Sabina Szymczak[1]

Production fragmentation and employment. Country-industry level analysis based on WIOD 2016[2]

Summary

The aim of this research is to reanalyse the possible impact of production fragmentation on employment using the newest world input-output database (WIOD) release (2016) and recently proposed by Timmer, Los, Stehrer and de Vries measure of production fragmentation which traces the imports needed in all stages of production. This study is provided on country-industry level for 56 industries and 41 countries for the years 2000–2014. The estimated model is based on augmented labour demand function. Our empirical results show that certain countries and sectors can in fact feel the negative impact of increasing production fragmentation on labour demand.

Keywords: global value chains, production fragmentation, global import intensity, employment

JEL: F14, F16, J21

1. Introduction

Quoting a definition used by The Global Value Chains Initiative, global value chain describes the full range of activities, divided among multiple firms and geographic spaces, that firms and workers do to bring a product/good or service from its conception to its end use and beyond[3]. Global structure of production has been changing for years and these days it is characterised by fragmentation, offshoring and large share of intermediates trade in total trade. Comparing trade

[1] Gdańsk University of Technology, Faculty of Management and Economics.

[2] This research has been conducted within a project financed by the National Science Centre, Poland (Narodowe Centrum Nauki, NCN) – decision number DEC-2015/19/B/HS4/02884. The authors are grateful to Gdańsk University of Technology, Centre of Informatics TASK for granting access to the computing infrastructure built in the projects No. POIG.02.03.00-00-028/08 "PLATON – Science Services Platform" and No. POIG.02.03.00-00-110/13 "Deploying high-availability, critical services in Metropolitan Area Networks (MAN-HA)".

[3] https://globalvaluechains.org/concept-tools.

in intermediate goods and trade in final goods, the former had a greater contribution to the growth of total manufacturing trade in the years 2000–2014[4]. This kind of changes one can observe also for services – "close to two-thirds of the growth of services value added in exports is due to an increase in services embodied in exports of other sectors – particularly foreign services, revealing the growing importance of GVCs", as reported by World Bank Group et al.[5] In a presence of this changes in international trade, a natural question arose, namely, if this phenomenon can affect workers in terms of wages and labour demand and how this possible effect looks like.

One of the aspects of globalization in trade, widely described in literature, is offshoring. It is not exactly our case, as global value chains is a much wider notion, however, a general conclusion due to the ambiguous offshoring impact on domestic labour market might be adapted for the fragmentation of production. Castellani, Mancusi, Santangelo and Zanfei[6] pointed out two different ways of possible offshoring impact. The more direct one is when offshoring some activities results in reduction of demand for native workers. Even if they will be reabsorbed into the economy, they may feel a drop in wages, as it is described in work of Grossman and Rossi-Hansberg[7] as a notion of labour-supply effect. However, we have to take into account that such restructuring processes induce cost-saving, improves the productivity and competitiveness of firms, which again may lead to the increase of demand for native workers performing the tasks that are difficult to be offshored (non-tradable). This channel of impact is called by Grossman and Rossi-Hansberg[8] as a productivity effect and by Wright[9] as an output effect. The latter also takes notice of another one – a substitution effect among factors and tasks, which impact on domestic labour market can be ambiguous.

---

[4] *Measuring and analyzing the impact of GVCs on economic development*, World Bank Group, Institute of Developing Economies, Organisation for Economic Co-operation and Development, Research Center of Global Value Chains, & World Trade Organization, 2017, http://documents.worldbank.org/curated/en/440081499424129960/Measuring-and-analyzing-the-impact-of-GVCs-on-economic-development; *Interconnected Economies*, OECD Publishing, 2013.

[5] *Measuring and analyzing*…, op.cit.

[6] D. Castellani, M.L. Mancusi, G.D. Santangelo, A. Zanfei, *Special section: Offshoring, immigration and the labour market: a micro-level perspective*, "Economia E Politica Industriale" 2015, vol. 42(2), pp. 157–162.

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

[8] Ibidem.

[9] G.C. Wright, *Revisiting the employment impact of offshoring*, "European Economic Review" 2014, vol. 66, pp. 63–83.

Furthermore, there is relative-price effect mentioned by Grossman and Rossi-Hansberg[10]. It may occur if through increased offshoring relative prices of labour-intensive goods fall and so fall the wages of low qualificated workers. Another smilar discussion one can find in Feenstra and Hanson[11]. Summing up all of these various ways of influence, we can observe different final results on employment depending on which influence was predominant[12]. This makes the problem still open to new evidence.

