see Gemmell, 1982; Bhagwati, 1984; Dowrick, 1991). There are several empirical analyses on links between services and other industries. In the European Union, Rueda-Cantuche et al. (2012) find that the financial sector has significant forward linkages to the other sectors of the economy. In the Baltic countries, Šidlauskaitė and Miškinis (2013) observe strong forward linkages between manufacturing and the service sector. In Nigeria and Kenya, Freytag and Fricke (2017) identify both forward and backward linkages but only with financial services.

However, the literature has a significant gap because these studies on intersectoral linkages focus mainly on national economies. Because of the emergence of international input-output datasets (e.g. the WIOD IO tables), studies at a regional or multiregional level have received comparable attention. In general, previous empirical studies on regional/multiregional linkages can be divided into two main categories: interregional studies focused on single countries and studies based on the application of multinational IO databases (Gurgul & Lach 2018). In the first category, regional spatial linkages are applied to explore the way in which regions in a particular multi-region/nation system are connected (Okamoto 2005). The second category, which is more relevant to this paper, includes works by Dietzenbacher and van der Linden (1997) on the European Community and Wu and Chen (2006) on Asian economies, in which multinational interdependencies were measured in terms of forward and backward linkages. In the face of the emergence of GVC analysis (Koopman et al. 2008; Johnson and Noguera, 2012; Johnson, 2014), forward and backward linkages seem to be the most popular tool for determining the average distance between the input industry and final demand (Antràs et al. 2012; Antràs and Chor 2018), the distribution of gains between countries in GVCs (Banga 2013), and the role of the economy in global production structures (United Nations, 2018).

We combine traditional intersectoral linkages (the home market effect) with the role of the economy in GVCs (the global/interregional market effect), measured by the participation and position in GVC indexes. To the best of our knowledge, this type of analysis has never been conducted on the CEE region in the global framework until now. The central question is how linkages between domestic services and manufacturing are connected with the participation and position in GVCs. This potential relationship is associated with three economic concepts: GVC integration, impact of GVCs on economic transformation, and shock transmission in GVCs.

First, Kowalski et al. (2015) and Beverelli et al. (2016) argue that strong domestic linkages among firms reduce fragmentation costs associated with slicing up production and the cost of switching suppliers, i.e. higher domestic fragmentation reduces barriers to GVC integration due to one-time fixed fragmentation costs. Therefore, solid linkages between domestic services and manufacturing may result in a higher level of GVC integration, which could be due to higher labour productivity and higher value effects in countries' greater participation in GVCs.

Second, Jouanjean et al. (2017) explore some relationships between GVC participation and sectoral linkages in the economic transformation process. They confirm that GVC participation supports economic transformation in heterogeneous ways, based on the international and domestic structure of sectoral GVC linkages. Additionally, in a study on structural transformations in Nigeria though GVC development, Ogunleye (2014) underlines the particular role of service sector linkage swith other sectors in this economic transformation occurring in developing economies.

Third, participation in GVCs is closely related to intersectoral linkages in the shock transmission process. Hallegatte (2014) shows that the impact of shocks on GVCs are bidirectional, affecting both backward and forward linkages and resulting in a contagion effect along the chain. On the forward side, suppliers affected by a shock can no longer supply goods to their buyers, blocking production processes further down the chain. Backward linkages arise when a buyer reduces or completely disrupts purchases of intermediate goods following a shock such as a disaster, a trade finance loss, or a change in final demand resulting, for example, from a sudden and significant reduction in purchasing power. Value chains are also known for 'bullwhip' effects, in which even small changes in final demand trigger large changes in demand upstream the value chain because of the amplifying effect of coordination failure (Carvalho 2014).

In sum, linkages created by the service sector with manufacturing have a widespread impact on the rest of the economy. Our objective is to confirm whether these linkages account for the development of GVCs. We define 'GVC development' as a growing participation or strengthening position of a country in GVCs.

3. Research Methodology

As mentioned in the introduction section, we take intersectoral linkages into consideration in order to connect domestic service sectors as suppliers and domestic manufacturing as buyers, shaping a new structure in the domestic economy.

As a starting point for our investigation, we consider a Ghosh inverse matrix built on the basis of input-output tables:[2]

$$G = (I - B)^{-1}, \tag{1}$$

where B is a matrix of b_{ij} output coefficients, which describe the delivery from service sector i to manufacturing sector j per unit of seller's output. The elements in matrix G – g_{ij} reflect the direct and indirect value increase in output in sector j due to a unit increase in the primary inputs in sector i.

Using equation (1), we propose the first measure of intersectoral forward linkages: a normalised total forward linkage measure (NTFL)[3], which takes the following form:

$$NTFL_i = \frac{(1/n)\sum_{j=1}^{n} g_{ij}}{(1/n^2)\sum_{j=1}^{n}\sum_{i=1}^{n} g_{ij}}. \tag{2}$$

The NTFL illustrates the dependence of the total output of all manufacturing sectors linked to the growth of primary inputs for service sector i. If $NTFL_i$ is greater than one it indicates that a unit change in the primary input of service sector i creates an above-average production change

[2] Considering the supply side of linkages, the Ghosh supply-driven model is more appropriate than the Leontief approach (Temurshoev and Oosterhaven 2014). By applying the input-output tables, we ignore the impact of CO2 emissions on the production and the export, which is very important in many economies (Khan, Hou 2021; Khan et al. 2021).

[3] We normalise total forward linkages to obtain dimensionless and comparable measures. Our normalisation method is in line with the one presented by Rasmussen (1956); however, we employ the Ghosh matrix.

in manufacturing sectors using the outputs of sector *i* as intermediate inputs (Temurshoev and Oosterhaven 2014).[4]

The second way of measuring forward linkages is a non-complete hypothetical extraction method (Dietzenbacher and van der Linden 1997). The non-complete hypothetical extraction method (*NHEM*) considers a theoretical situation in which one of the sectors supplying services stops delivering intermediates. In this case, we hypothetically eliminate particular service sector to evaluate its importance in the economy and construct a measure of intersectoral linkages as follows (Temurshoev and Oosterhaven 2014):

$$NHEM_i = (f_i - 1)/g_{ii}, \tag{3}$$

where $f_i = \sum_{j=1}^{n} g_{ij}$, and g_{ii} refer to total self-dependence on outputs. The *NHEM* reflects the seller's dependence on buying sector as a share of seller's output.

The measures presented above describe forward linkages between services and manufacturing. The following part focuses on how to measure participation and position in GVCs.

GVC participation reflects the engagement of countries and industries in the international fragmentation of production. To measure it, we use the formula proposed by Koopman et al. (2010):

$$GVC_{participation} = VS1_{ij}/E_{ij} + VS_{ij}/E_{ij}. \tag{4}$$

Both VS_{ij} and $VS1_{ij}$ are derived from the decomposition of gross exports (E_{ij}). VS_{ij} reflects the value added that is imported from abroad (foreign value added) and that is subsequently embodied in sector *i* and country *j*'s exports. $VS1_{ij}$ is defined as indirect domestic value added that is embodied in sector *i* and country *j*'s exports (Hummels et al. 2011). The term 'indirect'

[4] Even though this assumption appears to be very strong, the analogous definition is widely employed, that is by Temurshoev (2016), who evaluates the importance of services from the perspective of interindustry linkages, or by the European Commission (2007) on sectoral monitoring and the evaluation of key sectors.

determines the domestic value added that is exported indirectly to third countries as well as the domestic value added that is exported but returns home[5].

