GDAŃSK UNIVERSITY OF TECHNOLOGY
FACULTY OF MANAGEMENT AND ECONOMICS

POSITION IN GLOBAL VALUE CHAINS: THE IMPACT ON WAGES IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

Sabina Szymczak*, Aleksandra Parteka, Joanna Wolszczak-Derlacz*****

GUT Faculty of Management and Economics
Working Paper Series A (Economics, Management, Statistics)
No 1/2019 (53)

January 2019

*Gdansk University of Technology, Faculty of Management and Economics,
sabina.szymczak@pg.edu.pl (corresponding author)
**Gdansk University of Technology, Faculty of Management and Economics,
aparteka@zie.pg.gda.pl
***Gdansk University of Technology, Faculty of Management and Economics,
jwo@zie.pg.gda.pl

POSITION IN GLOBAL VALUE CHAINS: THE IMPACT ON WAGES IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

Sabina Szymczak*, Joanna Wolszczak-Derlacz and Aleksandra Parteka *****

This version: 1 January 2019

Abstract

This paper examines the relationship between the relative position of industries in Global Value Chains (GVCs) and wages in ten Central and Eastern European countries in the period 2005-2014. We combine GVC measures of global import intensity of production, upstreamness (distance from final use), and the length of the value chain (based on WIOD) with micro-data on workers from EU-SILC. We find that the wages of CEEC workers are higher when their industry is at the beginning of the chain, far from final demand (high upstreamness) or at the end (low upstreamness – sectors close to final demand) than in the middle. Secondly, wage changes depend on the interplay between upstreamness and GVC intensity. In sectors close to final demand, greater production fragmentation, measured either by global import intensity or by vertical specialisation, is associated with lower wages. Higher upstream, this effect is not sustained.

JEL: F14, F16, J31

Keywords: wage, GVC, upstreamness, production fragmentation, CEECs

---

*Gdansk University of Technology, Faculty of Management and Economics, Narutowicza 11/12; 80-233 Gdańsk, Poland, e-mail: sabina.szymczak@pg.edu.pl (corresponding author)

**Gdansk University of Technology, Faculty of Management and Economics, Narutowicza 11/12; 80-233 Gdańsk, Poland, e-mail: jwo@zie.pg.gda.pl

***Gdansk University of Technology, Faculty of Management and Economics, Narutowicza 11/12; 80-233 Gdańsk, Poland, e-mail: aparteka@zie.pg.gda.pl

This research has been conducted within the project financed by the National Science Centre, Poland (Narodowe Centrum Nauki – NCN) – decision number DEC-2015/19/B/HS4/02884.

1. Introduction

The phenomena of international production fragmentation and task relocation have gained a good deal of attention in studies on the labour market implications of trade links due to offshoring (see Hummels et al., 2018 or Feenstra, 2010 for a review). The effects have been analysed either from the perspective of employment (assessing how production fragmentation affects the employment of native workers, as in Acemoglu et al., 2016; Harrison and McMillan, 2011; Hijzen and Swaim, 2007; Michel and Rycx, 2012; Sethupathy, 2013; Wright, 2014; Reijnders and de Vries, 2018), or wages (the earnings impact of shifting some parts of the production process outside the firm and/or outside the country, as in Baumgarten et al., 2013; Crinò, 2010; Ebenstein et al., 2014; Geishecker and Görg, 2008; Geishecker and Görg, 2013; Geishecker et al., 2010; Görg and Görlich, 2015; Hummels et al., 2014; Kim and Hwang, 2016; Parteka and Wolszczak-Derlacz, 2015; Wolszczak-Derlacz and Parteka, 2018).

In the early literature, international production fragmentation was typically seen as a threat to low-skilled native workers, especially in the developed countries, as production was transferred to countries with cheaper labour. The main effects analysed included job loss due to changes in relative demand for skilled labour, job offshoring, declining middle class wages, and rising inequality, i.e. higher skill premiums (Bound and Johnson, 1992; Freeman, 1995; Feenstra and Hanson 1999). Over time, with the theoretical advances in offshoring theory this view has evolved. The seminal model of Grossman and Rossi-Hansberg (2008) shows that the labour market effect of production fragmentation may differ for different types of workers, and some can even benefit thanks to rising productivity. The ambiguity of these effects is accentuated by the increasing complexity of production – inputs are now likely cross more than one border, and the share of value added produced outside the country of completion, mainly added outside that country's region, has risen, giving us what has been dubbed the 'Factory World' (Los et al., 2015). Consequently, the recent literature on production fragmentation (among others Amador and Cabral, 2016; Baldwin et al., 2012; Johnson, 2014; Los et al., 2015; Timmer et al., 2014; Timmer et al., 2015; Timmer et al., 2016) focuses more on global value chains[1] (GVCs) than on pure intensity of offshoring.

There has also been significant progress in the measurement of production fragmentation (Feenstra, 2017; Hummels et al., 2018). Where the traditional indices measure offshoring as the ratio of imported intermediate inputs to the output of domestic industry (Feenstra and Hanson, 1999), a new generation of statistics utilises input-output data and breaks gross trade down into the foreign and domestic components of value added embodied in exports (among others: Wang et al., 2013; Koopman et al., 2014). The literature considers both involvement in GVCs, i.e. the intensity of production

[1] The global value chain for a final product is defined as "the value added of all activities that are directly and indirectly needed to produce it. The global value chain is identified by the country-industry where the last stage of production takes place before delivery to the final user" (Timmer et al., 2014:100).

fragmentation as gauged by international input-output data (Timmer et al., 2015; Timmer et al. 2016) and industry-level measures of relative production line position with respect to the final demand (Antras et al., 2012; Chen, 2017; Miller and Temurshoev, 2017; Wang et al., 2017). Recent evidence available for the U.S. confirms that the labour market outcomes of value added trade are strongly dependent on how far upstream or downstream the industry is within the GVC (Shen and Silva, 2018).

This is the aspect we emphasise here, namely the position of industries in the production chain and how this affects wages. We focus on the case of workers in Central and Eastern European countries (CEECs), which have still not been widely described in the GVC literature (for exceptions, see Hagemejer, 2018; Hagemejer and Ghodsi, 2017; Parteka, 2018). So far, the impact of fragmentation on labour markets has been analysed mainly for highly developed economies – in particular the U.S. and a few Western European countries (e.g. Michel and Rycx, 2012; Hummels et al., 2014; Geishecker and Görg, 2008, Baumgarten et al., 2013). Studies explicitly analysing the wage impact of GVCs are very scarce (Parteka and Wolszczak-Derlacz, 2018; Shen and Silva, 2018 – see Section 2). To the best of our knowledge there is no specific empirical evidence on the relationship between wages and GVC position in CEECs. We seek to fill this gap by answering the following research question: does an industry's position in the global value chain significantly affect the wages of workers in CEECs?

To answer this question, in the first instance we utilise the measure of 'upstreamness' or 'downstreamness', i.e. the relative production-line position of an industry, by approximating its average distance from final use. The index constructed by Fally (2011) or, alternatively, that of Antràs et al. (2012), was extended by Fally (2012) with the inclusion of an indicator of average production chain length in GVCs. Additionally, apart from classic offshoring indicators, we consider a novel measure of the global import intensity of production, GII (Timmer et al., 2016), which captures all the stages backward up the production chain.[2] We correlate these industry-level measures of GVC intensity and upstreamness with micro-level data on the wages of workers in ten CEECs in the period 2005-2014.

The structure of our paper is as follows. Section 2 reviews the literature, and Section 3 gives an overview of production fragmentation and GVC indicators computed with sectoral data and describing CEECs' production and export structures. Section 4 reports the estimate of the augmented wage regression and the results, and Section 5 concludes. We find that the wages of CEEC workers are higher when they are employed near the beginning of the chain (high upstream stages) or at the end (relatively far downstream stages – closer to final demand) than in the middle stages. Secondly, wage changes depend on the interplay between upstreamness and GVC intensity. In sectors near final demand an increase in production fragmentation, whether gauged by global import intensity or vertical specialisation, is associated with a wage decline. For higher values of upstreamness, this effect is not sustained. This means that not only the degree of involvement in GVCs but also the position an

[2] The code in R concerning the calculation of GII and elaborated for the purpose of this paper is available for download upon request.

industry occupies in the value chain is a factor in wage determination. Additionally, different measures of production fragmentation may yield different results; thus global import intensity is better at capturing the full GVC dimension.

2. Literature review

The literature on the labour market outcomes of production fragmentation is obviously very abundant (see Feenstra, 2010 or Hummels et al., 2018 for reviews). However, the contributions bearing specifically on Central and Eastern European countries are quite scarce. If anything, CEECs tend to appear in comparative studies of larger groups of European countries, and for the most part in an industry-level setting (e.g. Parteka and Wolszczak-Derlacz, 2015). Polgár and Wörz (2010), for the EU25 countries, found that trade is a more significant determinant of wages in the new than in the old EU member states. Wages in Eastern Europe were found to benefit from trade with the West (in keeping with the long-standing evidence that international outsourcing drove Eastern European wages up in the 1990s – Egger and Egger, 2002), those in Western Europe to be depressed by trade with the East. Parteka and Wolszczak-Derlacz (2015) include ten CEECs in their EU27 sample, documenting large and persistent cross-country differences in wage levels and finding that international outsourcing plays a negligible role in wage equalization in the enlarged EU; however, that article does not explicitly analyse wage trends in the CEECs separately from those in the old EU member states.

The recent literature on the effects of fragmentation on wages has usually adopted the micro-level setting and taken a task-based approach, distinguishing workers according to the degree of job routinisation. Here, country-specific studies dominate. The case of Germany was analysed by Brändle and Koch (2014,) who show that lower wages are positively correlated with the job's offshorability or outsourceability; by Geishecker and Görg (2008), who report a negative relationship between industry-level measures of international outsourcing and wages; and by Baumgarten et al. (2013), who conclude that non-routine job content effectively protects German workers from the wage repercussions of production relocation. Similar conclusions were obtained for the Danish data examined by Hummels et al. (2014), who found that the effects of firm-level offshoring on wages vary with educational levels and tasks, hurting workers with lower skills and more routine jobs.[3] Geishecker and Görg (2013) investigated the effects of service offshoring on wages in the U.K., concluding that the adverse impact concerns low- and medium-skilled workers. Finally, Geishecker et al. (2010) studied the impact of outsourcing on wages in Germany, the U.K. and Denmark, discovering that wage losses due to production fragmentation are typical for low-skilled workers and do not depend greatly on country-

[3] Heterogeneity (in worker skills or job routinisation) of the wage response to offshoring has also been found in many studies using the U.S data (among others Autor et al., 2014; Ebenstein et al., 2014; Kim and Hwang, 2016).

specific labour market institutions. Görg and Görlich (2015), finally, find that there are no systematic differences between temporary and permanent workers with respect to the wage impact of offshoring.

As the introduction notes, the studies explicitly relating GVCs with labour market outcomes have essentially begun to emerge only in recent years. Reijnders and de Vries (2018) offer a task-based model of production in GVCs, proposing to decompose the changes in occupational labour demand (not wages as such) into the effects of technological change, task relocation, and other factors within GVCs. Lopez Gonzalez et al. (2015) focus on the relationship between GVCs and aggregate wage inequality. Parteka and Wolszczak-Derlacz (2018) quantify the wage consequences of increasingly substantial GVC ties using microdata for workers in a good many industries in nine European countries and the United States. The share of foreign value added in output is used as the measure of industries' GVC involvement, and it is found to correlate negatively (albeit weakly) with wage levels. This concords with an earlier work (Parteka and Wolszczak-Derlacz, 2017) in which the adverse wage effect of GVC involvement is found to depend on workers' skill and tasks, affecting mostly workers in routine jobs. The negative correlation between GVC involvement and wages, magnified by degree of routinisation, is further confirmed by Parteka (2018) for the case of Poland.

Some papers (still only a few) have addressed the issue of measuring industries' position in terms of upstreamness/downstreamness on the basis of recent developments (Antras et al., 2012; Wang et al., 2017). Chen (2017) studies firm-level data on domestic value chains in Chinese manufacturing from 2000 to 2007. Wage inequality proves to be greater in upstream than in downstream industries, and in the firms more exposed to trade. However, exporting firms in upstream industries have less wage inequality than their counterparts in downstream industries. Along the same lines, Shen and Silva (2018) analyze the effects of rising value-added trade from China on U.S. labour market outcomes, finding that the effects of intra-GVC trade depend on how far downstream the exporting industry is, i.e. on its position within the GVC. For instance, the increase in U.S. exposure to value-added exports from China in downstream industries leads to negative employment effects. This observation is a powerful argument for our approach of studying wage determinants with a focus on industries' relative position within GVCs.

The evidence on this issue in the new EU member states, essentially the Central and Eastern European countries, is scanty and for the most part not related to labour market-GVC interactions (apart from Hagemejer and Tyrowicz, 2017). Hagemejer and Ghodsi (2017) found that the upstreamness of the exports of the new member states converged with that of the EU15, so that in 2011 it was comparable in the two groups of countries. Hagemejer (2018) analyses the interaction between upstreamness and value added or productivity growth in the EU new member states (1995-2009). His results show that what matters is chiefly the position of exports within the GVC: faster growth was observed for upstream than downstream export sectors, the contrary for non-exporting

sectors. Productivity growth tended to be higher in sectors importing or exporting intermediate goods and positioned further from final demand. Hagemejer and Tyrowicz (2017), using firm-level data from 2000 to 2011, find that GVC position matters for employment levels, job creation and destruction, but with different impacts in different CEECs. In Poland faster employment growth was correlated with greater upstreamness, but the effect of GVC position on job destruction was insignificant. During the global financial crisis, more job creation and less job destruction were observed in activities closer to final demand. Job creation effects were similar in the other countries analysed, but job destruction effects differed: in contrast to Poland, in the Czech Republic, Hungary, and Slovenia job destruction was milder in the sectors closer to final demand. Parteka and Wolszczak-Derlacz (2018) incorporate three CEECs (Czech Republic, Estonia and Slovakia) in their study on the interactions between GVC and wages, but they examine GVC involvement in general, i.e. foreign value added shares, not the relative position of industries within the chain. By their estimates, workers in the EU15 are more in danger of unfavourable wage effects of GVCs than those in the new member states. Indeed, some workers in the new member states - in jobs low in routine and high in abstractness and service tasks – even appear to benefit from greater involvement of their industries in GVCs.

We are not aware of any study that uses micro-level data and explicitly relates industries' relative GVC upstreamness with wage developments in a larger sample of CEECs.

3. Trends in production fragmentation and GVC position in CEECs

Our main focus here is on GVC position, but in order to present a broader picture we also describe some key features of production fragmentation in the CEECs. We consider import-based and export-based indices separately. The former focus on backward participation in GVCs and generally take into account the foreign (imported) inputs used in a given industry. This is the "user" perspective, in contrast to the 'supplier' viewpoint taken in the export-based approach (as in Wang et al., 2013, with its gross trade decomposition).[4] We then shift to the recently proposed index of global import intensity of production (GII) and measures of GVC upstreamness. All the measures in this section are calculated using the World Input-Output Database, WIOD (2016 release data, Timmer et al., 2015) for 56 industries (for the list, see Table A1 in the appendix). Average national values of all the indices and the correlations between them are reported in Table 2A and Table 3A in the appendix.

[4] This particular case is an example of an approach that utilises backward linkages (e.g. foreign value added in exports) as well as forward linkages (e.g. domestic value added in intermediates re-exported to third countries). See explanatory notes to WTO, "Trade in value-added and global value chains: statistical profiles": https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf

3.1 The import-based measure of offshoring versus Global Import Intensity

The classic import-based measure of offshoring utilising sectoral (industry level) data (Feenstra and Hanson, 1999; Hijzen and Swaim, 2007) is the ratio of the value of imported intermediates to the industry's value added (VA) or total output (country subscripts omitted):

$$Off_{it} = \frac{\sum_{k=1}^{N} imp\_inputs_{ikt}}{VA_{it}} \quad (1)$$

where *i, k* are industry indices (*i,k =1,2,…,N*) and imp_inputs_{ikt} denotes the volume of inputs imported from industry *k* to industry *i* in year *t*.