2. Literature review

There are many studies which investigate offshoring effect on labour markets, while the literature considering particularly production fragmentation is significantly poorer, as pointed out in Castellani et al.[13] Production fragmentation impact on employment in manufacture industries is studied in Helg and Tajoli[14], using re-imports over gross domestic output as a fragmentation index but only for a case of Germany and Italy. Manufacturing industries are studied also in work of Wolszczak-Derlacz and Parteka[15], where the implications of international fragmentation of production on wages are examined, employing import- versus export-based measures for 1995–2011 period. Timmer, Los, Stehrer and de Vries[16], by introducing a framework of 'manufactures GVC jobs', measure the number and types of workers in a country who are involved in GVC production and show for EU that declining number of jobs in manufacturing occurs simultaneously with increasing number of manufactures GVC jobs in non-manufacturing, in particular in business services. In more theoretical works Long,

[10] G.M. Grossman, E. Rossi-Hansberg, op.cit.

[11] R. Feenstra, G. Hanson, *Global Production Sharing and Rising Inequality: A Survey of Trade and Wages*, NBER Working Paper Series no. 8372, 2001.

[12] G.C. Wright, op.cit.

[13] D. Castellani, M.L. Mancusi, G.D. Santangelo, A. Zanfei, op.cit.

[14] R. Helg, L. Tajoli, *Patterns of international fragmentation of production and the relative demand for labor*, "The North American Journal of Economics and Finance" 2005, vol. 16(2), pp. 233–254.

[15] J. Wolszczak-Derlacz, A. Parteka, *Quantifying wage effects of offshoring: import- versus export-based measures of production fragmentation*, "Economics and Business Review" 2016, vol. 2(16), pp. 99–120.

[16] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *Fragmentation, incomes and jobs: an analysis of European competitiveness*, "Economic Policy" 2013, vol. 28(76), pp. 613–661.

Riezman and Soubeyran[17] explore the link between services and fragmentation, while Egger and Kreickemeier[18] investigate how international fragmentation affects the skill premium and unemployment in a small open economy.

In our paper we decide to investigate labour demand changes rather than wages. Taking into account a potential danger, pointed out in Wolszczak-Derlacz and Parteka[19], that political regulations and rigid wages in some countries may disturb the real impact of changes like increasing offshoring and international fragmentation on wages, it seems to be reasonable to focus on employment on which this disturbances should be weaker.

Another thing to consider is that there are different ways to estimate the international trade, such as Trade in Value Added approach, proposed by OECD & WTO, trade in tasks as in Grossman and Rossi-Hansberg[20], or several decompositions of gross trade[21] or offshoring[22]. In particular case of fragmentation, one can mention a measure of upstreamness describing relative position of an industry in a production line[23]. In this paper as a measure of production fragmentation we decided to use global import intensity index (GII) proposed by Timmer, Los, Stehrer and de Vries[24], which traces the imports needed in all stages of production, not only the import of intermediates from first-tier suppliers. It is showed in Timmer's et al.[25] work that more classical measure which is the last-stage indicator shows much lower import intensities than the new one. Hence, it is reasonable to apply GII to the analysis as a more precise tool to follow

[17] N. Van Long, R. Riezman, A. Soubeyran, *Fragmentation and services*, "The North American Journal of Economics and Finance" 2005, vol. 16(1), pp. 137–152.

[18] H. Egger, U. Kreickemeier, *International fragmentation: Boon or bane for domestic employment?*, "European Economic Review" 2008, vol. 52(1), pp. 116–132.

[19] J. Wolszczak-Derlacz, A. Parteka, *Does offshoring affect industry employment? Evidence from a wide European panel of countries*, "Journal of International Studies" 2015, vol. 8, no 1.

[20] G.M. Grossman, E. Rossi-Hansberg, op.cit.

[21] Z. Wang, S.-J. Wei, K. Zhu, *Quantifying International Production Sharing at the Bilateral and Sector Levels*, National Bureau of Economic Research, 2013.

[22] D. Castellani, M.L. Mancusi, G.D. Santangelo, A. Zanfei, op.cit.

[23] P. Antràs, D. Chor, T. Fally, R. Hillberry, *Measuring the Upstreamness of Production and Trade Flows*, "American Economic Review" 2012, vol. 102(3), pp. 412–416; J. Hagemejer, M. Ghodsi, *Up or down the value chain? The comparative analysis of the GVC position of the economies of the new EU member states*, Faculty of Economic Sciences, University of Warsaw, Working Papers no. 2016-23, 2016, https://ideas.repec.org/p/war/wpaper/2016-23.html.