When using formula (4), two sectors/countries can participate in GVCs to a similar extent, but their position along GVCs may differ. As a complement to equation (4), we employ a measure suggested by Koopman et al. (2010), which takes the following form:

$$GVC_{position} = \ln(1 + VS1_{ij}/E_{ij}) - \ln(1 + VS_{ij}/E_{ij}). \quad (5)$$

This formula takes a negative or positive value depending on the relation between foreign value added embodied in exports and exported domestic value added. Positive values of formula (5) indicate that $VS1_{ij}$ exceeds VS_{ij} and that sector/country is more upstream, i.e. it is rather at the beginning of the production process and provides raw materials or intermediates for further production On the other hand, negative values mean that a particular sector/country is more downstream, i.e. it is closer to final demand.

To calculate formulas (4) and (5), we need decomposed data for gross export flows. The decomposition process uses a methodology proposed by Wang, Wei, and Zhu (2013).[6]

We focus on potential bidirectional causal relationships between forward linkages, measured with the NTFL and NHEM, and measures of participation and position in GVCs. To do so, we employ a panel Granger causality test.

In the panel data context, the econometric literature only provides several ways to evaluate Granger causality, which can be grouped into two categories depending on the assumptions about the parameters in the vector autoregressive model (VAR).[7] When using

[5] For such defined measures, it can be observed that (domestic or foreign) value added crosses the borders of countries more than once, which is the essence of GVC trade flows.

[6] To decompose gross export flows, we use the decompr R package provided by Quast and Kummritz (2015); all calculations are available on request.

[7] The first methods date back to the mid-1980s and are linked to research by Holtz-Eakin, Newey, and Rosen (1985), allowing both autoregressive (γ^k) and slope (β_i^k) parameters and the individual effect (α_i) in equation (6) to vary over time. The second group of methods is based on the assumption of constancy in both autoregressive parameters and regression parameters over time and variability in the regression parameters across individuals. This approach is employed by e.g. Hurlin and Venet (2001). Similar results in terms of heterogeneity can be obtained with the help of a bootstrap panel Granger causality approach proposed by Kónya

panel data, there are two reasons for heterogeneity between individuals. The first reason is a natural cross-sectional difference between panel members. The other reason stems from the presence of two subgroups: the first, in which causality is observed, and the second, in which causality is absent. As long as the first type of heterogeneity is recognised using both methods, the second type of heterogeneity can be identified by the methods linked to Hurlin and Venet (2001). Because of the advantages of this approach in terms of our investigation, we rely on the methodology proposed by Hurlin and Venet (2001) to explain causal relationships.

The Granger procedure for testing causality requires data to be stationary. Taking our sample size into consideration, we employ two unit-root tests: the Harris-Tzavalis (1999) test and the Im-Pesaran-Shin (2003) test.

In a three-step Hurlin and Venet (2001) panel causality test, for *T* periods and *N* individuals, we consider the following model:

$$y_{i,t} = \sum_{k=1}^{p} \gamma^k y_{i,t-k} + \sum_{k=0}^{p} \beta_i^k x_{i,t-k} + v_{i,t} \quad (6)$$

in which error term $v_{it} = \alpha_i + \varepsilon_{it}$ and α_i are assumed to be fixed. In this case $\alpha_i \sim IID(0, \sigma_\alpha^2)$, $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$, and both error terms are mutually independent. We also impose strict exogeneity on variable x_{it}. We additionally assume that autoregressive coefficients γ^k and coefficients β_i^k are constant for all lags, and autoregressive coefficients γ^k are identical for all individuals, but regression coefficient slopes β_i^k may have individual dimensions. The details of the procedure are presented in Table 1.

Step 1 tests the absence of a causal relationship for all individuals. Using the unrestricted and restricted residual sums of squares of regression (6), we test whether coefficients β_i^k for all panel groups *i* and all lags *k* are statistically significant. If we reject the hypothesis, we can proceed to the next step. Step 2 tests whether coefficients β_i^k for all

(2006); however, the application of the method is limited by the sample size. In spite of the merits of this approach, our sample size (N ≫T) forces us to reject the Kónya's methodology.

individuals are identical. The rejection of the HC hypothesis implies differences among β_i^k and allows us to consider the panel heterogeneous in terms of causality. In the third step, the test is conducted for each panel member separately. The decision about rejecting the HENC hypothesis results in the identification of a subgroup of individuals that demonstrate a causal relationship and a subgroup that does not.

Table 1. Hypotheses and test statistics in Granger causality tests for panel data models

Hypotheses	Test statistics
Step 1 – homogeneous non-causality hypothesis (HNC)	
$H_0: \beta_i^k = 0 \ \forall i = 1,\dots,N \ \forall k = 1,\dots,p$ $H_1: \exists (i,k)\ \beta_i^k \neq 0$	$F_{HNC} = \frac{(RSS_2 - RSS_1)/Np}{RSS_1/(NT - N(1+p) - p)}$
Step 2 – homogeneous causality (HC)	
$H_0: \forall k = 1,\dots,p/\beta_i^k = \beta^k \quad \forall i = 1,\dots,N$ $H_1: \exists k \in [1,p],\ \exists (i,j) \in [1,N]/\beta_i^k \neq \beta_j^k$	$F_{HC} = \frac{(RSS_3 - RSS_1)/(N-1)p}{RSS_1/(NT - N(1+p) - p)}$
Step 3 – heterogeneous non-causality hypothesis (HENC)	
$H_0: \exists\, i \in [1,N]/\forall k \in [1,p]\ \beta_i^k = 0$ $H_1: \forall i = 1,\dots,N\ \exists k \in [1,p]/\beta_i^k \neq 0$	$F_{HENC} = \frac{(RSS_{2,i} - RSS_1)/p}{RSS_1/(NT - N(1+2p) + p)}$

4. Description and Analysis of Data

The main goal of our paper is to evaluate a potential bidirectional relationship between forward linkages measured with equations (2) and (3) and measures of participation and position in GVCs for thirteen tradable service sectors in seven CEE countries: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, and Slovakia. The analysis covers the

period 2000–2014.[8] Our main database for intersectoral analyses is the World Input-Output Database (WIOD), 2016 (Timmer et al. 2015). The identification of service sectors that have a tradable character is based on the approach used by Mano and Castillo (2015).[9]

We start our analysis by assessing the position of services in GVCs among the selected CEE countries compared with CEE7 and EU28 countries (Figure 1) [10]. The global economy has an overall trend of increasing upstreamness (large distance to final demand) in GVCs during the mid-2000s (Suganuma 2016). The general trend in EU28 countries between 2000 and 2014 is the opposite of the Suganuma's results in the mid-2000s. Since 2008, services in the EU have become more downstream; however, the decline in the index is more visible in the original EU member states (Figure A.1 in the Appendix).

Over the entire period of 2000 to 2014, service sectors in CEE7 countries are located upstream, and the position measure reveals slight growth. To be more specific, services in the Czech Republic, Lithuania, Poland, and Latvia are positioned at the beginning of production, whereas services in Estonia and Hungary are downstream in the entire period. The only country with a strong upward trend in the position index is Slovakia. Hagemejer and Ghodsi (2017) believe that the difference in the position of the EU and several CEE countries in GVCs can be explained in part by the difference in the sectoral structure of EU15 and CEE economies. Even