The offshoring measure (1) counts only the imports involved in the last observed stage of production. We draw on recent methodological developments in the field and also present the index of global import intensity (GII) proposed by Timmer et al. (2016) as an alternative indicator of country/sector involvement in GVCs. As they argue, the standard approach, ignoring previous production stages, may well omit a large part of the complex value chain structure. To address this limitation, GII traces the imported inputs at all the previous stages.

The idea of GII is to measure the imports needed along the entire chain, not only one stage previous. The sum of all imports (of intermediate goods and services) along the chain for the final product is called GVC imports. The GII index is defined as GVC imports divided by the value of the final product. In practice, for each country *j* and industry *i* (*i*=1,2,…,N, *j*=1,2,…,C) GII is the sum of the elements of a matrix M_{ij}^{Int} constructed as follows (Timmer et al., 2016, p.11):

$$M_{ij}^{Int} = M_{ij}^{tier1} + M_{ij}^{tier2} + M_{ij}^{tier3} + \cdots = T * (A\bar{z}) + T * (A\overline{Az}) + T * \left(A\overline{A^2 z}\right) + \cdots == T * \left[A\left[\overline{(I-A)^{-1}z}\right]\right] \quad (2)$$

where each $M_{ij}^{tier\,n}$ matrix corresponds to imports at the *n*-th stage of production. A is a matrix of intermediate input requirements of dimensions CNxCN, I stands for the CNxCN identity matrix, $\bar{z}$ is a CN-column vector with 1 for sector *i* in country *j* and 0 elsewhere, and T denotes the 'trade selection' CNxCN matrix, which is needed to cut out domestic transactions. The bar sign denotes diagonalisation, and the asterisk means elementwise multiplication of matrices.[5]

As a ratio of GVC imports to value of final product, GII takes values between 0 and 1, 1 standing for greater fragmentation of production.[6] Timmer et al. (2016) show that greater GII may be caused by a larger number of production stages or by more imported inputs at given stages. Moreover, higher GII means a greater probability that any link between two stages will involve cross-border trade. GII equal to 0 means a purely domestic production process.

[5] The codes in R to compute GII are available upon request. For more detailed explanation of the formulation, as well as the conditions of convergence of summation, see Timmer et al. (2016) and Miller and Blair (2009).

[6] Timmer et al. (2016) notes that there may be cases when GII is greater than 1 – for instance, where imports are measured on a gross basis or when there is some double counting of value added.

In fact, the difference between GII and the index based on imports from first tier suppliers only is an appreciable one. Figure 1 shows the average shares in ten CEECs of first, second, third and fourth tier suppliers' imports in GII across various main industries in 2014. While first tier imports (the classic gauge of offshoring) usually account for a significant share of GII, they do not cover even half of the total GII value. There is a cross-industry variation in GII levels – unsurprisingly, dependence on GVC imports is heavy in manufacturing and related sectors (B-E), while the least fragmentation is found in domestically supplied services like public administration (O) and education (P). However, there are also services heavily dependent on foreign inputs, such as transportation (H) and information and communication (J).

[Figure 1 about here]

Figure 2 illustrates the course of production fragmentation in CEECs between 2000 and 2014 as measured both by the classic offshoring index (eq. 1) and by GII (eq. 2). Following Los et al. (2015), the *OFF* and *GII* data are regressed on dummies for country-of-completion and industry-of-completion (the inclusion of these two sets of dummies isolates year-specific effects) and year dummies. Figure 2 shows the estimated coefficients for the year dummies and the related 95 percent confidence intervals; the dummy for the initial year (2000) has been omitted so all point estimates are shown with respect to 2000. In general, both graphs reflect the upward trend in offshoring intensity (measured by *OFF)* and in GVC involvement (measured by *GII)* in our sample countries from 2002 up until the short-run fall in the year of the global crisis and stagnation after 2010 (in accord with the finding of Timmer at al., 2016, of general, worldwide slowdown in fragmentation in these recent years). It should be noted, however, that year dummies are statistically different from 0 at the 5% level of significance starting in 2005 (in the case of *GII*) or 2006 (*OFF*).

[Figure 2 about here]

3.2 Export based measures of fragmentation

The export based approach is powerful, in that it tracks a broad spectrum of gross trade elements specified by backward and forward industry connections. Wang et al. (2013) introduced a framework that obtains a complete structure of international production sharing where gross exports are divided into four main components. One is domestic value added absorbed abroad (DVA). Another, more interesting from our standpoint, is foreign value added embodied in exports (FVA); this can be understood as value added deriving from imported inputs used in the production of goods or services (intermediate or final) and then re-exported. The third, returned value added (RDV), corresponds to the domestic value added that comes back home after being exported to other countries as an intermediate input. Fourth is the pure double counting component (PDC). Further decompositions are also possible. FVA can be separated into the FVA embodied in final goods exports

and in exports of intermediates (FVA_INT, FVA_FIN). PDC can be divided into PDC from foreign and domestic sources.

Based on the export decomposition, we calculate different measures of cross country-industry production sharing. The first is the share of FVA in gross exports (FVA/EXP). Adding PDC from foreign sources to FVA, we obtain a component called vertical specialisation (VS, or import content), and analogously we construct its share in exports (VS/EXP). As Wang et al. (2013) show, different elements contained in FVA and in VS correspond to different characteristics of country-industry participation in GVCs. Depending on the share of FVA_INT or FVA_FIN components in gross exports, one can approximate a given unit's position in the production line. Where the share of FVA_FIN in export value is large, the unit is closer to final demand. Where the share of FVA_INT in exports is significant, it is farther upstream. Furthermore, as a higher PDC/EXP ratio is associated with more frequent border-crossing of intermediates, this is a good measure of the intensity of cross-country production sharing. Figure 3 shows trends in FVA and VS shares in CEEC exports, plotted analogously to Figure 2. Here too, a statistically significant trend sets in after mid-2000, followed by the brief negative impact of the crisis, an increase in FVA and VS shares after it, followed by the stagnation of fragmentation as measured by export-based indices.

[Figure 3 about here]

3.4 GVC position and length

Recent empirical work on the linkages between production fragmentation and labour market outcomes indicate not only that involvement in production fragmentation is important *per se*, but also that a country or sector's position in the production chain is relevant. In other words, it is important to verify both how long the production chain is and where a given country/industry is within it, i.e. how far from final demand (see Antras et al., 2012; Chen, 2017; Wang et al., 2017; Hagemejer and Ghodsi, 2017; Miller and Temurshoev, 2017). To check the average industry position in GVCs, we use the upstreamness index introduced by Fally (2011) and Antràs et al. (2012). The index is based on forward linkages and describes an industry's average distance from the final stage of production. We treat the world as a single closed economy, which makes it possible to measure the distance from global final demand – the approach proposed by Miller and Temurshoev (2017) and applied by Hagemejer and Ghodsi (2017), among others.

Let d_{ik} be the share of industry *i*'s output used as an intermediate input in industry *k* to produce the gross output of *k*. The gross output of *i* can then be expressed as:

$$Y_i = F_i + \sum_{k=1}^{N} d_{ik} F_k \quad (5)$$

where the output of an industry equals the sum of final goods and of intermediates used as inputs in further production. One can then define $\delta_{ik} = \frac{d_{ik}Y_k}{Y_i}$ equal to the output of *i* used as intermediates by *j*, divided by the output of *i*. The upstreamness of an industry *i* will be given by:

$$u_i = 1 \quad + \sum_{k=1}^{N} \delta_{ik} u_k \tag{6}$$

Fally (2011) and Antràs et al., (2012) interpret this formula as follows: when an industry is selling a significant part of its output to industries that are relatively upstream, then it should be relatively upstream itself. If we were to calculate upstreamness indices for all *N* industries, the matrix form of this system of linear equations would be:

$$UP = (I - \Delta)^{-1} u \tag{7}$$

where matrix Δ contains elements δ_{ik}. The greater the degree of upstreamness, the further the industry is from final demand. A strictly downstream industry (one whose output is the final good) will have an upstreamness index equal to 1

The next index allowing one to approximate the position of an industry in the value chain is GVC length, proposed by Fally (2012). This is an import based measure looking back on the product's production line. Let μ_{ik} be a value of intermediates from industry *k* used to produce one dollar's worth of industry *i* output. The number of stages in the production of the good in industry *i* depends on the length of the production line for the intermediate goods needed. The average number of stages embodied in industry *i's* production is then:

$$L_i = 1 + \sum_k \mu_{ik} L_k \tag{8}$$

This can be expressed in matrix form as:

$$L = (I - M)^{-1} u \tag{9}$$

where vector *L* contains values of (backward) GVC length for every industry,[7] *M* is a matrix of μ_{ik} coefficients and *u* is a summation vector. If a good's production does not involve any previous stages, then the sum equals 0 and the length equals 1.

Upstreamness and GVC length are useful tools insofar as they describe the relative positon of a unit (industry or country) in a production line. Figure 4 shows the average of the values of individual industries, weighted by value added, of upstreamness and GVC length in CEECs in 2014. By relative position in the chain (chart A), the Czech Republic is furthest upstream in respect to final demand, Lithuania the furthest downstream. By length (chart B), Poland, the Czech Republic and Romania are characterised by longer chains than the other CEECs.

[Figure 4 about here]

Figure 5 plots how countries' average positions within GVCs changed between 2000 and 2014. All the CEECs became more upstream (the biggest change was in Bulgaria), while the average length of

[7] The country indices are omitted here for convenience, but in fact 'industry' is tantamount to 'country-industry,' as we calculate GVC length on the basis of world input-output tables.

GVCs increased only in Romania and Poland (by 20%), which indicates that the production typical of GVCs in these countries involves more stages. At the other extreme we find Slovakia, where the average number of production stages decreased by 20%.

[Figure 5 about here]

4. The response of wages in Central and Eastern Europe to international production fragmentation

4.1 The data

The micro data are drawn from the EU-SILC database (Statistics on Income and Living Conditions), available from Eurostat.[8] We combine individual files (personal data and personal register) with household information (household data and household register) using year, country, individual ID and household ID as matching variables.[9] We use cross-sectional data (longitudinal files lack some variables that are crucial for data merger, such as the sector of employment used to match microdata with sector-level indices of fragmentation). The analysis covers pooled waves of EU-SILC data for 2005-2014 in ten Central and Eastern European countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

We calculate gross hourly wages from gross annual employee income,[10] number of months worked during the year, and number of weekly hours in the main job, assuming 4.2 weeks per working month.[11] Wages are in euros (EUR, exchange rates from EU-SILC) and are in real terms, deflated by the HICP (2015 = 100) from Eurostat.

EU SILC is also the source for other individual characteristics that play a role in determining wages, namely sex, age, marital status, education (the highest ISCED level attained, reclassifed into status groups: high, or level 6, 7 or 8, and medium-low, level 0 to 4), and work experience (the number of years spent in paid work). The job characteristics considered are: company size (small for fewer than 11 employees, medium for 11-49, large for 50 or more), type of contract (permanent or temporary, including fixed-term), managerial position (if there are supervisory duties), sector (NACE Rev.2).

[8] Access to Eurostat microdata (including EU-SILC) is granted to researchers under confidentiality rules. This study draws on EUSILC UDB 2015 – version 1 of August 2016 (the documentation can be found at: http://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions). The authors alone are responsible for the conclusions drawn from the data.

[9] To convert the original EU-SILC data into a format suitable for our analysis, we used tools and routines from GESIS (http://www.gesis.org/en/services/data-analysis/official-microdata/european-microdata/eu-silc/).

[10] This variable corresponds to gross cash or near cash income (monetary compensation payable by an employer to an employee), i.e.: wages and salaries paid in cash for time worked or work done, holiday payments, payments for overtime, and additional payments (thirteenth month, productivity pay, commissions, tips, gratuities). 'Gross' means neither taxes nor social contributions are deducted.

[11] Poland, Hungary and Bulgaria provide data on monthly gross earnings and number of hours worked per week, from which gross hourly wages can be calculated (as in Schäfer and Gottschall, 2015). The correlation between gross hourly wages calculated from annual income and from monthly earnings is high (0.78), meaning that these calculations of wages are good proxies of salaries.

Summary descriptive statistics of crucial micro-level variables for our sample are reported in Table 4A in the appendix.[12]

We also have data on individuals' occupations (2 digit ISCO-88 classification through 2011, ISCO-08 afterwards), which we map with country-specific indices of Routine Task Intensity (RTI), which reflect differences in routinisation between occupations but also between countries (Hardy et al., 2018a).[13] The higher the index, the more routine the job.

In our sample we retain only full time workers aged 18-65 for whom we have the data needed to compute hourly wages plus the information on occupation and sector. We exclude military personnel. To eliminate outliers and extreme values, we set a cut-off at 1/100 of the country-specific mean wage and set any wages higher than ten times the national median to that value. The trimming is performed separately for each year and each country.

The average wage in our sample of CEEC workers in 2014 was €3.79 an hour. Obviously, this average value conceals cross-country differences as well as wage differentials between different groups of workers in each country. Therefore in Figure 6 we report the country-specific average hourly wages of workers characterised by different levels of education. On average, the highest wages in 2014 are reported for workers in Slovenia (€7.30 an hour for workers with low and medium education, €8.65 for those with tertiary education) and the lowest for Romania (€1.71 and €2.76 an hour, respectively). Unsurprisingly, in all countries better educated workers earn more than the less well educated.

[Figure 6 about here]

4.2 Model specification

Our empirical analysis is directed to determining whether wages in CEECs depend on an industry's position within a GVC, once the other factors in wage determination are accounted for. To this end we merge micro-level data on workers' characteristics with the industry-level upstreamness indicator (*UP*) for the sector in which the worker is employed. We use this combined dataset to estimate the basic model of the following form:[14]

$$\ln wage_{ijct} = \alpha + \beta X_{it} + \gamma Prod_{jct} + \theta UP_{jct-1} + \vartheta UP^2_{jct-1} + D_t + D_j + D_c + \varepsilon_{ijct} \qquad (10)$$

where *i* denotes workers; *j,* sector (industry) of employment; *c,* country; and *t,* time. We regress the log of the gross hourly wage (ln*wage*) on a set of demographic and job characteristics *X* (sex, age, age^2,

[12] The average worker in our sample is 41.5 years old with 18.7 years of work experience; 73% have medium or low education and 22% completed tertiary education. Over 60% are married; 91% have a permanent contact, 15% hold a supervisory position. The distribution of workers by company size is: 22% in small, 33% in medium-sized and 42% in large firms. See Table 4A in the appendix.

[13] The authors thank Piotr Lewandowski (IBS Warsaw) for sharing country-specific RTI indices (described in Hardy et al., 2018a), available for 42 countries that participated in PIAAC, STEP, and CULS surveys. For those CEECs for which RTI is not available, we use the values of the most similar country (in terms of economic development, location, and size); specifically, for Bulgaria, Hungary and Romania we used the Polish RTI, for Latvia the Lithuanian.