[24] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release*, "GGDC Research Memorandum" 2016, https://ideas.repec.org/p/gro/rugggd/gd-162.html.

[25] Ibidem.

complicated structure of global value chains, in which a significant part of value creation might take place in deeper stages of a supply chain.

Our paper contributes to the literature not only by employing this new measure of production fragmentation as a variable describing GVCs in a model analysing changes in labour demand. We carry out our research for all 56 sectors available in WIOD database, while existing literature mainly focus either on manufacturing or (rarely) on services. Additionally, our analysis covers a wide group of 41 countries. Also, we use the latest available input-output data to make our results up to date. The research hypothesis which we want to verify is that production fragmentation has a significant and negative impact on domestic level of employment.

This paper is structured as follows. In section 2 we describe the data and model for further estimation. Section 3 presents results of empirical analysis of general model as well as estimations conducted for groups of countries, sectors and different time periods. Section 4 concludes our findings.

3. Data and methodology

The analysis carried out in this paper is based on data from World Input-Output Tables (WIOT) and Socio Economic Accounts (SEA), both from WIOD, release 2016. The general estimations are made for 56 industries and 41 countries available in WIOD, except China and Taiwan, which we had to exclude due to the lack of data[26]. Time period of the analysis are years between 2000 and 2014. From SEA we take information about total hours worked by employees, nominal capital stock and labour compensation. Variables expressed in national currencies are deflated by a price deflator for basic year 2011 (taken from Penn World Table) and converted in USD PPPs using 2011 USD PPPs for private consumption (taken from OECD)[27]. This methodology is consistent with the one adapted by OECD e.g. for average annual wages.

[26] No data about total hours worked by employees for China in SEA, no PPPs for Taiwan in OECD.

[27] As a robustness check we repeat the same analysis using 2011 exchange rate, national currency/USD, taken from Penn World Table. Obtained results does not differ significantly from presented ones.

Following Timmer's methodology[28], we calculate global import intensity (GII) of production for every country, industry and year using data from input-output tables[29]. This measure traces the imports needed in all stages of production, not only the import of intermediates from first-tier suppliers, however, we calculate first-tier suppliers imports as well for estimating alternative model for comparison. According to Timmer et al.[30], GII as the total value of imports related to production of the final output of industry i in country j (i = 1, 2,…, N, j = 1, 2, …, C) can be obtained by summing elements of the matrix M_{ij}^{Int}, which is calculated as a sum of sequence of matrices corresponding to imports from subsequent tier suppliers:

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

where A is a matrix of intermediate input requirements of dimensions CNxCN, I denotes identity matrix of the same dimension, z is a CN-column vector with 1 for sector i in country j and zeros elsewhere and T stands for 'trade selection' CNxCN matrix, which cuts off domestic transaction[31]. The asterisk denotes elementwise multiplication of matrices. GII takes values between 0 and 1 and can be interpreted as a dollar amount of imports related to the production of one dollar worth in particular sector[32]. According to Timmer et al.[33], it increases if more imports are used in any stage of production, or because new stages (with similar import requirements) are added through further fragmentation. On the graph we can see averages of GII calculated for industries divided into 13 main groups (for description of the NACE Rev. 2 code see the table below the graph) over all countries for years 2000–2014. Manufacturing clearly distinguishes itself with the highest GII level. In construction and mining the values are comparable to the values for transportation or electricity, gas and water supply. However,

[28] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global…*, op.cit.

[29] The R code for calculation of GII can be shared upon request.

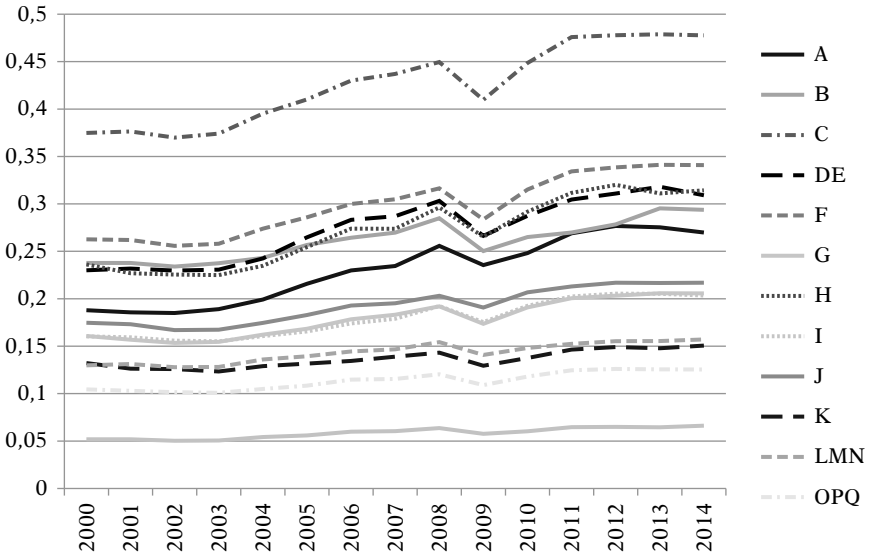
[30] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global…*, op.cit.