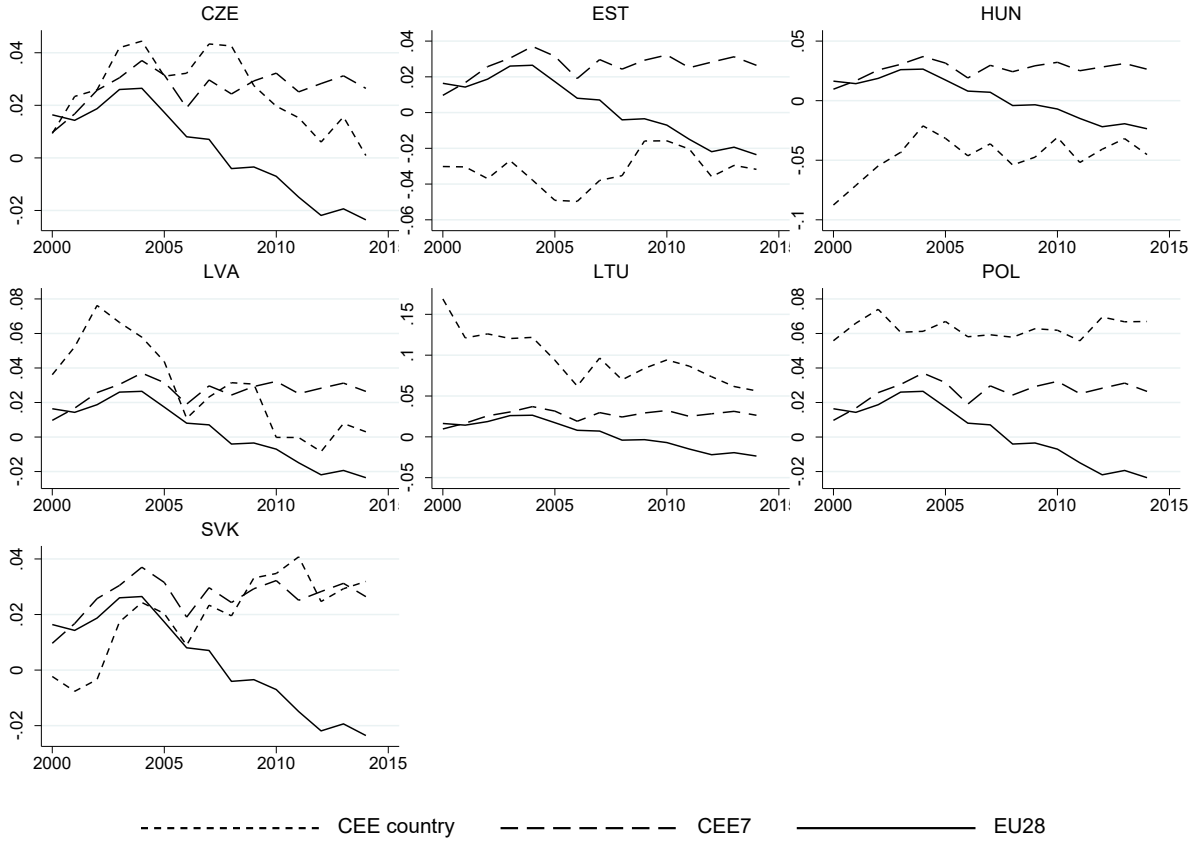
[8] The research period covers the years 2000–2014 due to WIOD database limitations. The latest WIOD data date back to 2014.

[9] We assume that tradable service sectors comprise: G46: Wholesale trade, except motor vehicles and motorcycles; H49: Land transport and transport via pipelines; H50: Water transport; H51: Air transport; H52: Warehousing and support activities for transportation; J58: Publishing activities; J62: Computer programming, consultancy, and related activities; J63: Information service activities; K64: Financial service activities, except insurance and pension funding; K65: Insurance, reinsurance, and pension funding, except compulsory social security; K66: Activities auxiliary to financial services and insurance activities; M69: Legal and accounting activities; M70: Activities of head offices, management consultancy activities; M71: Architectural and engineering activities, technical testing, and analysis; M73: Advertising and market research.

[10] To present the background for CEE countries, we are also interested in the position of services in the original EU member states (EU15). The overall trend for EU28 and EU15 countries is similar (Figure A.1 in the Appendix); therefore, our main analysis only includes a comparison of CEE and EU28 service sectors. The same goes for the participation index.

though CEE countries improved their integration with the EU and their share of services in output, this share is still lower than that of EU15 countries.

Figure 1. Position of service sectors in GVCs for CEE, CEE7, and EU28 countries, 2000–2014

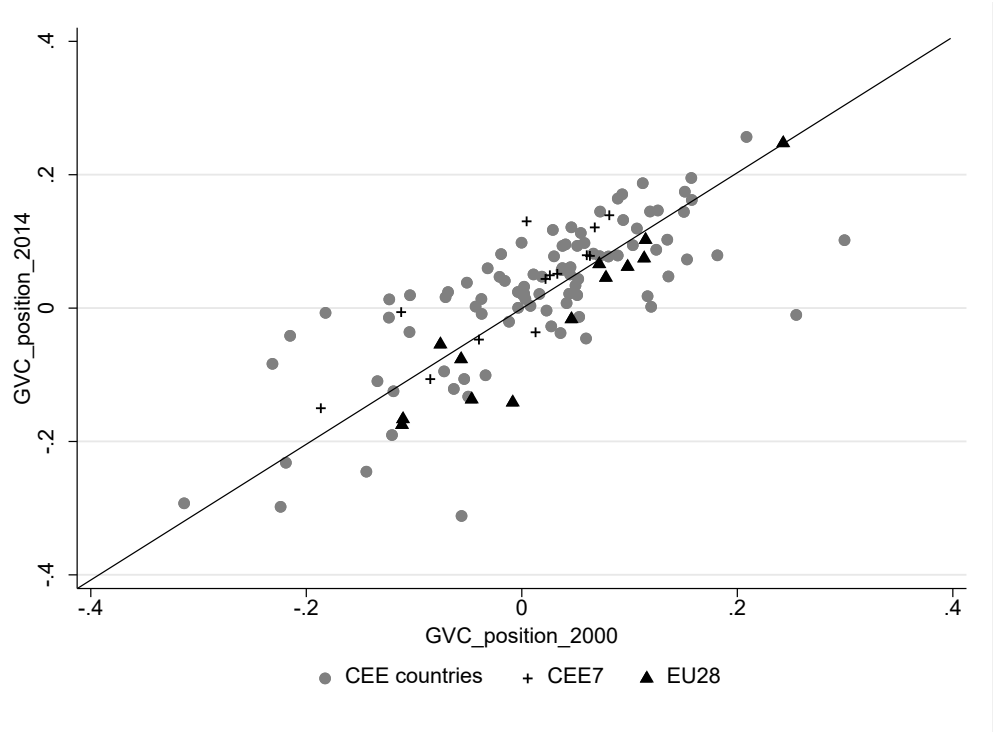


We examine service industries in more detail due to their heterogeneity. Comparing 2014 to 2000, we discover that the position measure decreases for all industries in EU28 countries, except for sector K66 (Figure 2). At the same time, almost all CEE7 service sectors, except for two transport industries (H49 and H50), provide services at early production stages. Generally, there is a clear distinction of tasks between EU and CEE countries in providing services in GVCs. As they are 'upstream in GVCs', CEE countries mainly deliver input services for manufacturing, while EU countries have a downstream position, offering services bundled with goods and sold by manufacturing firms.

The pattern varies across individual sectors and countries: 53 out of the 91 service sectors (13 sectors in 7 countries) are located in more upstream positions in GVCs, while at the

end of the analysed period, 36 service sectors are more downstream in supply chains.