[14] A similar empirical strategy was followed by Baumgarten et al. (2013), Geishecker et al. (2010), and Parteka and Wolszczak-Derlacz (2016), merging micro-level data on labour market outcomes with sector-level statistics on production fragmentation.

marital status, education, RTI , company size, contract type, managerial position). Industry-level covariates are productivity (*Prod*), measured as value added per hour worked, and the industry's relative upstreamness *(UP*). Given possible nonlinearities (the so-called 'smile curve', discussed thoroughly in IBRD/World Bank, 2017) we introduce UP^2 and apply lagged values of *UP* and UP^2 to capture the interval required for wage effects to materialise. This can also solve the potential problem of endogeneity. We argue that this procedure, unlike that of measuring wages at a more highly aggregated – say, sectoral – level, is most unlikely to produce a situation in which the wage of an individual worker can influence the decision of an entire industry concerning production fragmentation or GVC involvement. The marginal effect of *UP* on wages is $\frac{\delta lnwage}{\delta UP} = \theta + 2\vartheta$. The model also incorporates time effects D_t (controlling for time-specific economic fluctuations, i.e. the crisis of 2008/2009); industry dummies D_j (allowing for all the remaining industry-specific characteristics or wage regulations); and country dummies D_c (picking up all country-specific labour market conditions and wage-setting mechanisms).[15]

The model is developed further. In addition to the information on the relative position of a given sector in the production chain (*UP*), we consider a variable for the intensity of the sector's involvement in global value chains (*GVC*). The effect of *GVC* on wages can vary with upstreamness (that is, it can differ between particular parts of the value chain), so in the augmented regression we consider interactions between *GVC* and *UP (UP²*):

$$ln\text{wage}_{ijct} = \alpha + \beta X_{it} + \gamma Prod_{jct} + \theta UP_{jct-1} + \vartheta UP^2_{jct-1} + \mu GVC_{jct-1} + \\ +\rho GVC_{jct-1} \times UP_{jct-1} + +\sigma GVC_{jct-1} \times UP^2_{jct-1} + D_t + D_j + D_c + \varepsilon_{ijct} \quad (11)$$

and, alternatively, between *GVC* and chain length (*L*):

$$ln\text{wage}_{ijct} = \alpha + \beta X_{it} + \gamma Prod_{jct} + \theta L_{jct-1} + \vartheta L^2_{jct-1} + \mu GVC_{jct-1} + \\ +\rho GVC_{jct-1} \times L_{jct-1} + +\sigma GVC_{jct-1} \times L^2_{jct-1} + D_t + D_j + D_c + \varepsilon_{ijct} \quad (12)$$

These models are more complicated and interpreting them may seem cumbersome, but they do allow a better understanding of the complex process of production fragmentation and its impact on wages. In (11) the effect of *GVC* on wages varies with the values of *UP*, and the marginal effect of *GVC* on wages is equal to: $\frac{\delta lnwage}{\delta GVC} = \mu + \rho UP + \sigma UP^2$ while in (12) the variable's effect on wages varies with the value of *L* (marginal effect: $\frac{\delta lnwage}{\delta GVC} = \mu + \rho L + \sigma L^2$).

[15] Our robustness checks consider additional characteristics of labour market institutions that vary from country to country.

4.3 The results

The estimation results for models (10) and (11) are reported in Table 1. The estimates use weighted regression (with normalised weights[16] calculated on the basis of personal weights provided by EU-SILC) and robust standard errors clustered at country-sector level. Every one of the individual characteristics is statistically significant and has the expected sign: on average male, older, married, highly educated workers earn more than their opposite categories. We have the information on job routinisation, and the coefficient of *RTI* is highly significant: the more routine the job, the lower the wage.

We are especially interested in the coefficients of our measures of international production fragmentation and GVC position. In the first column of Table 1 (corresponding to eq. 10) the wage regression is augmented by the upstreamness measure and its square. We confirm the smile curve illustrated in Figure 7, which plots predicted wages (vertical axis) as a function of *UP*. The wages of CEEC workers are higher at the beginning of the chain (high *UP*) and at the end, closer to final demand (low *UP*) than in the middle. The lowest wages are paid in sectors with *UP* around 2 (the mean).

Columns 2-9 of Table 1 correspond to eq. 11; they show the results from augmented model specifications where *UP* is interacted with alternative measures of GVC participation. In specifications (2) and (3) the regression is augmented by the traditional offshoring measure (*OFF*); in specifications (4) and (5), by global import intensity of production (*GII*), and in (6)-(9), by export-based fragmentation measures, namely share of foreign value added in exports (*FVA/EXP*) and vertical specialisation, also expressed as share in total exports (*VS/EXP*).

The non-linear effect of *UP* on wages always stands confirmed. When measures of *GVC* are introduced without interactions with *UP*, they are not among the statistically significant determinants of wages in our sample countries. Nor do we find a statistically significant correlation of the traditional offshoring measure (*OFF*) with wages (column 3). However, taking the interactions of the input-output measure of *GVC* with upstreamness (UP) alters the situation. When production fragmentation is measured by *GII* (thus counting not only the last stage of production but also all the previous tiers), the coefficients for *GII* and for its interaction with *UP* and UP^2 are statistically significant (columns 4 and 5). For export based measures, the results are not so strong: *FVA /EXP* is not related to wages (columns 6 and 7), and for *VS/EXP* we find statistically significant results only for conditional coefficients (column 9).

[Table 1 about here]

[Figure 7 about here]

[16] We use the original country-specific personal cross-sectional weights provided by EU-SILC to calculate normalised weights that always sum to 10,000 within each country. We thank Piotr Paradowski from the Luxembourg Income Study (LIS) for giving us the STATA codes.

Since the augmented model comprises different interaction terms, to assess the impact of *GVC* on wages one must calculate the marginal conditional effects. Accordingly we present marginal plots (Figure 8) and contour plots (Figure 9), which show how the wage level changes depending on the interplay between upstreamness and *GVC* intensity (four different measures of fragmentation). For sectors near final demand (*UP*=1), greater production fragmentation, measured either by *GII* or *VS/EXP*, is associated with lower wages. For higher values of *UP,* this effect is not sustained. This is confirmed by the contour plots: the highest wages (darkest colour) are found in sectors with low upstreamness (near final demand) and relatively little fragmentation.

[Figure 8 about here]

[Figure 9 about here]

In a series of analogous estimations the explanatory variable hypothesised is *L* (the length of the production chain) rather than *UP*. In the basic regressions (without interactions), the nonlinearities are not confirmed – indeed neither length nor *GVC* measures are statistically significantly correlated with individual wages (columns 1, 3, 5 and 7 of Table 2). However, the estimates for the interaction terms indicate that the effect of *GVC* on wages varies with the length *L*. In order to interpret these results, we show the predicted values of wages for different values of *GVC* at given *L* (Figure 10 and Figure 11). For short and long chains, an increase in fragmentation is associated with declining wages, but for chains of average length it is associated higher wages. These results do not conflict with those obtained on the basis of upstreamness: recall that chain length refers to the number of previous stages of production.

[Table 2 about here]

[Figure 10 about here]

[Figure 11 about here]

4.4 Extensions and robustness checks

[The detailed results corresponding to this section are available as supplementary materials: Tables SM 1-SM 26]

The basic estimations presented to this point do not take account of differing national labour market arrangements that could influence the wage impact of production fragmentation. The basic specification can now be augmented with information on various aspects of labour market institutions. The information comes from ICTWSS: Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (Visser, 2016). First we add information on coordination in wage setting (*Coord*), in which our sample countries differ. For example, only in Romania is the coordination of wage-setting based on centralized bargaining (*Coord*=4); in the other

countries wage bargaining is fragmented, either confined largely to individual firms (*Coord*=1: Lithuania, Latvia, and Poland for the entire sample period, Estonia since 2009) or mixed industry and firm-level (*Coord*=2: Czech Republic and Slovenia until 2009). We also have information on minimum wages (*MW*), a variable that ranges from 0 (no statutory minimum wage) to 8 (minimum wage set by government). In all our countries there is a minimum wage, but the mechanism differs. For example, in Estonia a national minimum wage is set by agreement (*MW*=3), in Hungary it is set through tripartite negotiations (*MW*=4). For most of the sample countries *MW* is set by government, which is either bound by fixed rules (Slovenia) or not (Czech Republic, Slovakia, Lithuania (since 2008), Latvia (since 2009), Poland (since 2010) and Romania for 2007). We also consider the sectoral organization of employment relations (*SECTOR*) which are characterized as weak for Bulgaria, Czech Republic, Estonia, Lithuania and Latvia (*SECTOR*=0) and medium for Hungary, Poland, Romania and Slovakia (*SECTOR*=1), while strong institutions (both employers and unions, some joint institutions) are found only in Slovenia (*SECTOR*=2). Trade unions do not negotiate sector agreements (*Unagr*) in Estonia, Lithuania and Latvia (*Unagr*=0); in the rest of the sample countries unions negotiate agreements at sector level, allowing enterprise or company branches to vary within limits (*Unagr*=1). Finally, the labour market institutions may provide for works councils and employee representation in the enterprise (*WC*). In all our countries work councils exist; in Estonia, Hungary, Poland, Slovenia and Slovakia they are mandated by law or established through basic collective bargaining agreements between unions and employers (*WC*=2), while in the rest they are voluntary (*WC*=1).

Adding in the foregoing labour market institutional variables, the results show their importance for the wages of individual workers in the more highly regulated countries (where wage coordination relies on centralised bargaining, the minimum wage is set by government, sectoral institutions are of at least medium strength, and works councils are mandatory). In these countries wages are higher, on average: see Tables SM1-SM5 and SM10-SM14. Where the chief mechanism is decentralised bargaining, individual wages are lower. However, adding these additional labour market variables does not alter our main conclusion on the effect of production fragmentation along GVCs.

Another extension involves adding other country- or sector-specific variables (Tables SM6-SM9 and Tables SM15-SM18). Here we find, for instance, that wages in more open countries are generally lower (with negative and significant coefficients for the ratios of both exports and imports to GDP), while more export-intensive sectors are characterized instead by higher individual wages. Again, as in previous examples, these additional variables do not change the conclusion concerning *GVC*.

In addition, we analyse sector heterogeneity more thoroughly. First we repeat the estimation for workers in manufacturing and non-manufacturing industries separately. In Table 3 we show the results for *GII* and *VS/EXP* (the results with other GVC measures are available in the supplementary materials), confirming that the wage effect of GVC position materialises mainly for workers in

manufacturing (larger *UP* and higher *GVC* coefficients). For non-manufacturing industries, however, the nonlinear relationship between wages and upstreamness is sustained. In the regressions with interaction between *GVC* and *L* the differences between manufacturing and non-manufacturing industries are less pronounced. To make sure our results are not driven by some specific industry, we run the estimation eliminating one industry at a time, finding no evidence of significant effects of any single sector (Tables SM21 and SM22 in supplementary materials).

[Table 3 about here]

Next, we split the measures of production fragmentation by source country: either high income or medium/low income. Tables 4 and 5 present the results. The effect differs depending on whether the measure of fragmentation is import-based or export-based. For offshoring measures and *GII*, the negative effect of *GVC* on wages materialises mainly when the fragmentation is between CEECs and medium/low income countries. For export-based measures, the picture is different: here the coefficients of *FVA/EXP* and *VS/EXP* are higher (in absolute terms) for high income countries.

[Table 4 about here]

[Table 5 about here]

Our final sensitivity checks involve including additional firm level variables (Tables SM25 and SM26) and making sure the results are not driven by any specific country (eliminating one country at a time, Tables SM23 and SM24). Again the main results stand confirmed. The impact of *GVC* on wages depends on the position of a given sector in the value chain.

5. Conclusions

This paper contributes to the literature by examining the relationship between industries' upstreamness (relative position in global value chains) and wages in ten Central and Eastern European countries in the period 2005-2014. The previous empirical literature on GVC-labour market interactions had not analysed this set of countries thoroughly, despite their increasing involvement in global production networks and the presumed labour market impact.

Specifically, we combined recently elaborated GVC measures of sector-level global import intensity of production, upstreamness and production chain length (computed with WIOD data) with EU-SILC micro-data on workers. We also compared the results with those obtained using 'classic' indices of offshoring. We built a rich database with over half a million observations, merging micro-level wage data variables, a set of individual wage determinants in the spirit of Mincer, with industry-level measures of GVC participation and industries' relative position in the chain. This allowed complete assessment of the wage response to recent developments in international production fragmentation in CEECs.

The essential conclusion is that the wages of CEEC workers are higher when their industry is at the beginning of the production chain (high upstreamness) or at the end (low upstreamness, close to final demand) than in the middle. Second, wage changes depend on the interplay between upstreamness and GVC intensity. For sectors that are near the final demand, an increase in production fragmentation, measured either by global import intensity or by vertical specialisation, is associated with a decline in wages. For those farther upstream, this effect is not observed.

Direct comparison with other studies is difficult, because the latter typically focus on the wage effects of classically measured offshoring, not GVC, or else use industry rather than individual wage data. Parteka and Wolszczak-Derlacz (2018), in an analysis based on observations for 110,000 workers in nine Eastern and Western European countries and the United States, found that it is hard to attribute lower wages to the involvement of countries or industries in global value chains. However, that work does not consider the possible effect of the particular position of industries in the chain and the 'smile curve,' as we do in this paper. We have thus extended the empirical setting, demonstrating that at least in our sample of Central and Eastern European countries, the interaction between GVC intensity and position within the production chain is important. In our view, this analysis represents a significant step forward, enriching the literature on the GVC-wage nexus.

References

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H., and Price, B. (2016). Import Competition and the Great U.S. Employment Sag of the 2000s. *Journal of Labor Economics*, 34(S1), S141–S198.

Amador, J., and Cabral, S. (2016). Global value chains: A survey of drivers and measures. *Journal of Economic Surveys*, *30*(2), 278–301

Antràs, P., Chor, D., Fally, T., and Hillberry, R. (2012). Measuring the Upstreamness of Production and Trade Flows. *American Economic Review*, *102*(3), 412–416.

Autor, D. H., Dorn, D., Hanson, G. H., and Song, J. (2014). Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, *129*(4), 1799-1860.

Baldwin, R., Venables, A. J., and Bridgman, B. (2012). Global supply chains: Why they emerged, why they matter, and where they are going. *Journal of International Economics*, *90*(1), 245–254.

Baumgarten, D., Geishecker, I., and Görg, H. (2013). Offshoring, tasks, and the skill-wage pattern. *European Economic Review*, 61, 132–152.

Bound, J., and Johnson, G. (1992). Changes in the structure of wages in the 1980's: an evaluation of alternative explanations. *The American Economic Review*, *82*(3), 371-392.

Brändle, T., and Koch, A. (2015). Offshorability and wages. Evidence from German task data. *Economia e Politica Industriale*, 42(2), 189–216.

Chen, B. (2017). Upstreamness, exports, and wage inequality: Evidence from Chinese manufacturing data. *Journal of Asian Economics*, *48*, 66-74.

Crinò, R. (2010). The effects of offshoring on post-displacement wages: Evidence from the United States. *World Economy*, *33*(12), 1836–1869

Ebenstein, A., Harrison, A., McMillan, M., and Phillips, S. (2014). Estimating the Impact of Trade and Offshoring on American Workers using the Current Population Surveys. *Review of Economics and Statistics*, 96(4), 581–595.

Egger, H., and Egger, P. (2002). How international outsourcing drives up Eastern European wages. *Weltwirtschaftliches Archiv*, 138(1), 83-96.

Fally, T. (2011). On the fragmentation of production in the US. *University of Colorado-Boulder*, mimeo.

Fally, T. (2012). Production Staging: Measurement and Facts. *University of Colorado-Boulder*. mimeo.Feenstra RC (2010) *Offshoring in the global economy: microeconomic structure and macroeconomic implications*. MA, MIT Press, Cambridge

Feenstra, R. C. (2017). Statistics to Measure Offshoring and its Impact . NBER Working Paper No. 23067. National Bureau of Economic Research.

Feenstra, R. C., and Hanson, G. H. (1999). The Impact of Outsourcing and High-Technology Capital on Wages: Estimates For the United States, 1979-1990. *The Quarterly Journal of Economics*, *114*(3), 907–940.

Freeman, R. B. (1995). Are your wages set in Beijing?. *Journal of Economic perspectives*, *9*(3), 15-32.

Geishecker, I., and Görg, H. (2008). Winners and losers: a micro-level analysis of international outsourcing and wages. *Canadian Journal of Economics*, 41(1), 243–270.

Geishecker, I., and Görg, H. (2013). Services offshoring and wages: evidence from micro data. *Oxford Economic Papers*, 65(1), 124–146.