[31] For more detailed explanation of the formulation see ibidem, as well as R.E. Miller, P.D. Blair, *Input-output analysis: foundations and extensions*, Cambridge University Press, New York 2009, https://econpapers.repec.org/bookchap/cupcbooks/9780521739023.htm for conditions of convergence of this summation.

[32] There might be some exceptions when it can be higher than 1 if imports are measured on a gross basis and double counting of value added contributions takes place. In our panel we found 114 such cases and we dropped them from our dataset.

[33] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global…*, op.cit.

in general services show the lowest global import intensities. Except a drop in the crisis period, the increasing tendency mentioned in introduction to this paper is clearly visible for each case, still in the last years we can observe a slowdown[34].



Graph 1. Global import intensity (GII) – industries averages over countries in years 2000–2014

Source: Own calculations following methodology from: M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release*, „GGDC Research Memorandum" 2016, https://ideas.repec.org/p/gro/rugggd/gd-162.html.

To investigate this increasing trend in fragmentation of production impact on employment we chose a model similar to the one used in work of Wolszczak-Derlacz and Parteka[35]. It can be expressed as:

$$\Delta lnEmp_{ij,t} = \alpha_{ij} + \beta_1 \Delta lnW_{ij,t} + \beta_2 \Delta lnK_{ij,t} + \beta_3 \Delta lnGII_{ij,t} + \varepsilon_{ij,t}$$

where *i* refers to country, *j* to industry and *t* to year. Employment (*Emp*) is measured in terms of total hours worked by employees, real wage denoted by *W* is measured as labour compensation per hour and *K* stands for capital per labour ratio. We also include time dummies in the model, as we expect time-fixed effects after providing Wald test for joint significance of time dummies. Relying on the

[34] Ibidem.

[35] J. Wolszczak-Derlacz, A. Parteka, *Does offshoring affect*..., op.cit.

Hausman test, we use fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors to prevent possible problems caused by heteroscedasticity[36].

Table 1. List of codes for main classification of industries (NACE rev.2)

	Code	Industry
1	A	Agriculture, forestry & fishing
2	B	Mining & quarrying
3	C	Manufacturing
4	DE	Electricity, gas, steam & air conditioning supply. Water supply, sewerage, waste management & remediation activities
5	F	Construction
6	G	Wholesale & retail trade; repair of motor vehicles & motorcycles
7	H	Transportation & Storage
8	I	Accommodation & food service activities
9	J	Information & communication
10	K	Financial & insurance activities
11	LMN	Real estate activities. Professional, scientific & technical activities. Administrative & support service activities
12	OPQ	Public administration & defence; compulsory social security. Education. Human health & social work activities
13	RSTU	Arts, entertainment & recreation. Other service activities. Activities of households as employers; undifferentiated goods- & services-producing activities of households for own use. Activities of extraterritorial organisations & bodies

Notes: For detailed description of 56 subsectors available in WIOD see: M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release*, "GGDC Research Memorandum" 2016, https://ideas.repec.org/p/gro/rugggd/gd-162.html.