Figure 2. Position of service sectors in GVCs for CEE, CEE7, and EU28 countries, 2000 and 2004 (45-degree line)

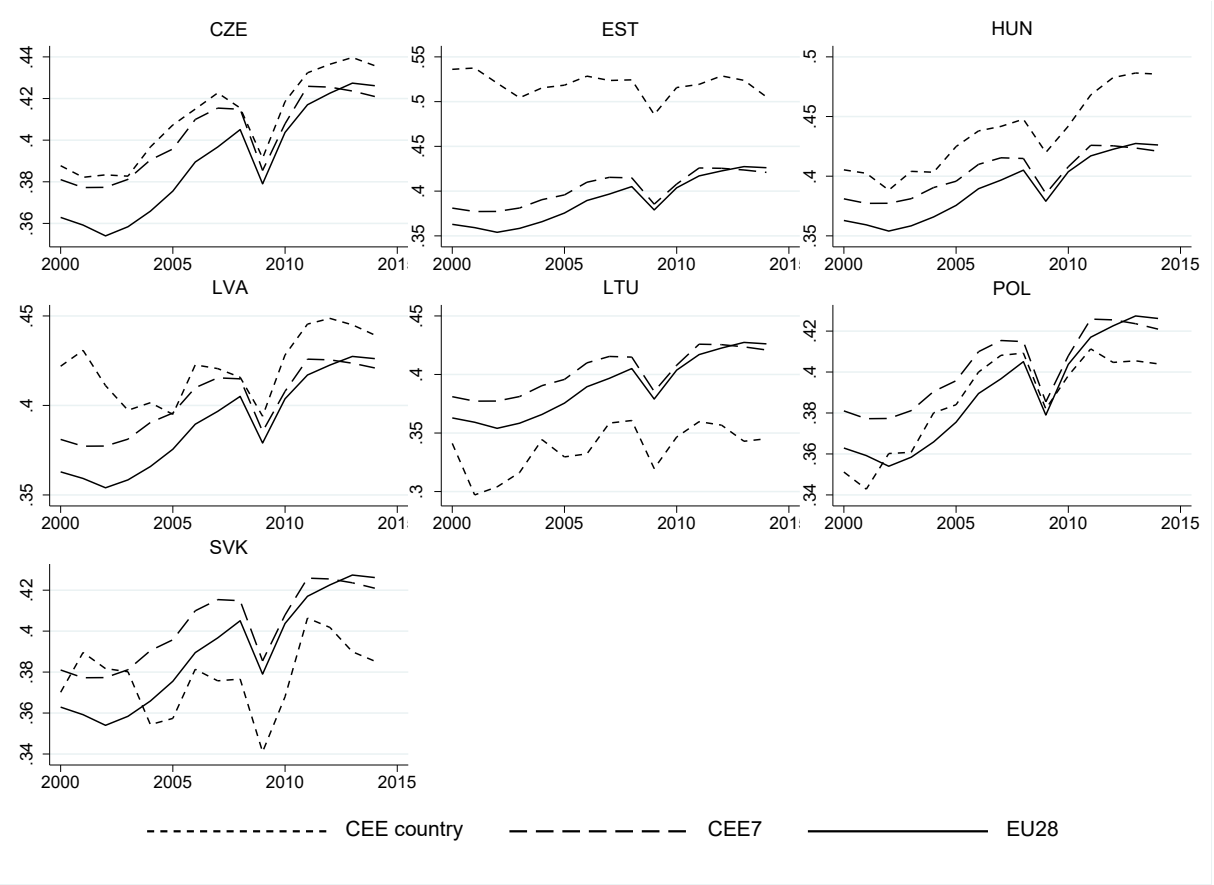


In the majority of the CEE countries under analysis, the service sectors whose upstreamness increased most, enabling them to become the upstreamness leaders in 2014 are business sectors: K64, K66, M69-70, M71, and M73. Poland is an exception: its transport sectors (H50 and H51) moved upstream the most between 2000 and 2014 (see Table A.1 in the Appendix for details). These two transport sectors – together with publishing activities (J58), land transport (H49), computer programming and consultancy (J62), and information services (J63) – were among the most downstream sectors in the remaining CEE countries in 2014. The sector that went downstream the most in supply chains in Lithuania was financial services (K64, K66), which constitute the most upstream sectors in the remaining CEE countries. This trend is also observed in Poland, but on a much smaller scale.

In the next step, we analyse the participation of CEE service sectors in GVCs as compared to CEE7 and EU28 countries (Figure 3). Regardless of the country or group of

countries, the impact of the economic crisis on the decline in GVC participation is observed. In the period 2000–2012, CEE7 countries are characterised by a higher level of GVC participation than EU28 countries, but that trend stopped from 2013 onwards.

Figure 3. Participation of service sectors in GVCs for CEE, CEE7, and EU28 countries, 2000-2014

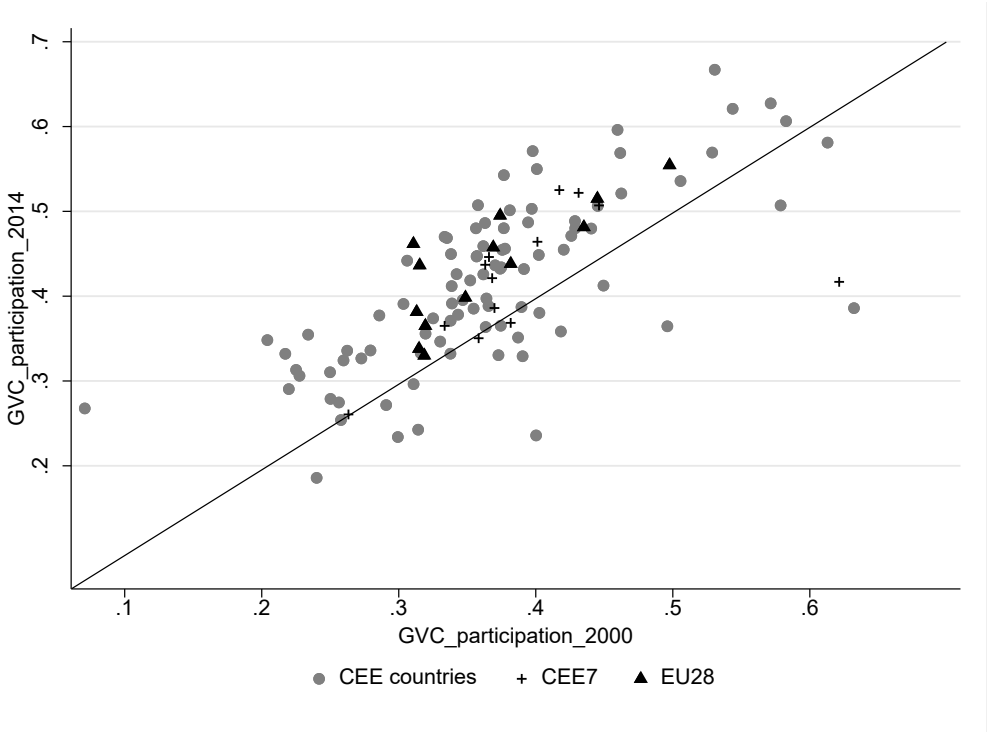


Different patterns can be observed when individual countries in the CEE7 and the EU28 are compared. The countries whose GVC participation index is higher than the index for the CEE7 group include Estonia (for all analysed years), Hungary, Latvia, and the Czech Republic, while Lithuania and Slovakia have lower participation than CEE7 and EU28 countries. This pattern could result from different FDI intensity among CEE countries (Kersan-Škabić 2019) or a cross-border effect between Poland and Germany, the Czech Republic and Germany, and Estonia and Sweden (Kordalska & Olczyk 2019).

A closer look at particular industries and their changes in GVC participation between

2000 and 2014 (Figure 4) reveals an upward trend of GVC participation in all EU28 service sectors on average. This trend is similar in the CEE7 except for three sectors, in which the CEE share in GVCs clearly deteriorates: K64, K65, and K66 (financial and insurance activities). This tendency is strongly negative, because financial services are high value-added sectors and they grew more rapidly than overall services and GDP in the majority of high-income countries.

Figure 4. Participation of service sectors in GVCs for CEE, CEE7, and EU28 countries, 2000 and 2004 (45-degree line)



The behaviour of individual sectors varies across CEE countries. The majority of them (71 out of 91) increase their degree of participation over the period of 2000 to 2014.

To complete our database, forward linkages are calculated, which indicate how much growth in service sectors affect growth in manufacturing when the outputs of the service sector are used as intermediate inputs in the manufacturing of a country (Table 2). Between 2000 and 2014, there was a deeper integration with manufacturing in most of the service sectors, with a growing number having forward linkages greater than 1. Strong forward linkages are observed

in all CEE countries in 2014 in the following sectors: warehousing (H52), financial activities (K64, K66), and professional, scientific, and technical activities (M69_M70, M73).