Geishecker, I., Görg, H., and Munch, J. R. (2010). Do labour market institutions matter? Micro-level wage effects of international outsourcing in three European countries. *Review of World Economics,* 146(1), 179–198.

IBRD/World Bank (2017). *Global Value Chain Development Report 2017. Measuring and analyzing the impact of* GVC*s on economic development*. International Bank for Reconstruction and Development/The World Bank.

Görg, H., and Görlich, D. (2015). Offshoring, wages and job security of temporary workers. *Review of World Economics*, 151(3), 533–554.

Grossman G.M., Rossi-Hansberg E. (2008). Trading Tasks: A Simple Theory of Offshoring, *American Economic Review* 98:5, 1978–1997

Hagemejer, J. (2018). Trade and Growth in the New Member States: The Role of Global Value Chains. *Emerging Markets Finance and Trade*, *54*(11), 2630-2649.

Hagemejer, J., and Ghodsi, M. (2017). Up or Down the Value Chain? A Comparative Analysis of the GVC Position of the Economies of the New EU Member States. *Central European Economic Journal*, *1*

Hagemejer, J., and Tyrowicz, J. (2017). Upstreamness of Employment and Global Financial Crisis in Poland: The Role of Position in Global Value Chains. In: Havlik P., Iwasaki I. (eds) *Economics of European Crises and Emerging Markets*. Palgrave, Singapore. 217-236.

Hardy, W., Lewandowski, P., Park, A., Yang, D. (2018). The global distribution of routine and non-routine work. findings from PIAAC, STEP and CULS. IBS Working Paper 05/2018.

Harrison, A., and McMillan, M. (2011). Offshoring Jobs? Multinationals and U.S. Manufacturing Employment. *The Review of Economics and Statistics*, *93*(3), 857–875.

Hijzen, A., and Swaim, P. (2007). Does offshoring reduce industry employment? *National Institute Economic Review*, *201*(1), 86-96

Hummels, D., Jorgensen, R., Munch, J., and Xiang, C. (2014). The wage effects of offshoring: Evidence from Danish matched worker-firm data. *American Economic Review*, *104*(6), 1597 1629.

Hummels, D., Munch, J. R., and Xiang, C. (2018). Offshoring and labor markets. *Journal of Economic Literature*, *56*(3), 981-1028.

Johnson, R. C. (2014). Five Facts about Value-Added Exports and Implications for Macroeconomics and Trade Research. *Journal of Economic Perspectives*, *28*(2), 119–142

Kim, S., and Hwang, J. (2016). Offshoring, wages, and heterogeneity. *Japan and the World Economy*, 37–38, 65–72.

Koopman, R., Wang, Z., and Wei, S. J. (2014). Tracing value-added and double counting in gross exports. *American Economic Review*, *104*(2), 459-94.

Lopez Gonzalez, J., Kowalski, P., and Achard, P. (2015). Trade, global value chains and wage-income inequality . OECD Trade Policy Papers No. 182. OECD Publishing.

Los, B., Timmer, M. P., and de Vries, G. J. (2015). How global are global value chains? A new approach to measure international fragmentation. *Journal of Regional Science*, *55*(1), 66-92.

Michel, B., and Rycx, F. (2012). Does offshoring of materials and business services affect employment? Evidence from a small open economy. *Applied Economics*, *44*(2), 229–251

Miller, R. E., and Blair, P. D. (2009). Input-output analysis : foundations and extensions. *Cambridge University Press.*

Miller, R. E., and Temurshoev, U. (2017). Output Upstreamness and Input Downstreamness of Industries/Countries in World Production. *International Regional Science Review*, *40*(5), 443–475.

Parteka, A. (2018). Import Intensity of Production, Tasks and Wages: Micro-Level Evidence for Poland. *Entrepreneurial Business and Economics Review*, 6(2), 71–89.

Parteka, A., and Wolszczak-Derlacz, J. (2017). Workers, Firms and Task Heterogeneity in International Trade Analysis: An Example of Wage Effects of Trade Within GVC. *Entrepreneurial Business and Economics Review*, 5(2), 9–25.

Parteka, A., and Wolszczak-Derlacz, J. (2018). Global Value Chains and wages: multi-country evidence from linked worker-industry data . *Open Economies Review*. https://doi.org/10.1007/s11079-018-9518-8

Parteka, A., and Wolszczak-Derlacz, J. (2015). Integrated sectors - diversified earnings: the (missing) impact of offshoring on wages and wage convergence in the EU27. *Journal of Economic Inequality*, *13*(3), 325–350.

Polgár, É. K., and Wörz, J. (2010). No risk and some fun? Trade and wages in the enlarged European Union. *Empirica*, 37(2), 127–163.

Reijnders, L. S., and de Vries, G. J. (2018). Technology, offshoring and the rise of non-routine jobs. *Journal of Development Economics*, *135*, 412-432.

Sethupathy, G. (2013). Offshoring, wages, and employment: Theory and evidence. *European Economic Review*, 62, 73–97.

Schäfer. A.. and Gottschall. K. (2015). From wage regulation to wage gap: how wage-setting institutions and structures shape the gender wage gap across three industries in 24 European countries and Germany. *Cambridge Journal of Economics*. 39(2). 467-496

Shen, L., and Silva, P. (2018). Value-added exports and US local labor markets: Does China really matter?. *European Economic Review*, *101*, 479-504.

Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R., and de Vries, G. J. (2015). An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production. *Review of International Economics*, *23*(3), 575–605.

Timmer, M. P., Erumban, A. A., Los, B., Stehrer, R., and de Vries, G. J. (2014). Slicing up global value chains. *Journal of Economic Perspectives*, *28*(2), 99-118.

Timmer, M. P., Los, B., Stehrer, R., and de Vries, G. J. (2016). An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release. *GGDC Research Memorandum*.

Visser, J. (2016) ICTWSS Data base. version 5.1. Amsterdam: Amsterdam Institute for Advanced Labour Studies (AIAS), University of Amsterdam.

Wang, Z., Wei, S. J., Yu, X., and Zhu, K. (2017). Characterizing global value chains: Production length and upstreamness. *NBER Working Paper* 23261. National Bureau of Economic Research, Cambridge, MA.

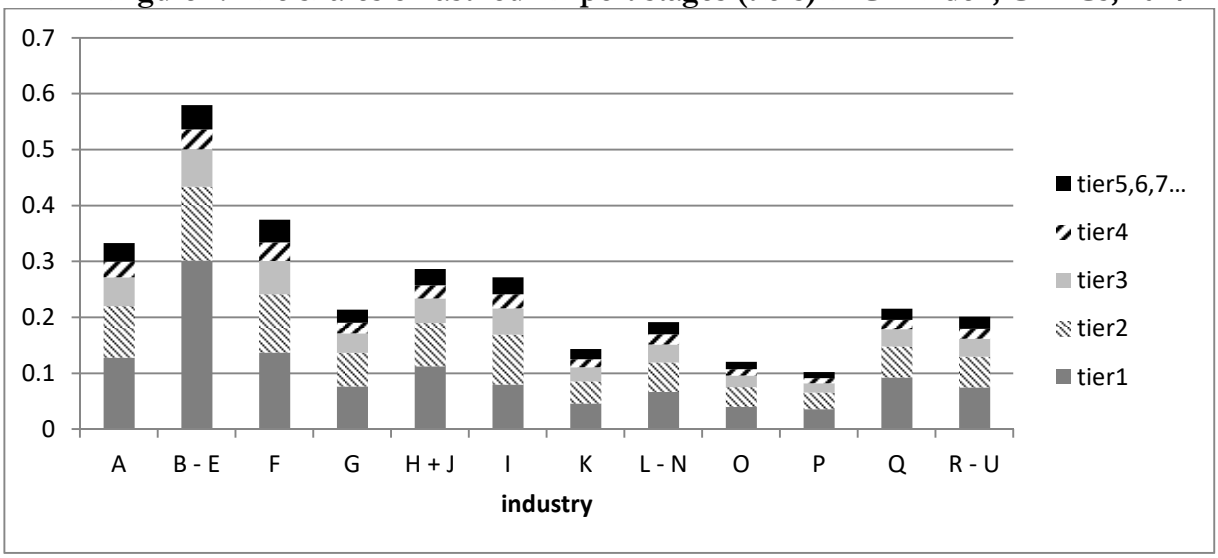
Wang, Z., Wei, S.-J., and Zhu, K. (2013). Quantifying International Production Sharing at the Bilateral and Sector Levels. *NBER Working Paper* 19677. National Bureau of Economic Research, Cambridge, MA.

Wolszczak-Derlacz, J., and Parteka, A. (2018). The effects of offshoring to low-wage countries on domestic wages – a worldwide industrial analysis. *Empirica*, 45: 129-163.

Wright G.C. (2014) Revisiting the employment impact of offshoring, *European Economic Review* 66: 63-83.

Tables and Figures

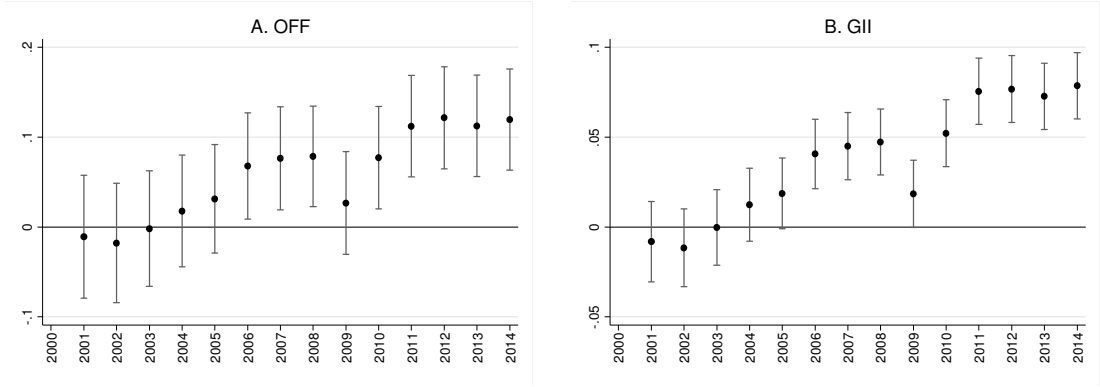
Figure 1. The shares of last four import stages (tiers) in GII index, CEECs, 2014



Notes: mean values over countries, observations weighted by value added. The list of industries in Appendix A1. Sample: 10 CEECs

Source: own elaboration based on WIOD (2016)

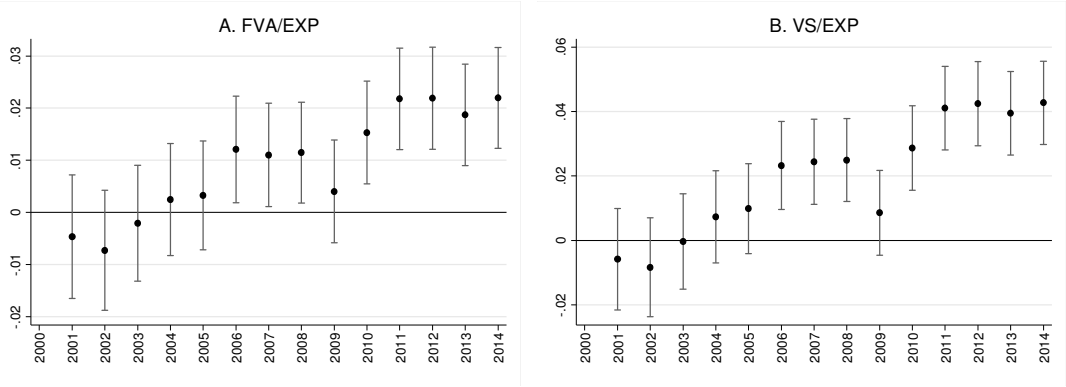
Figure 2. Trends in offshoring (*OFF*) and GVC involvement (*GII*) in CEECs, 2000-2014



Notes: The figures show estimated coefficients on year dummies (with respect to base year 2000) – point estimate plus and 95 percent confidence interval, based on regression of *OFF* (*GII*) on year dummies, country-of-completion dummies, and industry-of-completion dummies. The observations were weighted by the value added of industry of completion. Sample: 10 CEECs.

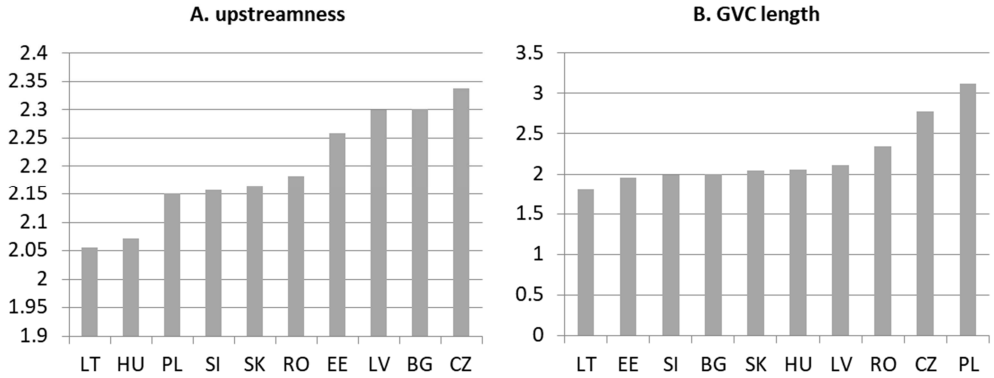
Source: own elaboration based on WIOD (2016). The codes have been adopted from the replication files provided for the paper Los et al. (2015), Figure 3.

Figure 3. Trends in FVA and VS shares of exports, CEECs, 2000-2014



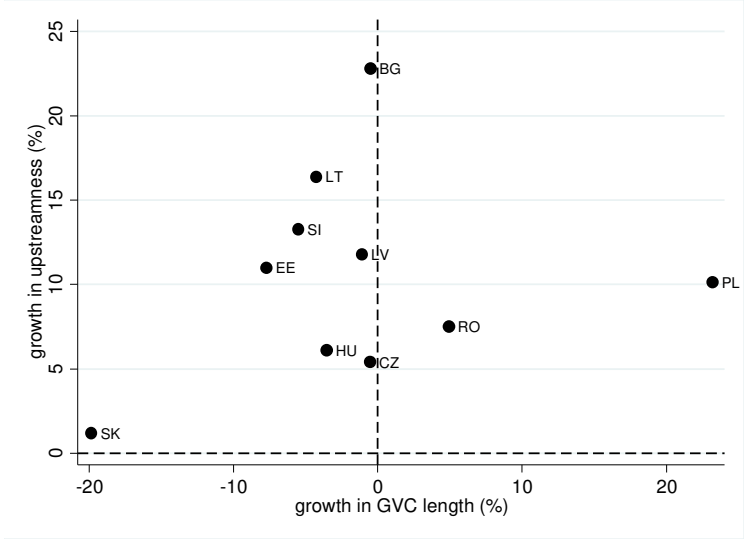
Notes: as under Figure 2.
Source: own elaboration based on WIOD (2016). The codes have been adopted from the replication files provided for the paper Los et al. (2015), Figure 3.