We also check for stationarity by Fisher test for panel unit root using an augmented Dickey-Fuller test. Finally, we estimate model given by equation:

$$\Delta lnEmp_{ij,t} = \alpha_{ij} + \beta_1 \Delta lnW_{ij,t} + \beta_2 \Delta lnK_{ij,t} + \beta_3 \Delta lnGII_{ij,t} + \gamma_t + \varepsilon_{ij,t} \quad (1)$$

[36] D. Hoechle, *Robust standard errors for panel regressions with cross-sectional dependence*, "Stata Journal" 2007, vol. 7(3), pp. 281–312, https://econpapers.repec.org/article/tsjstataj/v_3a7_3ay_3a2007_3ai_3a3_3ap_3a281-312.htm; A. Bramucci, V. Cirillo, R. Evangelista, D. Guarascio, *Offshoring, industry heterogeneity and employment*, "Structural Change and Economic Dynamics" 2017.

and an alternative one with additional country-time dummy[37]:

$$\Delta lnEmp_{ij,t} = \alpha_{ij} + \beta_1 \Delta nW_{ij,t} + \beta_2 \Delta lnK_{ij,t} + \beta_3 \Delta lnGII_{ij,t} + \gamma_t + \delta_{it} + \varepsilon_{ij,t} \quad (2)$$

As it was stated before, we also compare these results to the one obtained by employing only first-tier import intensity (denoted by *tier1*) instead of GII, to confirm if these measures really differ in a significant way.

4. Results

Table 2 presents results of the two regression models above ran for the all sectors and countries pooled together, each model separately with GII or first-tier import intensity. In each case we obtained a negative and statistically significant coefficients for wage and capital per labour ratio, which means that, ceteris paribus, the higher the change in wage (or analogously in a capital per labour ratio), the lower the change in labour demand, which is consistent with the existing literature[38].

We are especially interested in the response of employment to changes of global import intensity. For the term connected with GII we also obtained a statistically significant negative parameter. An interpretation of this might be as follows: the higher is the growth of global import intensity, the lower is the growth of employment. It might confirm expected loss in employment caused by increasing complexity and value of supply chains. For the variable tier1 coefficients are also negative and statistically significant but smaller in terms of absolute value than they were for GII. It might imply that when taking into account import flows only on the finishing stage of production we are not able to observe the real scale of production fragmentation impact on employment. Hence, following analysis will use GII as a measure of fragmentation employed in a model (2), as we can see in Table 2 that the specification with country-time dummies gives better fit that model (1).

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

[38] J. Wolszczak-Derlacz, A. Parteka, *Does offshoring affect…*, op.cit.; A. Bramucci, V. Cirillo, R. Evangelista, D. Guarascio, op.cit.

Table 2. Estimation results: comparison between using GII and last stage imports

Dependent variable: $\Delta lnEmp_{ij,t}$				
	(1)		(2)	
$\Delta lnW_{ij,t}$	–0.652***	–0.648***	–0.784***	–0.783***
	[0.018]	[0.018]	[0.019]	[0.019]
$\Delta lnK_{ij,t}$	–0.502***	–0.500***	–0.545***	–0.544***
	[0.035]	[0.036]	[0.039]	[0.039]
$\Delta lnGII_{ij,t}$	–0.179***		–0.159***	
	[0.020]		[0.022]	
$\Delta lntier1_{ij,t}$		–0.131***		–0.117***
		[0.014]		[0.015]
R ^ 2	0.552	0.548	0.667	0.664
No of groups	2 136	2 136	2 136	2 136
No of observations	29 764	29 764	29 764	29 764

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Constant not reported. Fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors (reported in square brackets).

As a next step of analysis, we study employment response to changes in global import intensity separately for agriculture (A), manufacturing (C) and services (codes D, E and from G onward). In each case the impact of GII on employment is negative and statistically significant. Not surprisingly, it is much higher for manufacturing than for the other two, which is consistent with common evidence present in literature that manufacturing is a sector most affected in the negative way by analysed processes[39].

Table 3. Estimation results: separately for Agriculture, Manufacturing and Services

Dependent variable: $\Delta lnEmp_{ij,t}$			
	A	C	Services
$\Delta lnW_{ij,t}$	–0.776***	–0.758***	–0.791***
	[0.036]	[0.033]	[0.024]
$\Delta lnK_{ij,t}$	–0.585***	–0.518***	–0.526***
	[0.054]	[0.059]	[0.050]
$\Delta lnGII_{ij,t}$	–0.135***	–0.240***	–0.144***
	[0.044]	[0.048]	[0.027]

[39] A. Bramucci, V. Cirillo, R. Evangelista, D. Guarascio, op.cit.; T. Brändle, A. Koch, *Offshoring and Outsourcing Potentials of Jobs Evidence from German Micro-Level Data*, "IAW-Diskussionspapiere" 2014, vol. 110, http://hdl.handle.net/10419/107648.

Dependent variable: $\Delta lnEmp_{ij,t}$			
	A	C	Services
R ^ 2	0.851	0.646	0.683
No of groups	119	762	1173
No of observations	1666	10561	16393

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Constant not reported. Fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors (reported in square brackets).