Table 2. Normalised total forward linkages (NTFL) in CEE service sectors in 2000 and 2014.

	CZE	EST	HUN	LTU	LVA	POL	SVK	CZE	EST	HUN	LTU	LVA	POL	SVK
	2000							2014						
G46														
H49														
H50														
H51														
H52														
J58														
J62_J63														
K64														
K65														
K66														
M69M70														
M71														
M73														

Note: shade cells NTFL>1; otherwise NTFL<1

Among the seven CEE countries, Estonia had the highest interconnectedness between services and manufacturing in 2014, achieving forward linkages of more than 1 in 12 out of the 13 service sectors. This could be related to the specific export structure in Estonia, in which the share of firms that exported services is even larger than the share of firms that exported goods (Benkovskis et al. 2020).

5. Empirical Results

This section includes the presentation of the results for the Hurlin and Venet (2001) panel causality test. It is preceded by the Harris-Tzavalis test and the IPS test that strongly

reject the null hypothesis of a unit root. All variables are assumed to be stationary and can be used in further analysis.[11]

Based on stationary panel data, for tradable service sectors *i* and for selected CEE countries *j* over the period 2000–2014, the following equations are estimated:

$$\begin{aligned} GVCposition_{ijt} &= \sum_{k=1}^{p} \gamma^k GVCposition_{ij,t-k} + \sum_{k=0}^{p} \beta_{ij}^k FLindex_{ij,t-k} + v_{ijt} \\ FLindex_{ijt} &= \sum_{k=1}^{p} \gamma^k FLindex_{ij,t-k} + \sum_{k=0}^{p} \beta_{ij}^k GVCposition_{ij,t-k} + v_{ijt} \end{aligned}, \quad (7)$$

and

$$\begin{aligned} GVCparticipation_{ijt} &= \sum_{k=1}^{p} \gamma^k GVCparticipation_{ij,t-k} + \sum_{k=0}^{p} \beta_{ij}^k FLindex_{ij,t-k} + v_{ijt} \\ FLindex_{ijt} &= \sum_{k=1}^{p} FLindex_{ij,t-k} + \sum_{k=0}^{p} \beta_{ij}^k GVCparticipation_{ij,t-k} + v_{ijt} \end{aligned}, \quad (8)$$

in which *FLindex* is measured in two ways: as NTFL and NHEM indices.

Considering the literature on estimators assigned to dynamic panel data models and our sample size of N=91 and T=15, we employ the GMM estimator for equations (7) and (8).[12] Additionally, when the N dimension is large enough, this estimator allows us to assume a standard distribution of the Wald test statistics (Hurlin and Venet 2001). Because of the small size of our sample in terms of T, we analyse the models described above, with the number of lags limited to three. The Wald statistics as described in Table 1 are presented in Tables 3-8 together with their statistical significance for each step of the analysis.

The results of the HNC hypothesis testing are given in Table 3. Having separately evaluated the causal relationship among intersectoral linkages and positions and participation in GVCs, we strongly reject the null hypothesis of the homogeneous non-causality for any lag length or either measure of forward linkages. In the opposite relation, the HNC hypothesis can

[11] Results of the unit-root tests are available on request.

[12] Discussions about dynamic panel data models and estimator properties focus mainly on samples in which N>>T. As Nickell (1981) states, such samples are characterised by bias and inconsistency of the LSDV estimator. However, growth in the T dimension can reduce the inconsistency of the estimator. Well-known solutions to correct this bias include the GMM estimator suggested by Arellano and Bond (1991) and its extensions.

be rejected in all cases except for the second and third lag, the NTFL measure, and the GVC participation index. This confirms that our data have bidirectional Granger causality. The linkages between tradable service sectors and manufacturing sectors Granger cause both the position and participation of service sectors in GVCs in CEE countries. In addition, the position and participation in GVCs are causes of forward intersectoral linkages each.

Table 3. Results of the homogeneous non-causality hypothesis testing – the F_{HNC} test statistics

	intersectoral linkages do not cause GVC position		intersectoral linkages do not cause GVC participation	
lags	NTFL	NHEM	NTFL	NHEM
1	1.869***	2.914***	2.682***	2.531***
2	1.479***	1.722***	1.696***	1.943***
3	1.296***	1.215**	1.428***	1.541***
	GVC position does not cause intersectoral linkages		GVC participation does not cause intersectoral linkages	
lags	NTFL	NHEM	NTFL	NHEM
1	2.681***	5.236***	2.116***	2.384***
2	1.660***	1.834***	1.074	1.367***
3	1.383***	1.391***	1.137	1.952***

Note: *** significant at 0.01%.

The rejection of the HNC hypothesis allows us to test whether the confirmed causality is homogeneous or rather heterogeneity among individual country-sectors can be demonstrated. The results of the HC hypothesis testing are presented in Table 4. The pattern of significance is similar to that discovered for the results in the previous step.

Table 4. Results of the homogeneous causality hypothesis testing – the F_{HC} test statistics

	intersectoral linkages do not cause GVC position		intersectoral linkages do not cause GVC participation	
lags	NTFL	NHEM	NTFL	NHEM
1	1.915***	2.841***	2.679***	2.526***
2	1.459***	1.711***	1.648***	1.895***
3	1.249**	1.215**	1.397***	1.509***
	GVC position does not cause intersectoral linkages		GVC participation does not cause intersectoral linkages	
lags	NTFL	NHEM	NTFL	NHEM
1	2.616***	5.238***	2.131***	2.306***
2	1.683***	1.814***	1.049	1.369***
3	1.349***	1.339***	1.137	1.942***

Note: significant at ** 0.05%, *** 0.01%.

Other than *NTFL = f(GVCparticipation)* for lags 2 and 3, we reject the HC hypothesis in the rest of the tests and discover a bidirectional causal relationship between the two different measures of forward linkages and service sector participation and in the service sector position in GVCs in at least one country-sector in CEE countries.

Having analysed the impact of intersectoral linkages on the position and participation in GVCs by CEE countries, we discover a stronger effect of these links on positions of these countries in global value chains (38 out of the 91 sectors) than on their participation in GVCs (23 out of the 91 sectors). Our results are consistent with the study by Muradov (2017), which underlines the role of structural features (interconnectedness between industries) in determining a country's position in GVCs.

Connections between service sectors and manufacturing have a relatively weak impact on positions in GVCs in the case of Poland (only 1 sector) and the Czech Republic (only 2 sectors), while in the other CEE countries this relation is statistically significant in the majority of service sectors (Table 5). In three sectors – K66 (activities auxiliary to financial services and insurance activities), H50 (water transport), H51 (air transport) – links with manufacturing have the greatest impact on the position in GVCs. This may be due to the fact that the highest share of these three sectors in total services value added is embodied in manufacturing exports in the majority of CEE countries (Ignatenko 2019). The impact of linkages between financial activities and manufacturing on the position in GVCs is much higher in the majority of the CEE countries than the impact of the relationship between transport and manufacturing. These results indirectly confirm the hypothesis about the strong impact of financial activities on GVC development, which we observed during the global financial crisis in 2009.