Figure 4. Upstreamness and GVC length, CEECs, 2014



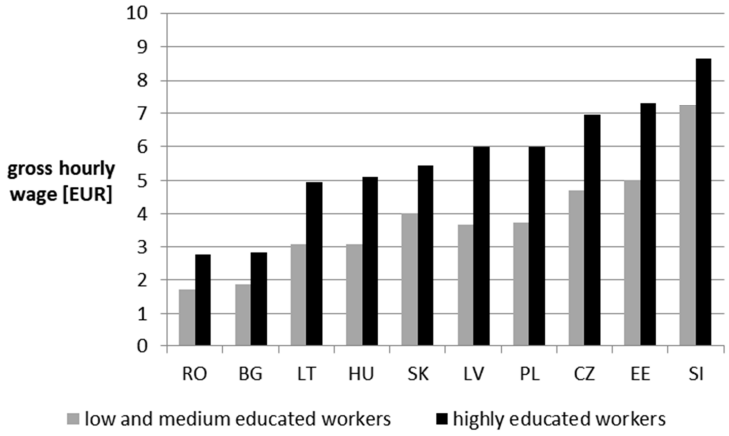
Notes: mean values over industries, observations weighted by industry value added.
Source: own elaboration based on WIOD (2016)

Figure 5. Changes in relative positon in GVC of CEECs between 2000 and 2014



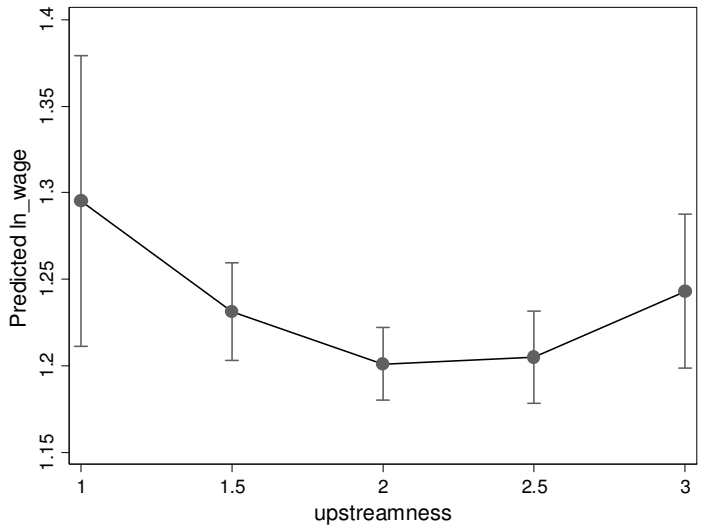
Notes: mean values over industries, observations weighted by industry value added. Changes calculated as a percentage growth in the indicator between 2000 and 2014.
Source: own elaboration based on WIOD (2016)

Figure 6. Gross hourly wages in CEECs, workers with different education levels, 2014



Note: observations weighted by personal cross-sectional weights
Source: own elaboration based on EU-SILC

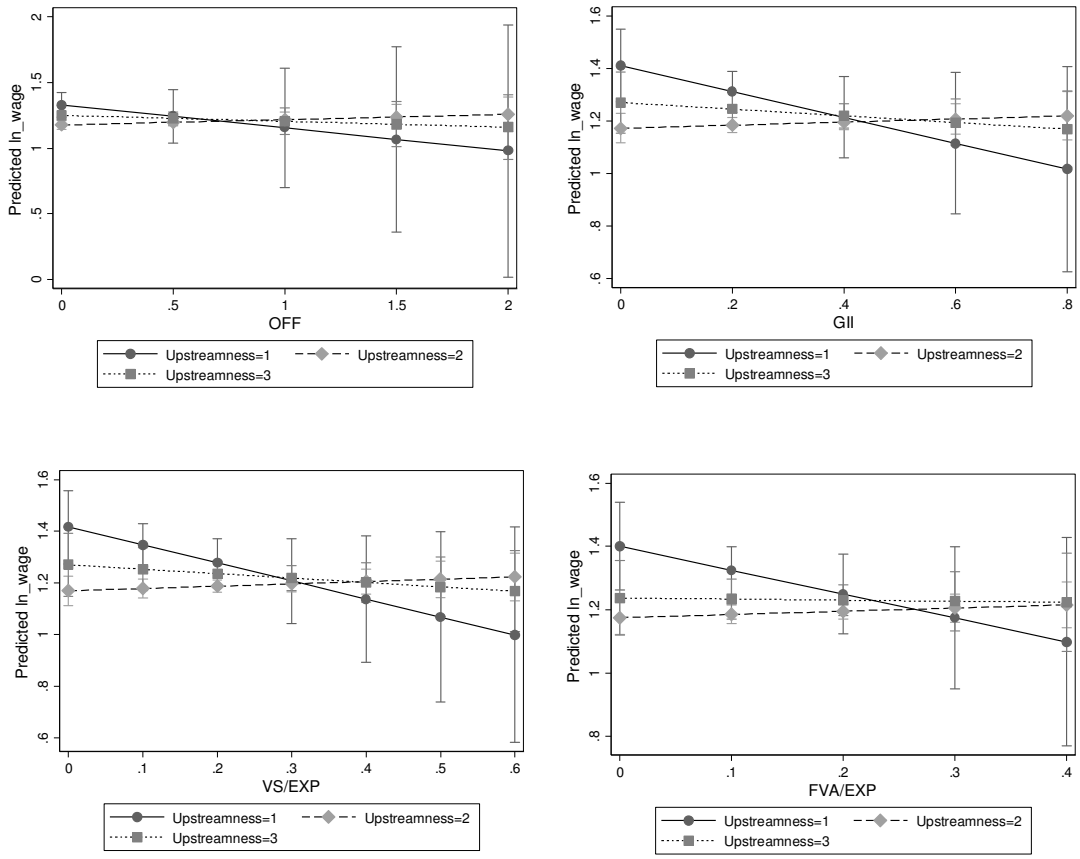
Figure 7. "Smile curve" - wages along the GVC



Note: Sample of 10 CEECs (2005-2014)

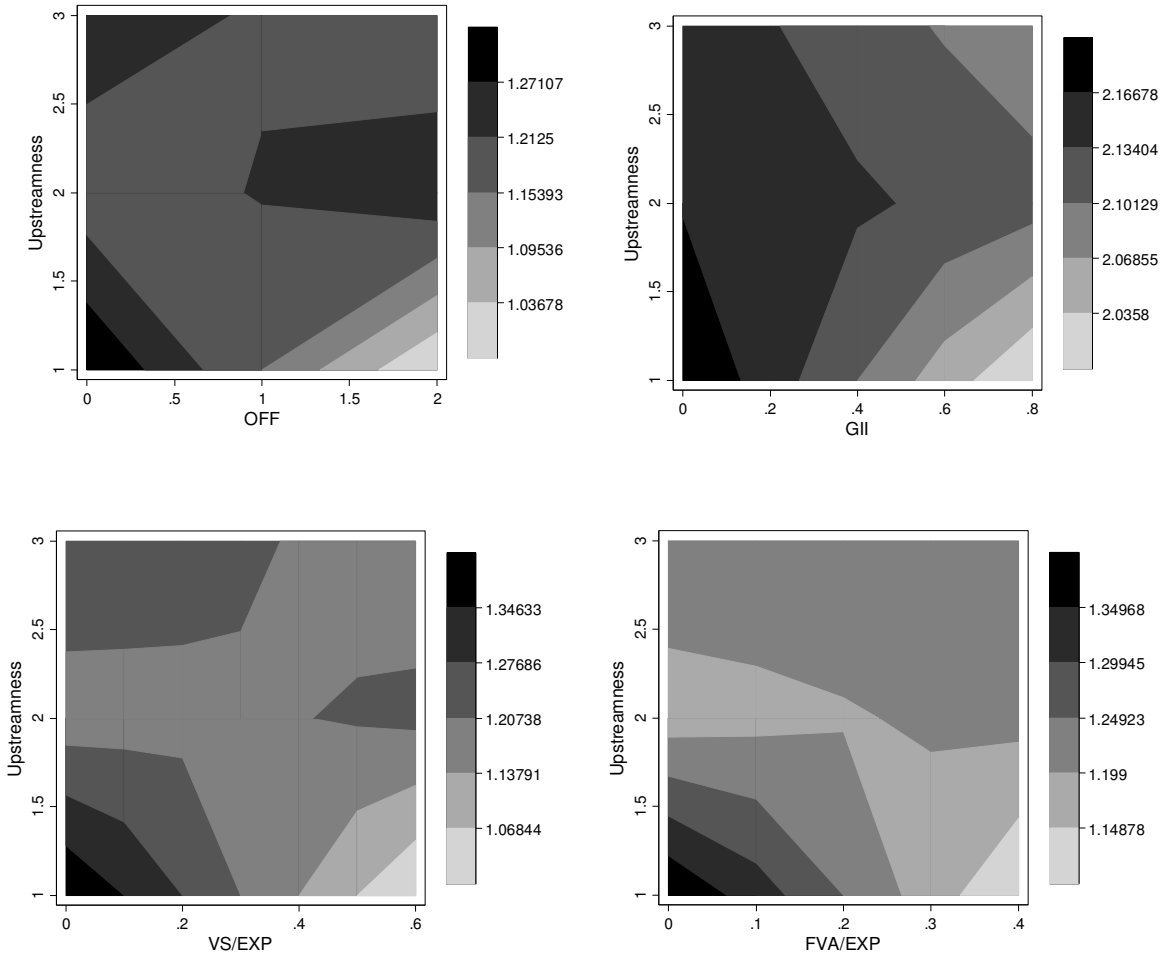
Source: own elaboration based on the estimation results of specification (1) reported in Table 1

Figure 8. Predicted wages due to the changes in GVC at different values of *UP* (illustrating the results from Table 1)



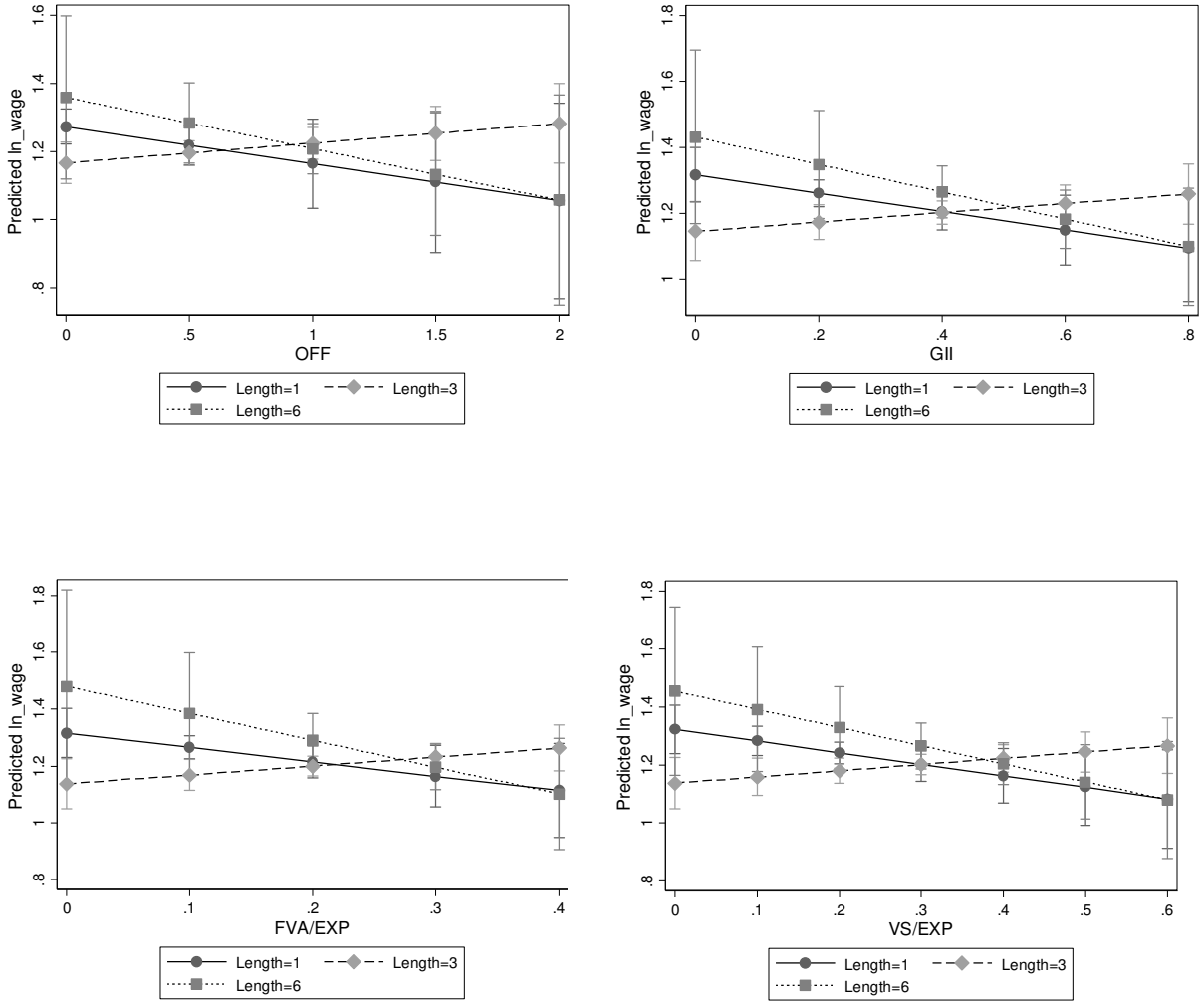
Source: own elaboration based on data from EU-SILC and WIOD

Figure 9 Contour plots with log hourly wage illustrating the results from Table 1



Note: shaded areas illustrate log(hourly wage)
Source: own elaboration based on data from EU-SILC and WIOD

Figure 10. Predicted wages due to changes in GVC at different values of chain length (illustrating the results from Table 2)



Source: own elaboration based on data from EU-SILC and WIOD

Figure 11. Contour plots with *log hourly wage* illustrating the results from Table 2

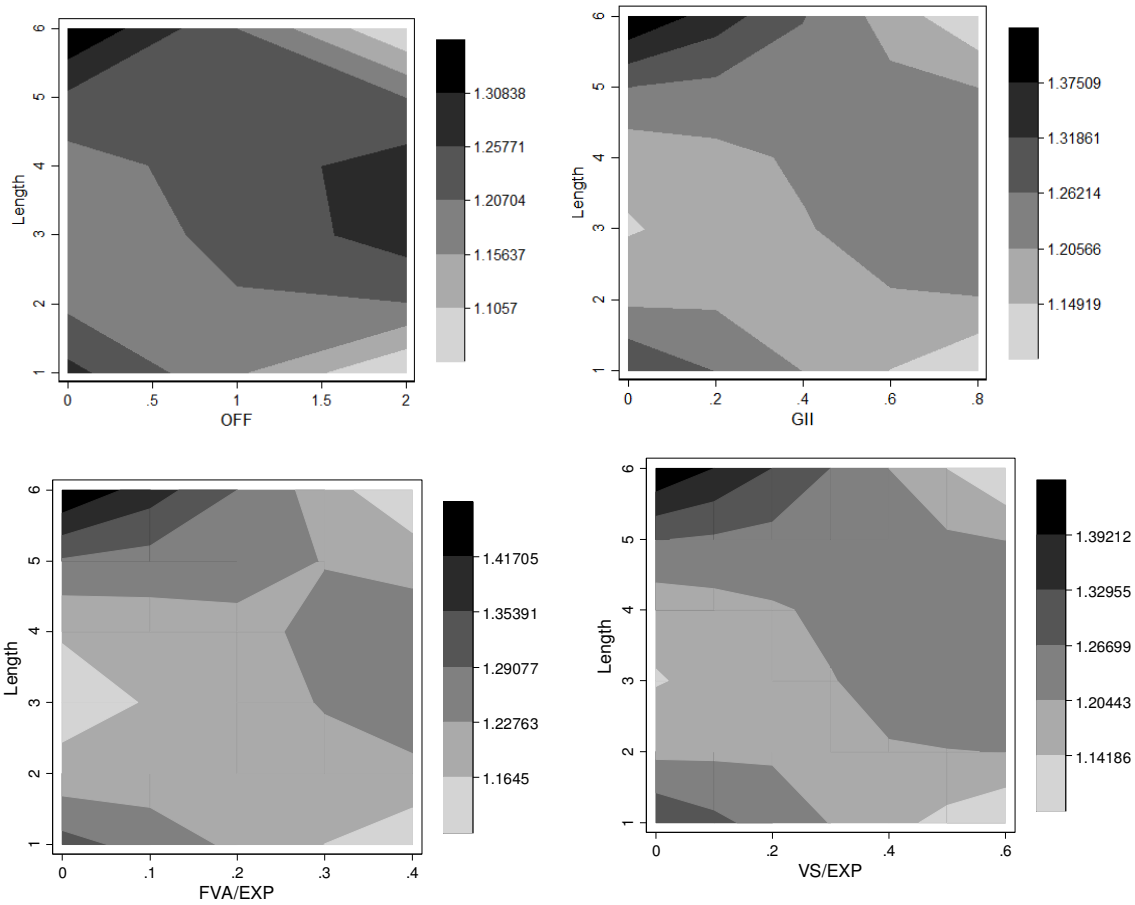


Table 1. Estimation results – wage regression, including the interaction between fragmentation and upstreamness (eq.10 and 11)