As the services group is a large aggregate, in the next table we present the results for more disaggregated services sectors. Results for RSTU group is not reported as the parameter connected to GII, in contrast to remaining services, was insignificant. We can observe relatively large coefficient (in the terms of absolute value) for transportation (H), in fact much bigger than the one we previously received for manufacturing. Also in information & communication as well as in wholesale increase in fragmentation of production process might negatively influence employment level in stronger manner than in other sectors. Coefficient much closer to zero for group containing mostly public services – administration, education and health (OPQ) is not a surprise. Other example of low employment response to changes in GII is visible for financial & insurance activities.

Table 4. Estimation results: different service sectors

Dependent variable: $\Delta lnEmp_{ij,t}$							
	DE	G	H	J	K	LMN	OPQ
$\Delta lnW_{ij,t}$	–0.882***	–0.781***	–0.792***	–0.866***	–0.769***	–0.768***	–0.731***
	[0.032]	[0.063]	[0.058]	[0.038]	[0.061]	[0.055]	[0.058]
$\Delta lnK_{ij,t}$	–0.640***	–0.672***	–0.526***	–0.661***	–0.313***	–0.593***	–0.379***
	[0.040]	[0.093]	[0.103]	[0.090]	[0.095]	[0.104]	[0.066]
$\Delta lnGII_{ij,t}$	–0.114***	–0.193**	–0.394***	–0.242***	–0.076*	–0.122***	–0.039***
	[0.031]	[0.091]	[0.081]	[0.078]	[0.042]	[0.045]	[0.013]
R ^ 2	0.909	0.863	0.684	0.845	0.756	0.747	0.857
No of groups	116	123	200	156	114	259	122
No of obs.	1618	1722	2790	2184	1583	3626	1708

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Constant not reported. Fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors (reported in square brackets).

We also run the estimations for each country separately. Due to the space constraints, we do not report here all detailed results (but available from authors

upon request). Instead of them, we would like to point out a brief summary. Statistically significant coefficient corresponding to GII term are obtained for 26 of 41 analysed countries. These are AUS, AUT, BEL, BGR, CAN, CHE, ESP, EST, FRA, GBR, HRV, HUN, IND, IRL, ITA, LTU, LUX, LVA, MLT, NLD, NOR, POL, ROU, RUS, SVN and TUR. Except a single case of Norway (this exception would need a deepened case study to be explained), for which the coefficient has a positive sign, all remaining 25 coefficients are negative. The largest GII impact on employment is observed for CEE countries like POL ($\beta_3 = -0.544$), SVN, EST, HRV, HUN, LTU and small countries like MLT or LUX. Smallest value among these 25 countries equals –0.036 and appears for Russia. Motivated by these particular results in the Table 5 we show results of our model ran for the whole group EU28 as well as for EU15 and CEE countries. Clear difference is visible between EU15 and CEE and so the partial results for particular countries are confirmed, namely, stronger impact of fragmentation on labour market is observed for CEE than for the old EU members. It may be connected to the evidence given in recent report regarding GVCs[40] that CEE countries are upgrading their position along the chain. Hence, they may take over the role of economies more affected by globalisation changes in trade.

Table 5. Estimation results: separately for EU28, EU15 and CEE

Dependent variable: $\Delta lnEmp_{ij,t}$			
	EU28	EU15	CEE
$\Delta lnW_{ij,t}$	–0.769***	–0.595***	–0.807***
	[0.023]	[0.051]	[0.021]
$\Delta lnK_{ij,t}$	–0.523***	–0.327***	–0.455***
	[0.043]	[0.046]	[0.048]
$\Delta lnGII_{ij,t}$	–0.174***	–0.105***	–0.192***
	[0.027]	[0.025]	[0.049]
R ^ 2	0.646	0.436	0.719
No of groups	1506	807	594
No of observations	20944	11251	8265

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Constant not reported. Fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors (reported in square brackets).

Motivated by the clear drop in GII visible on the graph presented above we provide separate analysis for pre- and post-crisis period, namely 2000 to 2008

[40] *Measuring and analyzing*..., op.cit.

and 2009 to 2014. This division is also suggested by slowdown in international trade and increased demand for services (which are less trade intensive than goods) in the latter period in relation to the former one[41]. Indeed, GII coefficients differ in both periods and for the years after crisis the parameter is two times smaller than before. It might be a sign that not only trade and fragmentation decreased, but also did the fragmentation impact on labour market. It might be worth noticing that while the impact of GII decreases after 2008, it is somehow compensated by increase of impact of change in wages and capital per labour ratio.