Table 5. Results of the heterogeneous non-causality hypothesis *GVCposition=f(FLindex)* testing – the F_{HENC} test statistics

	intersectoral linkages do not cause GVC position					
lag	NTFL			NHEM		
	1	2	3	1	2	3

CZE_K65	2.46	1.13	0.95	0.15	0.57	2.82**
CZE_K66	18.85***	7.35***	6.13***	18.47***	10.55***	2.29*
EST_G46	2.73*	0.46	0.18	2.85*	1.23	0.23
EST_H50	0.65	0.56	0.11	5.16**	0.58	0.11
EST_H51	9.44***	3.76**	0.93	8.16***	3.84**	1.01
EST_J62-63	3.11*	4.31**	1.43	0.07	1.51	0.65
EST_K64	3.73*	1.31	1.29	1.79	1.82	1.79
EST_K66	19.37***	3.22**	2.75**	23.66***	25.88***	11.90***
EST_M73	1.82	0.81	0.60	4.61**	0.54	0.37
HUN_H50	7.11***	2.19	2.34*	3.87**	3.79**	1.91
HUN_H51	4.50**	0.25	0.08	2.93*	0.89	0.74
HUN_H52	2.39	1.14	0.42	5.55**	3.35**	1.30
HUN_J58	0.58	0.12	2.97**	4.46**	3.43**	3.07**
HUN_J62-63	2.98*	1.14	0.34	0.48	0.41	0.30
HUN_K65	0.54	0.27	0.04	2.93*	0.39	0.30
HUN_K66	1.94	1.67	1.10	5.71**	4.44**	1.91
LTU_G46	0.84	1.17	0.22	7.65***	2.62*	0.40
LTU_H51	2.92*	5.59***	1.58	1.17	5.69***	1.40
LTU_K65	0.65	0.77	2.41*	4.03**	2.92*	4.20***
LTU_K66	13.96***	4.45**	1.97	33.76***	18.76***	6.08***
LVA_H50	2.24	3.02**	2.33*	3.71*	1.11	1.44
LVA_H51	0.12	2.38*	0.15	0.72	2.74*	2.75**
LVA_H52	3.70*	0.25	0.00	1.03	0.97	0.49
LVA_J58	1.51	1.25	0.67	6.75***	1.25	0.31
LVA_J62-63	0.04	0.23	0.14	2.71*	1.09	0.39
LVA_K64	1.95	0.96	0.21	4.72**	1.86	0.81
LVA_K65	0.33	2.71*	0.94	2.16	0.19	0.23
LVA_K66	9.14***	4.81***	3.35**	3.75*	0.90	3.56**
POL_H50	3.21*	0.06	1.99	2.80*	1.29	3.15**
SVK_H50	5.56**	5.64***	2.76**	4.32**	0.73	0.18
SVK_H51	7.05***	3.95**	3.43**	4.04**	4.12**	1.88
SVK_H52	5.28**	1.81	1.19	3.05*	1.46	0.76
SVK_J58	3.68*	2.13	2.56*	8.92***	3.16**	1.40
SVK_J62-63	2.15	0.61	0.52	3.14*	1.08	0.20
SVK_K64	4.17**	1.69	0.65	0.82	0.52	0.04
SVK_K65	2.57	0.97	0.12	3.96**	1.73	0.21
SVK_K66	0.34	4.94***	1.87	3.92**	2.22	1.32
SVK_M71	2.65	0.40	0.05	3.71*	1.79	0.86

Note: The table contains only statistically significant test statistics, significant at *0.1%, ** 0.05%, *** 0.01%,

We divide the seven CEE economies into two separate groups. The first consists of the Baltic countries (Estonia, Lithuania, Latvia) plus the Czech Republic, which strengthen their positions in GVCs based on a strong relationship between the financial insurance sector (K66)

and manufacturing. Poland, Hungary, and Slovakia improve their positions in GVCs by offering transport services to manufacturing.

Our results reveal that CEE countries can improve their participation in GVCs by building strong relations between their service sectors and manufacturing (Table 6).

Table 6. Results of the heterogeneous non-causality hypothesis *GVCparticipation=f(FLindex)* testing – the F_{HENC} test statistics

	intersectoral linkages do not cause GVC participation					
lag	NTFL			NHEM		
	1	2	3	1	2	3
CZE_K66	19.92***	27.63***	12.3***	11.30***	23.48***	12.62***
EST_K64	8.04***	3.26**	1.03	2.31	4.30**	1.59
EST_K65	2.74*	0.99	0.54	0.18	0.05	0.13
EST_K66	60.29***	14.59***	11.109***	59.86***	27.72***	11.17***
HUN_G46	3.10*	1.18	0.53	0.71	0.04	0.11
HUN_H51	5.89**	2.38*	1.38	0.10	0.89	1.19
HUN_J58	0.38	1.74	4.44***	6.77***	1.80	3.39**
LTU_G46	2.83*	0.85	0.37	8.37***	2.65*	1.11
LTU_H51	0.26	4.25**	1.51	0.62	2.94*	0.88
LTU_J62-63	2.44	2.30	0.37	2.91*	2.35*	1.20
LTU_K65	1.53	0.79	2.12*	1.37	4.39**	3.34**
LTU_K66	23.83***	7.12***	2.19*	51.24***	21.60***	10.78***
LVA_G46	4.81**	4.58**	1.15	0.46	0.85	0.02
LVA_K65	0.76	2.79*	0.68	2.08	0.80	0.57
LVA_K66	6.35**	0.46	3.46**	1.30	1.09	1.91
LVA_M69-70	4.64**	1.65	0.73	1.38	0.48	0.38
POL_H50	3.74*	3.81**	1.14	3.49*	3.04**	1.08
POL_H52	0.67	0.58	0.37	3.48*	1.50	0.71
POL_M73	1.49	0.61	0.47	3.17*	1.59	0.67
SVK_H50	6.90***	1.33	1.85	4.38**	1.76	0.57
SVK_H51	0.84	3.44**	0.86	1.47	1.07	2.93**
SVK_K66	9.1***	5.47***	3.67**	1.44	4.84***	1.45
SVK_M71	1.71	0.68	0.00	3.98**	2.11	1.01

Note: The table contains only statistically significant test statistics, significant at *0.1%, ** 0.05%, *** 0.01%.

This is particularly effective in the Baltic countries and in the Czech Republic because of their linkages between the financial services sector (K66) and manufacturing. However, only in the Estonian economy does the relationship between all financial sectors (K64, K65, K66) and manufacturing affect participation in GVCs. Moreover, in this economy the strength of the

linkages between sector K66 and manufacturing affects participation in GVCs three times more than in the other countries. Poland, Hungry, and Slovakia increase their participation in GVCs mainly by offering competitive transport services to manufacturing, but these linkages are much weaker than those observed in the Baltic states. Therefore, our results reveal that Estonia should be considered a regional benchmark for other CEE countries on how to build strong linkages between services and manufacturing, leading to the development of a country's position in GVCs.

Our results point to the importance of business services with linkages to manufacturing in a causal explanation of position and participation in GVCs. This could be the result of activities by international companies, which locate their service centres in the CEE region because of lower costs, automatically involving CEE domestic service sectors in global production. Moreover, in the majority of the analysed countries, this indicates the importance of transport sectors, which not only is related to increasing demand for transport services in production processes in GVCs but is also a result of a favourable central position of countries such as Poland or Hungary in regional supply networks.

We are also interested in investigating the inverse relationship, i.e. how the position in GVCs occupied by CEE economies reinforces linkages between services and manufacturing. These relationships are rather significant (in 33 out of the 91 sectors), but the results differ depending on the linkage measure employed (Table 7). It can be observed that the position in transport sectors (H49-52) in all analysed countries (except for Estonia) and in professional, scientific, and technical activities (M69-73) (except the Czech Republic and Poland) has the strongest influence on linkages between service sectors and manufacturing.