Dep.var.: ln*wage*	eq.10	Measure of *GVC* – eq.11							
		OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sex	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***
	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]
Age	0.030***	0.030***	0.029***	0.030***	0.029***	0.030***	0.029***	0.030***	0.029***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Age²	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Marital status	0.028***	0.028***	0.028***	0.028***	0.028***	0.028***	0.028***	0.028***	0.028***
	[0.005]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Higheduc	0.265***	0.265***	0.265***	0.265***	0.265***	0.266***	0.265***	0.266***	0.265***
	[0.012]	[0.012]	[0.011]	[0.012]	[0.011]	[0.012]	[0.011]	[0.012]	[0.011]
RTI	-0.417***	-0.417***	-0.418***	-0.417***	-0.418***	-0.417***	-0.418***	-0.417***	-0.418***
	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]
Prod	0.046	0.046	0.044	0.047	0.042	0.047	0.041	0.047	0.042
	[0.029]	[0.028]	[0.027]	[0.029]	[0.027]	[0.029]	[0.027]	[0.029]	[0.027]
UP	-0.299**	-0.319**	-0.494***	-0.302**	-0.741***	-0.308**	-0.656***	-0.306**	-0.767***
	[0.139]	[0.138]	[0.163]	[0.139]	[0.235]	[0.138]	[0.238]	[0.139]	[0.240]
UP²	0.068**	0.073**	0.114***	0.069**	0.168***	0.071**	0.144**	0.070**	0.174***
	[0.031]	[0.031]	[0.038]	[0.031]	[0.055]	[0.031]	[0.056]	[0.031]	[0.057]
GVC		0.04	-0.695	0.04	-1.777*	0.096	-2.598	0.065	-2.524*
		[0.031]	[0.751]	[0.085]	[0.943]	[0.146]	[1.729]	[0.116]	[1.334]
GVC×UP			0.671		1.653**		2.339		2.352**
			[0.630]		[0.827]		[1.557]		[1.163]
GVC×UP²			-0.151		-0.368**		-0.495		-0.522**
			[0.133]		[0.182]		[0.353]		[0.255]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562584	562337	562337	562337	562337

Notes: Time, country and sector dummies included. Normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses), the weights are based on personal cross-sectional weights (from EU-SILC) normalised by the number of observation per country (see main text for the details); *p ≤ .10, **p≤ .05, ***p ≤.01.
Source: own elaboration based on data from EU-SILC and WIOD

Table 2. Estimation results – wage regression, including interaction between fragmentation and length (eq. 12)

Dep.var.: ln*wage*	Measure of GVC – eq.12							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.147**	-0.023	-0.233***	-0.026	-0.253***	-0.025	-0.251***
	[0.039]	[0.064]	[0.039]	[0.087]	[0.040]	[0.096]	[0.039]	[0.090]
L^2	0.006	0.023**	0.003	0.037**	0.004	0.041**	0.004	0.040**
	[0.005]	[0.011]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.015]
GVC	0.048	-0.284*	0.051	-0.733**	0.108	-1.420**	0.08	-1.063**
	[0.036]	[0.154]	[0.092]	[0.296]	[0.165]	[0.644]	[0.127]	[0.418]
GVC×L		0.206**		0.532**		1.078**		0.779**
		[0.100]		[0.213]		[0.466]		[0.302]
$GVC \times L^2$		-0.031*		-0.080**		-0.167**		-0.118**
		[0.016]		[0.034]		[0.077]		[0.049]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses); *p ≤ .10, **p≤ .05, ***p ≤.01. Personal controls (included, not reported): sex, age, age², marital status (=1 if married), education (high, default category=medium and low), routinisation index of the occupation. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included.
Source: own elaboration based on data from EU-SILC and WIOD

Table 3 Estimation results manufacturing versus non-manufacturing sectors

Dep.var.: ln*wage*	Measure of GVC – eq. 11			
	GII	*GII*	*VS/EXP*	*VS/EXP*
	manufacturing	*non-manufacturing*	*manufacturing*	*non-manufacturing*
	(1)	(2)	(3)	(4)
UP	-2.621**	-0.690***	-2.969**	-0.721***
	[1.296]	[0.260]	[1.222]	[0.268]
UP^2	0.391	0.160**	0.468*	0.167**
	[0.266]	[0.062]	[0.250]	[0.064]
GVC	-6.744*	-1.475	-9.263**	-2.16
	[3.593]	[1.043]	[4.660]	[1.462]
GVC×UP	4.332	1.251	6.09	1.848
	[2.957]	[0.960]	[3.842]	[1.342]
$GVC \times UP^2$	-0.627	-0.279	-0.914	-0.414
	[0.609]	[0.217]	[0.793]	[0.303]
R^2	0.56	0.51	0.56	0.51
N	162135	400449	162135	400202

Notes: normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses); *p ≤ .10, **p≤ .05, ***p ≤.01. Personal controls (included, not reported): sex, age, age², marital status (=1 if married), education (high, default category=medium and low), routinisation index of the occupation. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included
Source: own elaboration based on data from EU-SILC and WIOD

Table 4. Estimation results – wage regression, including interaction between fragmentation and upstreamness (production fragmentation with high income versus medium/low income countries)

Dep.var.: ln*wage*	Measure of GVC – eq.12							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	High income	Medium and low income	High income	Medium and low income	High income	Medium and low income	High income	Medium and low income
UP	-0.474***	-0.468***	-0.663***	-0.666***	-0.625***	-0.759***	-0.774***	-0.788***
	[0.162]	[0.152]	[0.219]	[0.217]	[0.233]	[0.242]	[0.236]	[0.236]
UP^2	0.110***	0.106***	0.152***	0.149***	0.137**	0.170***	0.175***	0.178***
	[0.038]	[0.036]	[0.053]	[0.050]	[0.055]	[0.057]	[0.056]	[0.056]
GVC	-0.868	-2.561	-2.112*	-5.043*	-2.458*	-1.469*	-2.555*	-1.286*
	[0.972]	[2.320]	[1.179]	[2.904]	[1.822]	[0.801]	[1.327]	[0.664]
GVC×UP	0.849	2.283	1.935*	4.584*	2.213	1.362*	2.378**	1.198**
	[0.816]	[1.971]	[1.049]	[2.515]	[1.635]	[0.709]	[1.157]	[0.578]
$GVC \times UP^2$	-0.197	-0.487	-0.438*	-0.992*	-0.464	-0.300*	-0.528**	-0.266**
	[0.173]	[0.419]	[0.238]	[0.549]	[0.369]	[0.159]	[0.254]	[0.127]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	561503	557492	561503	557492

Notes: normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses); *p ≤ .10, **p≤ .05, ***p ≤.01. Personal controls (included, not reported): sex, age, age^2, marital status (=1 if married), education (high, default category=medium and low), routinisation index of the occupation. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included.
Source: own elaboration based on data from EU-SILC and WIOD

Table 5. Estimation results – wage regression, including interaction between fragmentation and length (production fragmentation with high income versus medium/low income countries)

Dep.var.: ln*wage*	Measure of GVC – eq.12							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	High income	Medium and low income	High income	Medium and low income	High income	Medium and low income	High income	Medium and low income
UP	-0.109*	-0.097*	-0.157*	-0.166***	-0.245**	-0.246***	-0.253***	-0.256***
	[0.063]	[0.054]	[0.084]	[0.062]	[0.096]	[0.090]	[0.089]	[0.089]
UP^2	0.017	0.013	0.025*	0.023**	0.040**	0.039**	0.040**	0.040***
	[0.011]	[0.009]	[0.014]	[0.010]	[0.017]	[0.015]	[0.015]	[0.015]
GVC	-0.376	-0.736**	-0.843*	-1.846***	-1.395**	-0.620**	-1.070**	-0.534**
	[0.252]	[0.325]	[0.441]	[0.666]	[0.697]	[0.258]	[0.415]	[0.207]
GVC×UP	0.246	0.448**	0.543*	1.210***	1.081**	0.462**	0.783**	0.394***
	[0.157]	[0.201]	[0.299]	[0.422]	[0.499]	[0.184]	[0.300]	[0.149]
$GVC \times UP^2$	-0.036	-0.053	-0.081*	-0.158**	-0.168**	-0.071**	-0.118**	-0.060**
	[0.024]	[0.032]	[0.048]	[0.066]	[0.083]	[0.030]	[0.049]	[0.024]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	561503	557492	561503	557492

Notes: normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses); *p ≤ .10, **p≤ .05, ***p ≤.01. Personal controls (included, not reported): sex, age, age^2, marital status (=1 if married), education (high, default category=medium and low), routinisation index of the occupation. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included.
Source: own elaboration based on data from EU-SILC and WIOD

Appendix

Table A1. List of industries

A	*A01*	*Crop and animal production, hunting and related service activities*
A	*A02*	*Forestry and logging*
A	*A03*	*Fishing and aquaculture*
B	*B*	*Mining and quarrying*
C	*C10-C12*	*Manufacture of food products, beverages and tobacco products*
C	*C13-C15*	*Manufacture of textiles, wearing apparel and leather products*
C	*C16*	*Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials*
C	*C17*	*Manufacture of paper and paper products*
C	*C18*	*Printing and reproduction of recorded media*
C	*C19*	*Manufacture of coke and refined petroleum products*
C	*C20*	*Manufacture of chemicals and chemical products*
C	*C21*	*Manufacture of basic pharmaceutical products and pharmaceutical preparations*
C	*C22*	*Manufacture of rubber and plastic products*
C	*C23*	*Manufacture of other non-metallic mineral products*
C	*C24*	*Manufacture of basic metals*
C	*C25*	*Manufacture of fabricated metal products, except machinery and equipment*
C	*C26*	*Manufacture of computer, electronic and optical products*
C	*C27*	*Manufacture of electrical equipment*
C	*C28*	*Manufacture of machinery and equipment n.e.c.*
C	*C29*	*Manufacture of motor vehicles, trailers and semi-trailers*
C	*C30*	*Manufacture of other transport equipment*
C	*C31_C32*	*Manufacture of furniture; other manufacturing*
C	*C33*	*Repair and installation of machinery and equipment*
D	*D35*	*Electricity, gas, steam and air conditioning supply*
E	*E36*	*Water collection, treatment and supply*
E	*E37-E39*	*Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services*
F	*F*	*Construction*
G	*G45*	*Wholesale and retail trade and repair of motor vehicles and motorcycles*
G	*G46*	*Wholesale trade, except of motor vehicles and motorcycles*
G	*G47*	*Retail trade, except of motor vehicles and motorcycles*
H	*H49*	*Land transport and transport via pipelines*
H	*H50*	*Water transport*
H	*H51*	*Air transport*
H	*H52*	*Warehousing and support activities for transportation*
H	*H53*	*Postal and courier activities*
II	*I*	*Accommodation and food service activities*
J	*J58*	*Publishing activities*
J	*J59_J60*	*Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities*
J	*J61*	*Telecommunications*
J	*J62_J63*	*Computer programming, consultancy and related activities; information service activities*
K	*K64*	*Financial service activities, except insurance and pension funding*
K	*K65*	*Insurance, reinsurance and pension funding, except compulsory social security*
K	*K66*	*Activities auxiliary to financial services and insurance activities*
L	*L68*	*Real estate activities*
M	*M69_M70*	*Legal and accounting activities; activities of head offices; management consultancy activities*
M	*M71*	*Architectural and engineering activities; technical testing and analysis*
M	*M72*	*Scientific research and development*
M	*M73*	*Advertising and market research*
M	*M74_M75*	*Other professional, scientific and technical activities; veterinary activities*
N	*N*	*Administrative and support service activities*
O	*O84*	*Public administration and defence; compulsory social security*
P	*P85*	*Education*
Q	*Q*	*Human health and social work activities*
R_S	*R_S*	*Other service activities*
T	*T*	*Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use*
U	*U*	*Activities of extraterritorial organizations and bodies*

Source: WIOD (2016)

Table 2A. Different measures of international production fragmentation and GVC position, CEECs, 2014

country	*OFF*	*GII*	*UP*	*L*	*FVA/EXP*	*VS/EXP*
BG	0.466	0.332	2.302	2.002	0.178	0.242
CZ	0.564	0.399	2.338	2.778	0.201	0.287
EE	0.504	0.371	2.258	1.951	0.198	0.268
HU	0.695	0.421	2.072	2.051	0.222	0.304
LT	0.400	0.285	2.055	1.799	0.160	0.212
LV	0.329	0.289	2.300	2.106	0.153	0.209
PL	0.311	0.272	2.151	3.120	0.143	0.199
RO	0.295	0.271	2.182	2.348	0.141	0.194
SI	0.400	0.330	2.157	1.990	0.173	0.238
SK	0.586	0.370	2.164	2.045	0.188	0.258

Notes: mean values over countries, observations weighted by industry value added
Source: own elaboration based on WIOD (2016)

Table 3A. Correlations between different measures of international production fragmentation and GVC position

	OFF	*GII*	*UP*	*L*	*FVA/EXP*	*VS/EXP*
OFF	1.000					
GII	0.946	1.000				
UP	0.321	0.358	1.000			
L	0.562	0.523	0.578	1.000		
FVA/EXP	0.917	0.968	0.218	0.465	1.000	
VS/EXP	0.944	0.999	0.364	0.526	0.969	1.000

Note: Sample of 10 CEECs, correlations based on values for 2014
Source: own elaboration based on WIOD (2016).

Table 4A. Sample characteristics - summary statistics of micro-level data

	n	mean	sd	min	max
Log Wage_hour (real gross hourly wage)	564261	1.223	0.689	-1.99301	3.808496
Sex (male=1)	564261	0.525754	0.499	0	1
Age (age, in years)	564261	41.03	10.9	18	65
Exp (experience, in years)	418429	18.7	11.29	0	62
Hieduc (high education completed)	563679	0.270	0.444	0	1
MedLow (medium and/or low education completed)	564261	0.728	0.444	0	1
Married (family status)	564261	0.603	0.489	0	1
MicroFirm (company size: micro, 1-10)	563286	0.225	0.417	0	1
SizeMed (company size: medium, 11-49)	531586	0.334	0.471	0	1
SizeBig (company size: big, >=50)	531586	0.424	0.494	0	1
Cont_Perm (permanent contract)	488689	0.915	0.27	0	1
Manag (managerial position)	492068	0.154	0.36	0	1

Note: values in an unbalanced sample of 10 CEECs (2005-2014), observations weighted by normalised weights
Source: own elaboration based on EU-SILC

Supplementary materials to the paper:

"Position in global value chains: the impact on wages in Central and Eastern European Countries" authored by Szymczak S., Parteka A., Wolszczak-Derlacz J.