Table 6. Estimation results: pre- and post-crisis period

Dependent variable: $\Delta lnEmp_{ij,t}$		
	pre-crisis 2000–2008	post-crisis 2009–2014
$\Delta lnW_{ij,t}$	–0.775***	–0.846***
	[0.028]	[0.026]
$\Delta lnK_{ij,t}$	–0.514***	–0.619***
	[0.059]	[0.053]
$\Delta lnGII_{ij,t}$	–0.224***	–0.100***
	[0.026]	[0.032]
R ^ 2	0.653	0.745
No of groups	2136	2128
No of observations	17052	10585

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Constant not reported. Fixed-effects (within) model, with robust and clustered (country-industry specific) standard errors (reported in square brackets).

5. Conclusion

The main aim of this paper was to investigate production fragmentation impact on domestic employment in the presence of progressing internationalization trends in trade and increasing importance of global value chains.

This question was raised in literature mostly in terms of offshoring, more often for manufacturing sectors than for services. To fulfil this gap we performed our analysis focusing on fragmentation of production aspect of GVCs for wide panel of 56 industries and 41 countries of the world for the period 2000–2014.

[41] M.P. Timmer, B. Los, R. Stehrer, G.J. de Vries, *An Anatomy of the Global…*, op.cit.

Thanks to the newest release of WIOD input-output tables we could built an up to date panel applying recently presented global import intensity measure, which traces the imports needed in all stages of production.

Our results confirm the negative impact of growth in GII on employment growth.. For more than 60% of analysed countries GII is a significant determinant of changes in employment. It is worth pointing out that in CEE group of countries this effect seems to be more visible than for rest of Europe. Not surprisingly, with regard to industry-oriented analysis, manufacturing turned out to be more responsive to fragmentation than services, however, with a closer look to particular service sectors we obtained cases even higher responsive to this phenomenon, e.g. transportation, information, communication and wholesale. Studies conducted separately for pre- and post-crisis periods showed that this impact decreased in the latter one.

As a further research it would be advisable to e. g. employ workers division into skill groups or include in the model country-level variables describing political regulation relative to labour market and wages. Such extended research could possibly lead to formulation of practical policy recommendations.

Acknowledgements

I am grateful to Joanna Wolszczak-Derlacz for useful comments and suggestions.

References

Antràs P., Chor D., Fally T., Hillberry R., *Measuring the Upstreamness of Production and Trade Flows*, "American Economic Review" 2012, vol. 102(3), pp. 412–416. https://doi.org/10.1257/aer.102.3.412.

Bramucci A., Cirillo V., Evangelista R., Guarascio D., *Offshoring, industry heterogeneity and employment*, "Structural Change and Economic Dynamics" 2017, https://doi.org/10.1016/J.STRUECO.2017.09.002.

Castellani D., Mancusi M.L., Santangelo G.D., Zanfei A., *Special section: Offshoring, immigration and the labour market: a micro-level perspective*, "Economia E Politica Industriale" 2015, vol. 42(2), pp. 157–162, https://doi.org/10.1007/s40812-015-0009-2.

Egger H., Kreickemeier U., *International fragmentation: Boon or bane for domestic employment?*, "European Economic Review" 2008, vol. 52(1), pp. 116–132, https://doi.org/10.1016/J.EUROECOREV.2007.01.006.

Feenstra R., Hanson G., *Global Production Sharing and Rising Inequality: A Survey of Trade and Wages*, NBER Working Paper Series no. 8372, 2001, https://doi.org/10.3386/w8372.

Grossman G.M., Rossi-Hansberg E., *Trading Tasks: A Simple Theory of Offshoring*, "American Economic Review" 2008, vol. 98(5), pp. 1978–1997, https://doi.org/10.1257/aer.98.5.1978.

Helg R., Tajoli L., *Patterns of international fragmentation of production and the relative demand for labor*, "The North American Journal of Economics and Finance" 2005, vol. 16(2), pp. 233–254, https://doi.org/10.1016/J.NAJEF.2005.02.002.

Interconnected Economies, OECD Publishing, 2013, https://doi.org/10.1787/9789264189560-en.

Polgár É.K., Wörz J., *No risk and some fun? Trade and wages in the enlarged European Union*, "Empirica" 2010, vol. 37(2), pp. 127–163, https://doi.org/10.1007/s10663-010-9131-6.