Table 7. Results of the heterogeneous non-causality hypothesis *FLindex =f(GVCposition)* testing – the F_{HENC} test statistics

	GVC position does not cause intersectoral linkages					
lag	NTFL			NHEM		
	1	2	3	1	2	3

CZE_H50	2.66	0.77	0.13	22.23***	2.46*	3.20**
CZE_K66	3.51*	3.49**	1.31	8.75***	6.92***	9.23***
EST_G46	0.30	0.12	0.32	4.51**	1.52	1.17
EST_K66	0.27	0.06	0.09	4.88**	1.53	1.76
EST_M69-70	0.03	0.04	0.02	9.47***	2.24	0.25
EST_M73	0.11	0.00	0.00	6.73***	0.96	0.01
HUN_H50	0.32	1.25	1.31	73.12***	20.22***	4.94***
HUN_M73	13.58***	4.33**	3.09**	65.47***	10.93***	16.83***
LTU_H49	0.08	0.31	0.16	4.54**	1.63	0.54
LTU_H52	0.10	0.10	0.11	16.73***	3.05**	0.28
LTU_M69-70	0.55	0.30	0.12	5.99**	2.60*	1.30
LVA_G46	2.56	3.34**	2.63*	1.50	0.25	0.08
LVA_H49	1.91	3.34**	2.01	2.10	0.33	0.64
LVA_H50	1.33	1.48	3.03**	0.36	0.09	0.24
LVA_H52	21.66***	22.95***	12.92***	2.12	0.01	0.25
LVA_J58	6.79***	1.96	3.74**	5.71**	1.15	0.10
LVA_J62-63	0.80	1.51	1.48	2.96*	1.22	0.65
LVA_K64	27.46***	17.94***	6.94***	0.99	0.27	0.64
LVA_K65	9.51***	7.11***	4.28***	0.84	0.21	0.14
LVA_K66	18.94***	19.50***	9.39***	5.76**	3.74**	1.54
LVA_M69-70	25.60***	4.05**	4.83***	2.42	0.70	0.17
LVA_M71	10.06***	5.12***	2.55*	1.36	0.14	0.10
LVA_M73	45.00***	11.05***	4.75***	1.68	0.92	0.12
POL_H50	1.60	0.82	0.45	13.91***	8.28***	4.51***
POL_H51	0.57	0.48	0.18	0.59	0.30	2.17*
SVK_H50	0.55	0.11	0.09	5.15**	1.61	1.30
SVK_H51	0.50	0.15	0.35	4.58**	1.41	3.06**
SVK_H52	0.54	0.16	0.05	6.28**	1.56	0.17
SVK_J58	0.36	0.03	0.01	3.60*	0.84	0.18
SVK_J62-63	0.09	0.11	0.05	2.76*	0.77	0.19
SVK_K66	0.12	0.07	0.05	2.71	3.79**	1.37
SVK_M69-70	1.02	0.54	0.30	6.69***	0.97	0.66
SVK_M73	0.03	0.14	0.07	8.22***	1.09	0.16

Note: The table contains only statistically significant test statistics, significant at *0.1%, ** 0.05%, *** 0.01%.

Table 8 includes individual F_{HENC} test statistics for the last analysed relationship. As shown in Table 8, the significance of a causal relationship depends crucially on the forward linkage measure. Surprisingly, and as shown in Table 7, this relationship is important in all thirteen service sectors in Latvia. To analyse differences between the results for two alternative measures of forward relations, one should back to their construction and meaning. The NHEM indices which are significantly caused by GVC development in all countries except for Latvia

underline the importance of potentially eliminated service industries. The results for Latvia indicate that the GVC development causes the NTFL i.e. it causes the overall service-manufacturing links.

From the sectoral perspective, GVC participation Granger causes sectoral linkages primarily in the areas of professional, scientific, and technical activities (M69-73) and transport services. Poland is the only country with causal relations in just one sector (H50).

Table 8. Results of the heterogeneous non-causality hypothesis *FLindex =f(GVCparticipation)* testing – the F_{HENC} test statistics

	GVC participation does not cause intersectoral linkages					
lag	NTFL			NHEM		
	1	2	3	1	2	3
CZE_H50	0.00	0.34	0.55	31.83***	2.39*	2.22*
CZE_K66	6.88***	0.51	0.01	5.60**	0.40	0.38
CZE_M73	0.14	0.11	0.06	2.84*	0.60	0.18
EST_K66	0.19	0.18	0.01	15.11***	4.42**	1.70
EST_M69-70	0.05	0.17	0.07	4.07**	1.11	0.27
EST_M73	0.04	0.02	0.00	6.88***	1.10	0.58
HUN_H50	0.94	0.62	0.21	59.03***	24.06***	15.36***
HUN_H52	0.03	0.26	0.12	2.87*	0.82	0.55
HUN_M73	3.35*	1.88	4.07***	35.96***	10.61***	30.33***
LTU_H50	1.10	0.41	0.16	3.54*	0.59	0.35
LTU_H51	0.22	0.26	0.10	2.24	2.51*	0.98
LTU_M69-70	1.02	0.43	0.26	1.81	2.72*	0.91
LTU_M73	6.92***	2.12	0.51	12.57***	2.06	1.34
LVA_G46	6.86***	3.28**	1.72	0.53	0.17	0.16
LVA_H49	1.99	5.39***	3.34**	0.94	0.34	0.18
LVA_H50	25.48***	0.64	10.22***	0.52	0.83	0.00
LVA_H51	8.27***	1.60	0.96	2.52	0.85	0.31
LVA_H52	32.87***	21.26***	10.13***	0.35	0.71	0.21
LVA_J58	10.96***	2.14	4.39***	2.04	1.16	0.54
LVA_J62-63	10.32***	5.64***	2.56*	3.97**	2.10	1.14
LVA_K64	12.09***	9.83***	4.15***	0.25	0.31	0.54
LVA_K65	5.73**	4.12**	2.66**	0.09	0.17	0.02
LVA_K66	0.66	0.42	0.94	3.18*	1.00	0.20
LVA_M69-70	7.33***	3.41**	2.84**	1.28	0.57	0.34
LVA_M71	10.35***	4.87***	2.65**	0.82	0.14	0.07
LVA_M73	7.54***	0.02	1.68	0.73	1.08	0.42
POL_H50	6.97***	2.12	1.03	34.04***	6.35***	6.08***
SVK_G46	0.43	0.33	0.22	4.48**	1.96	1.56
SVK_H51	0.37	0.38	0.33	0.63	2.02	2.13*
SVK_H52	0.38	0.02	0.06	4.63**	1.81	1.37

SVK_K65	0.23	0.18	0.03	2.89*	5.72***	2.89**
SVK_M69-70	0.85	0.79	0.47	7.39***	1.30	1.85
SVK_M71	0.07	0.01	0.05	3.93**	1.19	0.84
SVK_M73	2.68	0.81	0.54	18.39***	7.15***	2.57*

Note: The table contains only statistically significant test statistics, significant at *0.1%, ** 0.05%, *** 0.01%.

6. Conclusions

This paper focuses on the relationship between tradable services and manufacturing in CEE countries as a new factor that enables countries to reinforce their positions and participation in GVCs, or vice versa. We have discovered growing upstreamness and participation in GVCs in CEE countries in the analysed period, which was accompanied by deeper linkages between services and manufacturing. The Baltic countries and the Czech Republic improve their positions and participation in GVCs by building strong relations between financial sectors and manufacturing, while Poland, Hungary, and Slovakia do so by offering competitive transport services to manufacturing. We have also observed that participation in GVCs by CEE economies and their position reinforce the relationship between services and manufacturing, especially in transport sectors and in professional, scientific, and technical activities.

The results extend the findings of the standard gravity literature for GVC trade, which highlight the crucial role of product diversification, foreign direct investment inflows, intra-community trade, location, the quality of institutional features (e.g. contract enforcement and the quality of infrastructure) as the main determinants of GVC participation (Ignatenko et al. 2019). Only few studies indicate structural factors as determinants of GVC participation, which include the size of the market, the industrial structure, or the level of development (Kowalski et al. 2015; Pathikonda & Farole 2016). Our study is in line with these analyses, emphasising the role of particular structural characteristics of the domestic economy, i.e. the strength of linkages between services and manufacturing, in the development of GVCs.