Not to be included in the main text

Table SM1. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variable describing coordination of wage setting mechanism (*Coord*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.304**	-0.487***	-0.287**	-0.738***	-0.293**	-0.656***	-0.290**	-0.761***
	[0.131]	[0.151]	[0.132]	[0.221]	[0.132]	[0.228]	[0.132]	[0.227]
UP^2	0.070**	0.114***	0.067**	0.170***	0.069**	0.147***	0.067**	0.175***
	[0.029]	[0.035]	[0.029]	[0.052]	[0.029]	[0.054]	[0.029]	[0.054]
GVC	0.039	-0.705	0.051	-1.776**	0.108	-2.638	0.076	-2.516**
	[0.024]	[0.714]	[0.066]	[0.893]	[0.116]	[1.654]	[0.092]	[1.271]
GVC×UP		0.69		1.683**		2.44		2.385**
		[0.598]		[0.784]		[1.494]		[1.109]
$GVC \times UP^2$		-0.158		-0.379**		-0.528		-0.536**
		[0.126]		[0.173]		[0.338]		[0.243]
Coord	0.069***	0.069***	0.070***	0.070***	0.069***	0.069***	0.069***	0.069***
	[0.008]	[0.008]	[0.007]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM2. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variable describing minimum wage setting mechanism (*MW*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.322**	-0.496***	-0.303**	-0.745***	-0.309**	-0.646***	-0.305**	-0.756***
	[0.137]	[0.161]	[0.138]	[0.232]	[0.138]	[0.237]	[0.138]	[0.240]
UP^2	0.073**	0.114***	0.069**	0.169***	0.070**	0.141**	0.069**	0.171***
	[0.030]	[0.038]	[0.031]	[0.055]	[0.030]	[0.056]	[0.031]	[0.057]
GVC	0.041	-0.679	0.046	-1.758*	0.11	-2.487	0.075	-2.428*
	[0.032]	[0.742]	[0.089]	[0.932]	[0.153]	[1.710]	[0.121]	[1.322]
GVC×UP		0.659		1.647**		2.26		2.283**
		[0.622]		[0.817]		[1.540]		[1.153]
$GVC \times UP^2$		-0.149		-0.368**		-0.479		-0.509**
		[0.131]		[0.180]		[0.349]		[0.253]
MW	0.013***	0.013***	0.013***	0.012***	0.013***	0.013***	0.013***	0.013***
	[0.004]	[0.004]	[0.004]	[0.005]	[0.004]	[0.005]	[0.004]	[0.005]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	558026	558026	558026	558026	558026	558026	558026	558026

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM3. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variable describing sectoral organization of employment relations (*Sector*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.319**	-0.494***	-0.302**	-0.741***	-0.308**	-0.656***	-0.306**	-0.767***
	[0.138]	[0.163]	[0.139]	[0.235]	[0.138]	[0.238]	[0.139]	[0.240]
UP^2	0.073**	0.114***	0.069**	0.168***	0.071**	0.144**	0.070**	0.174***
	[0.031]	[0.038]	[0.031]	[0.055]	[0.031]	[0.056]	[0.031]	[0.057]
GVC	0.04	-0.695	0.04	-1.777*	0.096	-2.598	0.065	-2.524*
	[0.031]	[0.751]	[0.085]	[0.943]	[0.146]	[1.729]	[0.116]	[1.334]
GVC×UP		0.671		1.653**		2.339		2.352**
		[0.630]		[0.827]		[1.557]		[1.163]
$GVC \times UP^2$		-0.151		-0.368**		-0.495		-0.522**
		[0.133]		[0.182]		[0.353]		[0.255]
Sector	0.688***	0.691***	0.688***	0.694***	0.689***	0.694***	0.689***	0.694***
	[0.039]	[0.038]	[0.040]	[0.038]	[0.040]	[0.038]	[0.040]	[0.038]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM4. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variable describing union negotiation agreement (*Unarg*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.319**	-0.494***	-0.302**	-0.741***	-0.308**	-0.656***	-0.306**	-0.767***
	[0.138]	[0.163]	[0.139]	[0.235]	[0.138]	[0.238]	[0.139]	[0.240]
UP^2	0.073**	0.114***	0.069**	0.168***	0.071**	0.144**	0.070**	0.174***
	[0.031]	[0.038]	[0.031]	[0.055]	[0.031]	[0.056]	[0.031]	[0.057]
GVC	0.04	-0.695	0.04	-1.777*	0.096	-2.598	0.065	-2.524*
	[0.031]	[0.751]	[0.085]	[0.943]	[0.146]	[1.729]	[0.116]	[1.334]
GVC×UP		0.671		1.653**		2.339		2.352**
		[0.630]		[0.827]		[1.557]		[1.163]
$GVC \times UP^2$		-0.151		-0.368**		-0.495		-0.522**
		[0.133]		[0.182]		[0.353]		[0.255]
Unagr	-0.733***	-0.738***	-0.730***	-0.737***	-0.731***	-0.736***	-0.730***	-0.737***
	[0.024]	[0.024]	[0.025]	[0.024]	[0.025]	[0.024]	[0.025]	[0.024]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM5. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variable describing the characteristic of works councils and employee representation in the enterprise (WC)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.317**	-0.499***	-0.298**	-0.759***	-0.306**	-0.664***	-0.303**	-0.782***
	[0.138]	[0.162]	[0.139]	[0.233]	[0.138]	[0.237]	[0.139]	[0.238]
UP^2	0.072**	0.115***	0.068**	0.172***	0.070**	0.146**	0.068**	0.177***
	[0.031]	[0.038]	[0.031]	[0.055]	[0.031]	[0.056]	[0.031]	[0.056]
GVC	0.041	-0.715	0.042	-1.838*	0.105	-2.652	0.07	-2.588*
	[0.031]	[0.751]	[0.087]	[0.933]	[0.147]	[1.722]	[0.118]	[1.323]
GVC×UP		0.695		1.723**		2.411		2.431**
		[0.629]		[0.816]		[1.548]		[1.150]
$GVC \times UP^2$		-0.158		-0.386**		-0.513		-0.544**
		[0.133]		[0.179]		[0.351]		[0.252]
WC	0.059**	0.061**	0.057**	0.061**	0.058**	0.060**	0.058**	0.061**
	[0.024]	[0.025]	[0.025]	[0.025]	[0.024]	[0.025]	[0.024]	[0.025]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM6. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional country variables describing unemployment (*UN*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.315**	-0.509***	-0.297**	-0.768***	-0.303**	-0.680***	-0.301**	-0.794***
	[0.138]	[0.163]	[0.139]	[0.237]	[0.139]	[0.238]	[0.139]	[0.242]
UP^2	0.072**	0.117***	0.068**	0.175***	0.069**	0.150***	0.069**	0.180***
	[0.031]	[0.038]	[0.031]	[0.056]	[0.031]	[0.057]	[0.031]	[0.057]
GVC	0.038	-0.773	0.031	-1.897**	0.078	-2.803	0.052	-2.689**
	[0.030]	[0.742]	[0.083]	[0.933]	[0.142]	[1.709]	[0.113]	[1.319]
GVC×UP		0.742		1.765**		2.533		2.504**
		[0.624]		[0.822]		[1.544]		[1.155]
$GVC \times UP^2$		-0.168		-0.395**		-0.543		-0.559**
		[0.132]		[0.182]		[0.351]		[0.255]
UN	-0.005**	-0.005***	-0.005**	-0.006***	-0.005**	-0.005***	-0.005**	-0.006***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM7. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional measure of country openness (Export to GDP)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.316**	-0.509***	-0.298**	-0.760***	-0.305**	-0.671***	-0.302**	-0.785***
	[0.137]	[0.163]	[0.137]	[0.236]	[0.137]	[0.236]	[0.137]	[0.240]
UP^2	0.072**	0.118***	0.068**	0.174***	0.070**	0.148***	0.069**	0.179***
	[0.031]	[0.038]	[0.031]	[0.056]	[0.031]	[0.056]	[0.031]	[0.057]
GVC	0.04	-0.746	0.036	-1.834**	0.093	-2.685	0.061	-2.602**
	[0.030]	[0.730]	[0.084]	[0.917]	[0.143]	[1.674]	[0.114]	[1.293]
GVC×UP		0.726		1.723**		2.457		2.446**
		[0.614]		[0.809]		[1.514]		[1.134]
$GVC \times UP^2$		-0.166		-0.388**		-0.529		-0.549**
		[0.130]		[0.180]		[0.346]		[0.251]
Export	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM8. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional measure of country openness (Import to GDP)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.313**	-0.480***	-0.295**	-0.719***	-0.302**	-0.640***	-0.299**	-0.746***
	[0.135]	[0.159]	[0.136]	[0.230]	[0.135]	[0.231]	[0.136]	[0.234]
UP^2	0.071**	0.111***	0.067**	0.164***	0.070**	0.142**	0.068**	0.170***
	[0.030]	[0.037]	[0.030]	[0.054]	[0.030]	[0.055]	[0.030]	[0.055]
GVC	0.042	-0.633	0.048	-1.681*	0.109	-2.465	0.078	-2.398*
	[0.029]	[0.738]	[0.081]	[0.921]	[0.137]	[1.680]	[0.109]	[1.299]
GVC×UP		0.627		1.586*		2.267		2.265**
		[0.617]		[0.804]		[1.510]		[1.127]
$GVC \times UP^2$		-0.144		-0.356**		-0.486		-0.507**
		[0.130]		[0.176]		[0.342]		[0.246]
Import	-0.007***	-0.006***	-0.006***	-0.006***	-0.007***	-0.006***	-0.007***	-0.006***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM9. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional sectoral openness (Export to VA)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UP	-0.306**	-0.474***	-0.290**	-0.689***	-0.294**	-0.616**	-0.293**	-0.719***
	[0.138]	[0.162]	[0.137]	[0.238]	[0.138]	[0.242]	[0.138]	[0.243]
UP^2	0.069**	0.108***	0.064**	0.157***	0.065**	0.135**	0.065**	0.164***
	[0.031]	[0.038]	[0.031]	[0.056]	[0.031]	[0.057]	[0.031]	[0.057]
GVC	0.02	-0.649	-0.051	-1.609*	-0.037	-2.385	-0.049	-2.308*
	[0.041]	[0.755]	[0.099]	[0.968]	[0.168]	[1.768]	[0.134]	[1.370]
GVC×UP		0.622		1.471*		2.13		2.127*
		[0.635]		[0.857]		[1.598]		[1.203]
$GVC \times UP^2$		-0.142		-0.333*		-0.462		-0.481*
		[0.134]		[0.187]		[0.359]		[0.262]
Export_VA	0.025	0.021	0.044**	0.03	0.039**	0.026	0.042**	0.029
	[0.022]	[0.022]	[0.019]	[0.020]	[0.019]	[0.021]	[0.019]	[0.020]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM10. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variable describing coordination of wage setting mechanism (*Coord*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.036	-0.140**	-0.019	-0.233***	-0.021	-0.251***	-0.02	-0.247***
	[0.036]	[0.057]	[0.036]	[0.075]	[0.037]	[0.087]	[0.036]	[0.079]
L^2	0.005	0.023**	0.003	0.038***	0.003	0.042***	0.003	0.040***
	[0.005]	[0.010]	[0.005]	[0.013]	[0.005]	[0.016]	[0.005]	[0.014]
GVC	0.045	-0.261*	0.061	-0.694**	0.11	-1.378**	0.086	-1.005***
	[0.029]	[0.144]	[0.077]	[0.269]	[0.140]	[0.611]	[0.108]	[0.384]
GVC×L		0.197**		0.532***		1.081**		0.769***
		[0.090]		[0.182]		[0.428]		[0.263]
$GVC \times L^2$		-0.030**		-0.083***		-0.173**		-0.121***
		[0.014]		[0.029]		[0.071]		[0.043]
Coord	0.069***	0.069***	0.070***	0.069***	0.070***	0.069***	0.070***	0.069***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM11. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variable describing minimum wage setting mechanism (*MW*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.039	-0.151**	-0.019	-0.241***	-0.023	-0.260***	-0.021	-0.260***
	[0.038]	[0.065]	[0.038]	[0.088]	[0.039]	[0.097]	[0.038]	[0.092]
L^2	0.005	0.025**	0.003	0.039***	0.003	0.043**	0.003	0.042***
	[0.005]	[0.012]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.016]
GVC	0.047	-0.291*	0.052	-0.745**	0.115	-1.419**	0.083	-1.069**
	[0.036]	[0.153]	[0.094]	[0.293]	[0.170]	[0.644]	[0.130]	[0.415]
GVC×L		0.215**		0.555**		1.113**		0.809***
		[0.099]		[0.213]		[0.467]		[0.303]
$GVC \times L^2$		-0.033**		-0.086**		-0.178**		-0.126**
		[0.016]		[0.034]		[0.077]		[0.049]
MW	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	558026	558026	558026	558026	558026	558026	558026	558026

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM12. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variable describing sectoral organization of employment relations (*Sector*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.147**	-0.023	-0.233***	-0.026	-0.253***	-0.025	-0.251***
	[0.039]	[0.064]	[0.039]	[0.087]	[0.040]	[0.096]	[0.039]	[0.090]
L^2	0.006	0.023**	0.003	0.037**	0.004	0.041**	0.004	0.040**
	[0.005]	[0.011]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.015]
GVC	0.048	-0.284*	0.051	-0.733**	0.108	-1.420**	0.08	-1.063**
	[0.036]	[0.154]	[0.092]	[0.296]	[0.165]	[0.644]	[0.127]	[0.418]
GVC×L		0.206**		0.532**		1.078**		0.779**
		[0.100]		[0.213]		[0.466]		[0.302]
$GVC \times L^2$		-0.031*		-0.080**		-0.167**		-0.118**
		[0.016]		[0.034]		[0.077]		[0.049]
Sector	0.696***	0.693***	0.696***	0.697***	0.697***	0.698***	0.697***	0.698***
	[0.038]	[0.038]	[0.039]	[0.038]	[0.039]	[0.037]	[0.039]	[0.037]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM13. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variable describing union negotiation agreement (*Unarg*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.147**	-0.023	-0.233***	-0.026	-0.253***	-0.025	-0.251***
	[0.039]	[0.064]	[0.039]	[0.087]	[0.040]	[0.096]	[0.039]	[0.090]
L^2	0.006	0.023**	0.003	0.037**	0.004	0.041**	0.004	0.040**
	[0.005]	[0.011]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.015]
GVC	0.048	-0.284*	0.051	-0.733**	0.108	-1.420**	0.08	-1.063**
	[0.036]	[0.154]	[0.092]	[0.296]	[0.165]	[0.644]	[0.127]	[0.418]
GVC×L		0.206**		0.532**		1.078**		0.779**
		[0.100]		[0.213]		[0.466]		[0.302]
$GVC \times L^2$		-0.031*		-0.080**		-0.167**		-0.118**
		[0.016]		[0.034]		[0.077]		[0.049]
Unagr	-0.745***	-0.751***	-0.742***	-0.748***	-0.743***	-0.750***	-0.742***	-0.749***
	[0.026]	[0.026]	[0.027]	[0.026]	[0.027]	[0.026]	[0.027]	[0.026]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM14. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variable describing the characteristic of works councils and employee representation in the enterprise (WC)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.039	-0.141**	-0.019	-0.224**	-0.022	-0.243**	-0.021	-0.243***
	[0.039]	[0.066]	[0.039]	[0.089]	[0.040]	[0.097]	[0.039]	[0.092]
L^2	0.005	0.022*	0.003	0.034**	0.003	0.039**	0.003	0.038**
	[0.005]	[0.012]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.016]
GVC	0.048	-0.293*	0.048	-0.747**	0.113	-1.403**	0.078	-1.075**
	[0.036]	[0.152]	[0.094]	[0.292]	[0.167]	[0.642]	[0.129]	[0.415]
GVC×L		0.206**		0.527**		1.054**		0.773**
		[0.100]		[0.214]		[0.468]		[0.304]
$GVC \times L^2$		-0.030*		-0.077**		-0.160**		-0.114**
		[0.016]		[0.035]		[0.078]		[0.050]
WC	0.058**	0.062**	0.057**	0.063**	0.058**	0.060**	0.057**	0.062**
	[0.024]	[0.024]	[0.024]	[0.025]	[0.023]	[0.024]	[0.024]	[0.024]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM15. Estimation results – wage regression, including the interaction between fragmentation and length with additional country variables describing unemployment (*UN*)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.151**	-0.022	-0.240***	-0.024	-0.259***	-0.023	-0.258***
	[0.039]	[0.064]	[0.039]	[0.087]	[0.040]	[0.095]	[0.040]	[0.090]
L^2	0.006	0.024**	0.003	0.037**	0.003	0.041**	0.003	0.040**
	[0.005]	[0.011]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.015]
GVC	0.046	-0.310**	0.043	-0.781***	0.089	-1.503**	0.066	-1.130***
	[0.035]	[0.153]	[0.092]	[0.291]	[0.163]	[0.638]	[0.127]	[0.412]
GVC×L		0.218**		0.554***		1.116**		0.809***
		[0.099]		[0.209]		[0.461]		[0.297]
$GVC \times L^2$		-0.032**		-0.082**		-0.171**		-0.121**
		[0.016]		[0.034]		[0.077]		[0.049]
UN	-0.005**	-0.006***	-0.005**	-0.006***	-0.005**	-0.006***	-0.005**	-0.006***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM16. Estimation results – wage regression, including the interaction between fragmentation and length with additional measure of country openness (Export to GDP)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.169**	-0.021	-0.265***	-0.025	-0.285***	-0.023	-0.287***
	[0.039]	[0.066]	[0.039]	[0.088]	[0.039]	[0.097]	[0.039]	[0.092]
L^2	0.006	0.028**	0.003	0.043***	0.003	0.047***	0.003	0.047***
	[0.005]	[0.012]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.016]
GVC	0.048	-0.333**	0.046	-0.827***	0.106	-1.583**	0.076	-1.197***
	[0.035]	[0.153]	[0.092]	[0.290]	[0.162]	[0.636]	[0.126]	[0.409]
GVC×L		0.243**		0.610***		1.223***		0.894***
		[0.101]		[0.212]		[0.465]		[0.300]
$GVC \times L^2$		-0.037**		-0.095***		-0.195**		-0.140***
		[0.016]		[0.035]		[0.079]		[0.050]
Export	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM17. Estimation results – wage regression, including the interaction between fragmentation and length with additional measure of country openness (Import to GDP)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.046	-0.162**	-0.026	-0.254***	-0.029	-0.275***	-0.028	-0.276***
	[0.038]	[0.065]	[0.037]	[0.086]	[0.038]	[0.095]	[0.038]	[0.089]
L^2	0.006	0.026**	0.004	0.041***	0.004	0.045***	0.004	0.045***
	[0.005]	[0.012]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.015]
GVC	0.052	-0.294**	0.064	-0.753***	0.129	-1.474**	0.099	-1.097***
	[0.034]	[0.147]	[0.088]	[0.285]	[0.156]	[0.630]	[0.121]	[0.403]
GVC×L		0.221**		0.570***		1.159**		0.841***
		[0.097]		[0.207]		[0.456]		[0.292]
$GVC \times L^2$		-0.034**		-0.089***		-0.184**		-0.131***
		[0.016]		[0.033]		[0.076]		[0.048]
Import	-0.007***	-0.007***	-0.007***	-0.007***	-0.007***	-0.007***	-0.007***	-0.007***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM18. Estimation results – wage regression, including the interaction between fragmentation and length with additional sectoral openness (Export to VA)