Timmer M.P., Dietzenbacher E., Los B., Stehrer R., de Vries G.J., *An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production*, "Review of International Economics" 2015, vol. 23(3), pp. 575–605, https://doi.org/10.1111/roie.12178.

Timmer M.P., Los B., Stehrer R., Vries G.J. de, *Fragmentation, incomes and jobs: an analysis of European competitiveness*, "Economic Policy" 2013, vol. 28(76), pp. 613–661, https://doi.org/10.1111/1468-0327.12018.

Van Long N., Riezman R., Soubeyran A., *Fragmentation and services*, "The North American Journal of Economics and Finance" 2005, vol. 16(1), pp. 137–152, https://doi.org/10.1016/J.NAJEF.2005.01.001.

Wang Z., Wei S.-J., Zhu K., *Quantifying International Production Sharing at the Bilateral and Sector Levels*, "National Bureau of Economic Research, 2013, https://doi.org/10.3386/w19677.

Wolszczak-Derlacz J., Parteka A., *Does offshoring affect industry employment? Evidence from a wide European panel of countries*, "Journal of International Studies" 2015, vol. 8, no. 1, pp. 41–52, https://doi.org/10.14254/2071-8330.2015/8-1/4.

Wolszczak-Derlacz J., Parteka A., *Quantifying wage effects of offshoring: import- versus export-based measures of production fragmentation*, "Economics and Business Review" 2016, vol. 2(16), pp. 99–120, https://doi.org/10.18559/ebr.2016.3.7.

Wright G.C., *Revisiting the employment impact of offshoring*, "European Economic Review" 2014, vol. 66, pp. 63–83, https://doi.org/10.1016/j.euroecorev.2013.11.008.

Web resources

Brändle T., Koch A., *Offshoring and Outsourcing Potentials of Jobs Evidence from German Micro-Level Data*, "IAW-Diskussionspapiere" 2014, vol. 110, http://hdl.handle.net/10419/107648.

Hagemejer J., Ghodsi M., *Up or down the value chain? The comparative analysis of the GVC position of the economies of the new EU member states*, Faculty of Economic Sciences, University of Warsaw, Working Papers no. 2016-23, 2016, https://ideas.repec.org/p/war/wpaper/2016–23.html.

Hoechle D., *Robust standard errors for panel regressions with cross-sectional dependence*, "Stata Journal" 2007, vol. 7(3), pp. 281–312, https://econpapers.repec.org/article/tsjstataj/v_3a7_3ay_3a2007_3ai_3a3_3ap_3a281-312.htm.

https://globalvaluechains.org/concept-tools (access: 14.04.2018).

Measuring and analyzing the impact of GVCs on economic development, World Bank Group, Institute of Developing Economies, Organisation for Economic Co-operation and Development, Research Center of Global Value Chains, & World Trade Organization, 2017, http://documents.worldbank.org/curated/en/440081499424129960/Measuring-and-analyzing-the-impact-of-GVCs-on-economic-development.

Miller R.E., Blair P.D., *Input-output analysis: foundations and extensions*, Cambridge University Press, New York 2009, https://econpapers.repec.org/bookchap/cupcbooks/9780521739023.htm.

Timmer M.P., Los B., Stehrer R., Vries G.J. de, *An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release*, "GGDC Research Memorandum" 2016, https://ideas.repec.org/p/gro/rugggd/gd-162.html.

* * *

Fragmentaryzacja produkcji a zatrudnienie. Analiza na poziomie kraj–sektor z wykorzystaniem danych z WIOD 2016

Streszczenie

Artykuł przedstawia analizę wpływu fragmentaryzacji produkcji na poziom zatrudnienia. Do tego celu została wykorzystana najnowsza wersja bazy danych WIOD (2016) oraz miara fragmentaryzacji, którą zaproponowali M.P. Timmer, B. Los, R. Stehrer i G.J. de Vries i która pozwala na uwzględnienie importów potrzebnych na wszystkich poprzednich etapach produkcji. Analizę przeprowadzono na poziomie kraj–sektor dla 56 sektorów i 41 krajów w okresie 2000–2014. Wykorzystany model jest oparty na rozszerzonej funkcji popytu na pracę. Uzyskane wyniki pokazują, że w przypadku części analizowanych krajów i sektorów możemy obserwować istotny negatywny wpływ rosnącej fragmentaryzacji na zmiany poziomu zatrudnienia.

Słowa kluczowe: globalne łańcuchy wartości, fragmentaryzacja produkcji, globalna intensywność importu, zatrudnienie