Our research points to certain important policy implications, which, in our opinion, may be applicable not only to the CEE countries analysed in this paper, but also to other economies. It is connected with the labour productivity slowdown observed in most countries during the last decade and the attempts to overcome it by more intensive participation in GVCs. This policy is in line with the results of Constantinescu et al. (2019), who argued that participation in GVCs is a significant driver of labour productivity in a set of 40 countries. However, stronger GVC integration causes several concerns about the negative impact of GVCs on the labour market, particularly about a decline in employment among low-skilled workers due to the progressing automation of industrial production. Still, even the results concerning the effects of GVC integration on employment are not unequivocal , however, Lopez-Gonzalez (2016) finds that importing intermediates has (short-term) positive effects on value added of a country and on jobs, especially in services. As a result, countries participating in GVCs and having strong domestics linkages between manufacturing and services could benefit both in higher productivity and higher employment in service sectors.

Policy makers rightly seek to understand what it takes to increase participation in GVCs. In practice, this means understanding what is required to attract lead firms and upgrade to higher value-added activities. In this context, we hope that our results will contribute to discussions about specific policies or adequate development strategies, including trade and industrial policies in CEE countries in a global economy. We recommend concentrating on hub sectors (with the strongest service–manufacturing linkages) for three reasons. First, several analyses show that the more closely sectors are connected with one another through trade in intermediate inputs, the more correlated their value-added growth is (European Central Bank 2019). Second, Gabaix (2011) claims that the presence of hub sectors is strongly relevant in terms of the transmission of economic shocks, as they connect otherwise unrelated entities through input-output linkages and can act as a transmission channel for shocks. Therefore,

strengthening linkages in hub sectors not only increases a country's participation in GVCs but also at the same time reinforces channels for spillovers of real economic activity. Third, our results are in line with the analysis performed by Beverelli et al. (2016), which provides evidence that strong relations in domestic value chains have a positive effect on GVC integration, i.e. a one standard deviation increase in domestic value chain integration before the rise of GVCs, increases the GVC integration by about 0.4%. Therefore, a strong domestic manufacturing–service relationship is an important factor of GVCs participation, because by high domestic fragmentation companies joining GVCs incur less additional fragmentation costs (they have already charged them).

To strengthen linkages between services and manufacturing, we also recommend that existing limitations in domestic services markets in CEE countries are overcome, especially the relatively low openness to foreign competitors and distortionary regulations in services (Kordalska & Olczyk 2018). Several studies show that appropriate regulations in domestic services markets affect industries relying on GVC linkages in services to generate value added (Van der Marel & Sáez 2016). Fernandes and Paunov (2012) found a positive effect of substantial FDI inflows in domestic producer service sectors on the total factor productivity of manufacturing firms. In general, an intensive use of modern, high-quality domestic services can help manufacturing firms increase productivity (Liu et al. 2018) and can affect GVC participation only to a certain extent.

Further analyses are needed. First, the participation and linkage indexes could be modified. The participation index could be replaced with two more detailed measures, i.e. forward and backward participation indexes, whereas the forward linkage index can be substituted by a weighted added-value forward linkage index. Second, it would also be beneficial to compare our results with those concerning other European economies. We believe that global industry leaders are no longer specific economies but, rather, three industrial centres

connected by a dense network of multilateral links and concentrated around Japan in Asia, around Germany and France in Europe, and around the United States in North America. Therefore, all European countries are competing to achieve a better position and participation in the GVC hub (Germany–France) and strong linkages between their services and manufacturing can play a key role in this process.

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Appendix

Figure A.1 GVC position and GVC participation of service sectors in EU28 and EU15 countries, 2000–2014

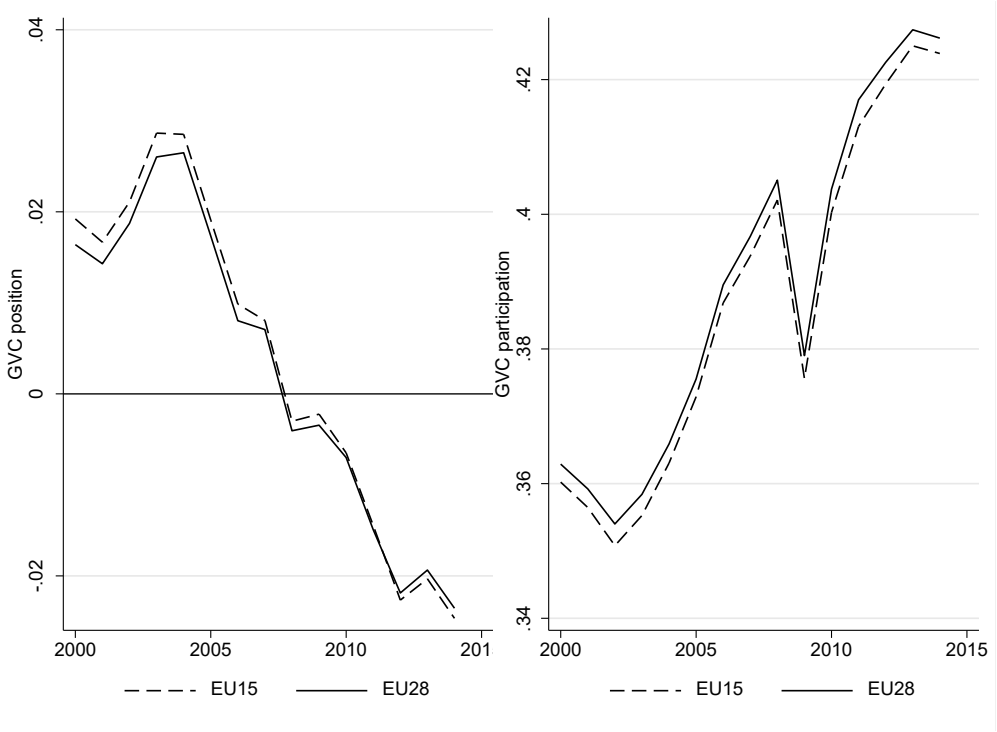

Table A.1 Major upstream and downstream service sectors in CEE countries in 2014

	Top 3 upstream sectors				**Top 3 downstream sectors**			
	2014		going up most		2014		going down most	
CZE	K66	0.098	K65	0.173	H51	-0.125	H49	-0.073
	J62_J63	0.077	K66	0.098	J58	-0.095	G46	-0.032
	K64	0.061	M71	0.020	H49	-0.038	J58	-0.023
EST	K66	0.174	M69_M70	0.075	H51	-0.298	H49	-0.083
	M69_M70	0.121	K65	0.067	H50	-0.232	H51	-0.074
	K64	0.095	K64	0.055	H49	-0.133	H52	-0.034
HUN	K66	0.171	M73	0.100	H50	-0.312	H50	-0.256
	M69_M70	0.093	J62_J63	0.089	H51	-0.293	H49	-0.058
	M73	0.081	K66	0.077	H49	-0.121	*	*
LTU	M73	0.257	M73	0.048	H51	-0.245	K66	-0.265
	M71	0.162	K65	0.039	H50	-0.046	H52	-0.198
	M69_M70	0.146	M69_M70	0.020	J62_J63	-0.027	K64	-0.118
LVA	M69_M70	0.164	K66	0.092	H51	-0.190	G46	-0.088
	H50	0.113	M69_M70	0.075	H49	-0.106	M73	-0.080
	H52	0.103	H50	0.058	J58	-0.101	H51	-0.069
POL	M73	0.195	H50	0.123	H51	-0.014	H49	-0.066
	M69_M70	0.187	H51	0.109	H49	-0.013	K64	-0.008
	H52	0.145	K65	0.087	J58	-0.003	K66	-0.006
SVK	M73	0.145	J58	0.136	H51	-0.084	J62_J63	-0.015
	M69_M70	0.132	M71	0.091	G46	-0.020	G46	-0.008
	K66	0.119	H52	0.088	*	*	*	*

Note: * in Slovakia only two sectors are downstream.