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.04	-0.156**	-0.025	-0.220**	-0.029	-0.248**	-0.027	-0.245***
	[0.038]	[0.063]	[0.037]	[0.089]	[0.038]	[0.095]	[0.038]	[0.092]
L^2	0.006	0.027**	0.004	0.037**	0.005	0.044***	0.004	0.042***
	[0.005]	[0.011]	[0.005]	[0.015]	[0.005]	[0.016]	[0.005]	[0.015]
GVC	0.02	-0.298*	-0.058	-0.689**	-0.041	-1.335**	-0.056	-1.012**
	[0.049]	[0.156]	[0.107]	[0.305]	[0.189]	[0.659]	[0.147]	[0.431]
GVC×L		0.212**		0.482**		1.018**		0.730**
		[0.101]		[0.225]		[0.477]		[0.316]
$GVC \times L^2$		-0.034**		-0.078**		-0.171**		-0.119**
		[0.016]		[0.035]		[0.076]		[0.050]
Export_VA	0.033	0.031	0.050**	0.036	0.045**	0.033	0.048**	0.034
	[0.024]	[0.023]	[0.020]	[0.022]	[0.020]	[0.022]	[0.020]	[0.022]
R^2	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
N	562584	562584	562584	562584	562337	562337	562337	562337

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM19 Estimation results manufacturing versus non-manufacturing sectors including the interaction between fragmentation and upstreamness

Dep.var.: ln*wage*	Measure of GVC – eq. 11			
	OFF	*OFF*	*FVA/EXP*	*FVA/EXP*
	manufacturing	*non-manufacturing*	*manufacturing*	*non-manufacturing*
	(1)	(2)	(3)	(4)
UP	-4.174***	-0.531***	-2.591***	-0.734**
	[0.449]	[0.178]	[0.669]	[0.282]
UP^2	0.769***	0.130***	0.403***	0.172**
	[0.089]	[0.043]	[0.134]	[0.070]
GVC	-5.942***	-0.649	-6.629	-2.748
	[0.938]	[0.838]	[4.284]	[1.932]
GVC×UP	4.541***	0.624	3.436	2.465
	[0.769]	[0.724]	[3.504]	[1.905]
$GVC \times UP^2$	-0.849***	-0.155	-0.261	-0.577
	[0.158]	[0.156]	[0.716]	[0.455]
R^2	0.56	0.51	0.56	0.51
N	162135	400449	162135	400202

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM 20 Estimation results manufacturing versus non-manufacturing sectors, interaction with length

Dep.var. : ln*wage*	Measure of GVC – eq. 12							
	OFF	*OFF*	*GII*	*GII*	*FVA/EXP*	*FVA/EXP*	*VS/EXP*	*VS/EXP*
	manufacturing	*non-manufacturing*	*manufacturing*	*non-manufacturing*	*manufacturing*	*non-manufacturing*	*manufacturing*	*non-manufacturing*
	(1)	(2)	(3)	(4)				
L	-0.265***	-0.221*	-0.562***	-0.362**	-0.429***	-0.421**	-0.591***	-0.395**
	[0.040]	[0.116]	[0.058]	[0.170]	[0.055]	[0.178]	[0.063]	[0.176]
L^2	0.039***	0.047*	0.083***	0.077*	0.066***	0.092**	0.089***	0.085**
	[0.006]	[0.027]	[0.009]	[0.040]	[0.009]	[0.042]	[0.009]	[0.041]
GVC	-0.498***	-0.465*	-1.614***	-1.052**	-1.877***	-2.173**	-2.158***	-1.562**
	[0.127]	[0.276]	[0.242]	[0.486]	[0.466]	[0.973]	[0.356]	[0.681]
GVC×L	0.356***	0.373*	1.211***	0.883**	1.653***	1.900**	1.684***	1.317**
	[0.070]	[0.202]	[0.137]	[0.412]	[0.267]	[0.850]	[0.202]	[0.578]
$GVC \times L^2$	-0.046***	-0.075*	-0.168***	-0.183**	-0.242***	-0.412**	-0.239***	-0.275**
	[0.010]	[0.039]	[0.019]	[0.086]	[0.037]	[0.180]	[0.028]	[0.122]
R^2	0.56	0.51	0.56	0.51	0.56	0.51	0.56	0.51
N	162135	400449	162135	400449	162135	400202	162135	400202

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM21. Estimation results – elimination industry by industry, including the interaction between fragmentation and upstreamness

	OFF			*GII*			*FVA/EXP*			*VS/EXP*		
Coefficient	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
UP	-0.503	-0.833	-0.387	-0.747	-1.204	-0.567	-0.668	-1.129	-0.471	-0.773	-1.226	-0.593
UP^2	0.115	0.090	0.183	0.168	0.129	0.262	0.146	0.102	0.241	0.174	0.135	0.268
GVC	-0.727	-1.225	-0.368	-1.796	-2.695	-1.359	-2.663	-4.241	-1.808	-2.557	-3.752	-1.953
GVC×UP	0.693	0.394	1.116	1.654	1.251	2.413	2.379	1.609	3.735	2.359	1.817	3.374
$GVC \times UP^2$	-0.156	-0.245	-0.094	-0.366	-0.524	-0.279	-0.504	-0.789	-0.343	-0.522	-0.733	-0.412

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM22. Estimation results – elimination industry by industry, including the interaction between fragmentation and length

	OFF			*GII*			*FVA/EXP*			*VS/EXP*		
Coefficient	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
L	-0.157	-0.223	-0.122	-0.249	-0.362	-0.194	-0.273	-0.421	-0.206	-0.269	-0.395	-0.209
L^2	0.026	0.019	0.047	0.041	0.030	0.077	0.046	0.032	0.092	0.044	0.032	0.085
GVC	-0.304	-0.465	-0.232	-0.772	-1.052	-0.609	-1.510	-2.173	-1.135	-1.123	-1.562	-0.878
GVC×L	0.224	0.168	0.373	0.570	0.442	0.883	1.168	0.870	1.900	0.839	0.645	1.317
$GVC \times L^2$	-0.035	-0.075	-0.024	-0.090	-0.183	-0.065	-0.190	-0.412	-0.131	-0.133	-0.275	-0.095

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM23. Estimation results – elimination country by country, including the interaction between fragmentation and upstreamness

	OFF			*GII*			*FVA/EXP*			*VS/EXP*		
Coefficient	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
UP	-0.488	-0.544	-0.403	-0.730	-0.833	-0.597	-0.646	-0.741	-0.584	-0.756	-0.848	-0.620
UP^2	0.112	0.089	0.126	0.165	0.127	0.189	0.141	0.125	0.166	0.171	0.132	0.193
GVC	-0.668	-1.347	-0.001	-1.736	-2.278	-1.205	-2.536	-3.508	-1.340	-2.467	-3.268	-1.674
GVC×UP	0.647	0.148	1.207	1.615	1.149	2.080	2.280	1.297	3.103	2.298	1.649	2.982
$GVC \times UP^2$	-0.146	-0.261	-0.051	-0.359	-0.458	-0.232	-0.481	-0.677	-0.278	-0.510	-0.655	-0.334

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM24. Estimation results – elimination country by country, including the interaction between fragmentation and length

	OFF			*GII*			*FVA/EXP*			*VS/EXP*		
Coefficient	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
L	-0.141	-0.208	-0.079	-0.223	-0.292	-0.131	-0.245	-0.314	-0.155	-0.242	-0.314	-0.153
L^2	0.022	0.010	0.034	0.034	0.016	0.046	0.039	0.022	0.050	0.038	0.020	0.050
GVC	-0.283	-0.366	-0.176	-0.721	-0.894	-0.505	-1.398	-1.673	-0.965	-1.046	-1.300	-0.747
GVC×L	0.202	0.135	0.265	0.517	0.381	0.635	1.053	0.779	1.283	0.759	0.579	0.929
$GVC \times L^2$	-0.030	-0.041	-0.020	-0.077	-0.098	-0.050	-0.161	-0.200	-0.107	-0.113	-0.144	-0.078

Notes: as under Table 3 in the main text
Source: own elaboration based on data from EU-SILC and WIOD

Table SM25. Estimation results – wage regression, including the interaction between fragmentation and upstreamness with additional firm level variables

Dep.var.: ln*wage*	Measure of GVC – eq.11							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sex	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
Age	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Age^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Marital status	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Higheduc	0.240***	0.240***	0.240***	0.240***	0.241***	0.240***	0.241***	0.240***
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]
RTI	-0.394***	-0.394***	-0.394***	-0.395***	-0.394***	-0.394***	-0.394***	-0.395***
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
SizeBig	0.201***	0.201***	0.201***	0.201***	0.202***	0.201***	0.202***	0.201***
	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]
SizeMed	0.090***	0.089***	0.090***	0.089***	0.090***	0.089***	0.090***	0.089***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
Contr_perm	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]
Manag	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Prod	0.039	0.038	0.04	0.037	0.041	0.036	0.04	0.037
	[0.026]	[0.025]	[0.027]	[0.026]	[0.027]	[0.025]	[0.027]	[0.025]
UP	-0.285**	-0.402**	-0.268**	-0.648***	-0.275**	-0.575**	-0.272**	-0.666***
	[0.130]	[0.162]	[0.131]	[0.234]	[0.130]	[0.232]	[0.131]	[0.239]
UP^2	0.067**	0.094**	0.063**	0.149***	0.065**	0.128**	0.064**	0.153***
	[0.029]	[0.038]	[0.029]	[0.055]	[0.029]	[0.054]	[0.029]	[0.056]
GVC	0.038	-0.45	0.047	-1.518*	0.112	-2.24	0.074	-2.139*
	[0.033]	[0.733]	[0.087]	[0.904]	[0.145]	[1.610]	[0.117]	[1.275]
GVC×UP		0.449		1.430*		2.031		2.015*
		[0.616]		[0.800]		[1.441]		[1.119]
$GVC \times UP^2$		-0.102		-0.319*		-0.427		-0.449*
		[0.130]		[0.177]		[0.324]		[0.246]
R^2	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
N	456153	456153	456153	456153	455930	455930	455930	455930

Notes: Time, country and sector dummies included. Normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses), the weights are based on personal cross-sectional weights (from EU-SILC) normalised by the number of observation per country (see main text for the details); *p ≤ .10, **p≤ .05, ***p ≤.01.
Source: own elaboration based on data from EU-SILC and WIOD

Table SM26. Estimation results – wage regression, including the interaction between fragmentation and length with additional firm level variables

Dep.var.: ln*wage*	Measure of GVC – eq.12							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sex	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
Age	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***	0.027***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Age^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Marital status	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Higheduc	0.240***	0.240***	0.240***	0.240***	0.240***	0.240***	0.240***	0.240***
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]
RTI	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***	-0.395***
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
SizeBig	0.201***	0.201***	0.202***	0.201***	0.202***	0.201***	0.202***	0.201***
	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]
SizeMed	0.089***	0.089***	0.090***	0.089***	0.090***	0.089***	0.090***	0.089***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
Contr_perm	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]
Manag	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Prod	0.03	0.028	0.03	0.026	0.03	0.026	0.03	0.026
	[0.025]	[0.025]	[0.026]	[0.025]	[0.026]	[0.025]	[0.026]	[0.025]
L	-0.037	-0.109	-0.019	-0.205**	-0.022	-0.224**	-0.021	-0.221**
	[0.037]	[0.066]	[0.037]	[0.091]	[0.038]	[0.099]	[0.037]	[0.093]
L^2	0.005	0.018	0.003	0.034**	0.003	0.038**	0.003	0.036**
	[0.005]	[0.012]	[0.005]	[0.015]	[0.005]	[0.017]	[0.005]	[0.016]
GVC	0.046	-0.153	0.058	-0.592*	0.118	-1.161*	0.088	-0.859**
	[0.039]	[0.161]	[0.096]	[0.305]	[0.171]	[0.662]	[0.131]	[0.429]
GVC×L		0.132		0.461**		0.942*		0.674**
		[0.105]		[0.223]		[0.482]		[0.313]
$GVC \times L^2$		-0.021		-0.073**		-0.153*		-0.107**
		[0.017]		[0.035]		[0.079]		[0.050]
R^2	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
N	456153	456153	456153	456153	455930	455930	455930	455930

Notes: Time, country and sector dummies included. Normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses), the weights are based on personal cross-sectional weights (from EU-SILC) normalised by the number of observation per country (see main text for the details); *p ≤ .10, **p≤ .05, ***p ≤.01.
Source: own elaboration based on data from EU-SILC and WIOD

Original citation: Szymczak S., Parteka A., Wolszczak-Derlacz J. (2019). Position in global value chains: the impact on wages in Central and Eastern European Countries. GUT FME Working Papers Series A, No 1/2019(53), Gdansk (Poland): Gdansk University of Technology, Faculty of Management and Economics.

Gdańsk University of Technology, Faculty of Management and Economics
Narutowicza 11/12, (premises at ul. Traugutta 79)
80-233 Gdańsk, phone: 58 347-18-99 Fax 58 347-18-61
www.zie.pg.edu.pl