Position in Global Value Chains and its Impact on Wages -The Case of Central and Eastern European Countries

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Motivation

- To empirically test the nexus between production fragmentation and labour market outcome (wages);
- Many different measures of international production fragmentation (e.g. offshoring indices, export decomposition, global import intensity, measures of relative industry position in the production chain)
- Do the obtained results of fragmentation impact on labour market depend on a choice of a measure? Are these measures strongly correlated?
- To empirically test smile curve - wages along the GVC

Previous studies of labour market response to fragmentation of production

- Recent studies of production fragmentation impact on wages: Baumgarten et al., 2013; Crin, 2010; Ebenstein et al., 2014; Geishecker and Gorg, 2013; Geishecker et al., 2010; Hummels et al., 2014; Parteka and Wolszczak-Derlacz, 2015; Wolszczak-Derlacz and Parteka, 2018
- Not only the involvement in production fragmentation is important, but also the position of a country-sector in the production chain (e.g. Hagemejer and Ghodsi, 2016)
- Central and Eastern European (CEE) countries - relatively less described in the literature than e.g. US or EU15 (Hagemejer 2015, 2017)

Data

- World Input-Output Database (WIOD), release 2016
- EU-SILC database (cross-sectional, ver. 1, August 2016)
  - 2005-2014
  - 10 CEE countries: BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK.
  - individual characteristics: sex, age, marital status, education level (high/medium&low).
  - labour characteristics: size of a company (micro/medium/big), type of contract (permanent/temporal), managerial position, sector of employment (NACE rev.1.1 / NACE rev.2), occupation (2-digit ISCO-88 / 08 classification), experience, NUTS region.
  - HICP from EUROSTAT (2015=100).

Data

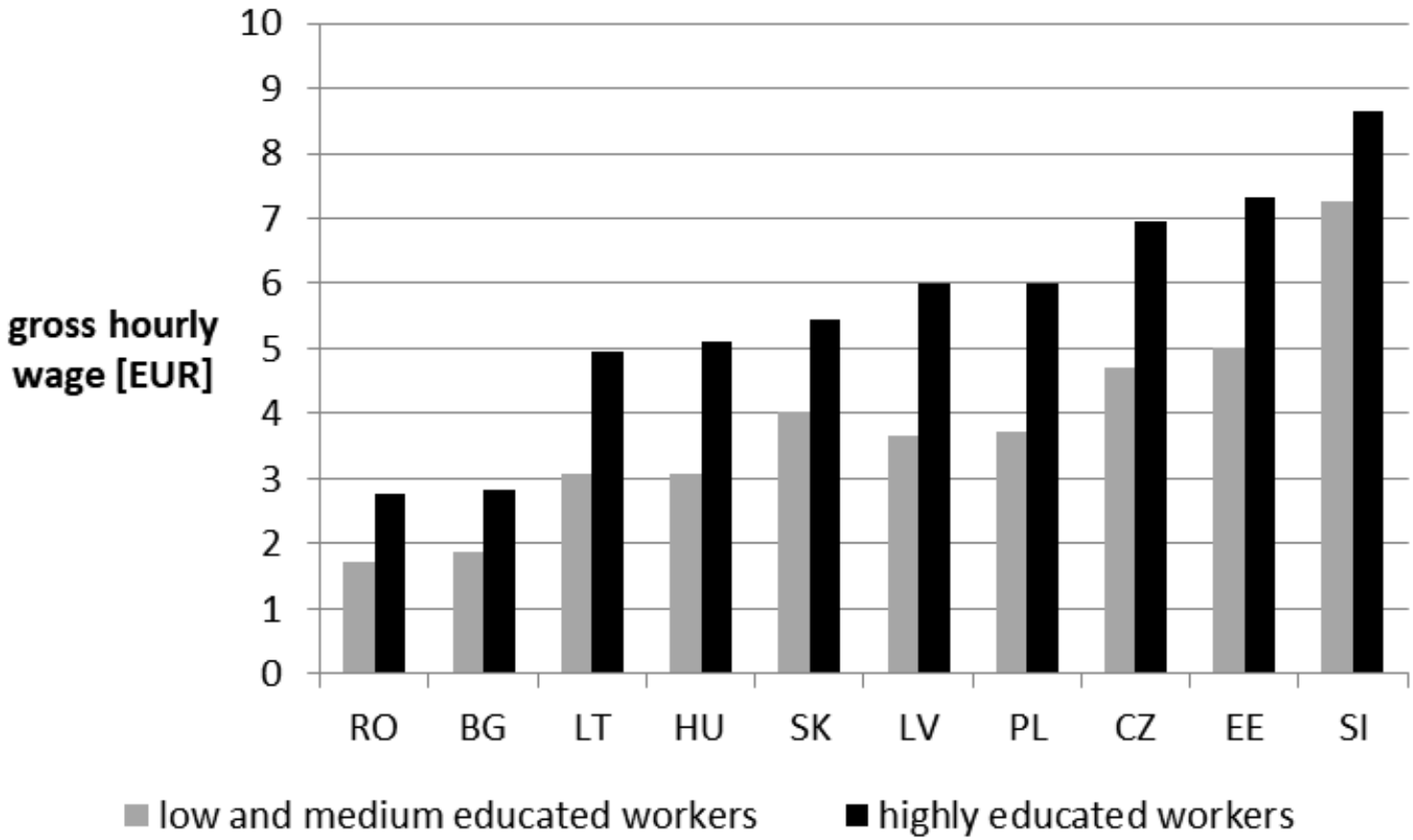
- Wage calculation (on EU-SILC data) based on Engel and Schafer (2012); Schafer and Gottschall (2015).
- Hourly earnings (gross hourly wages) calculated using data about gross annual employee income, number of months worked during the income reference year and number of hours worked per week in the main job.
- Sample: full-time workers, age 18-65, without armed force occupations.

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

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

The import-based measure of offshoring versus Global Import Intensity

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

where $i, k = 1, ..., N$ and:

- imp_inputs_{ikt} denotes the volume of inputs imported from industry k to industry i in year t

(Feenstra and Hanson, 1999; Hijzen and Swaim, 2007; Castellani et al., 2013)

Global import intensity

Timmer et al., 2016

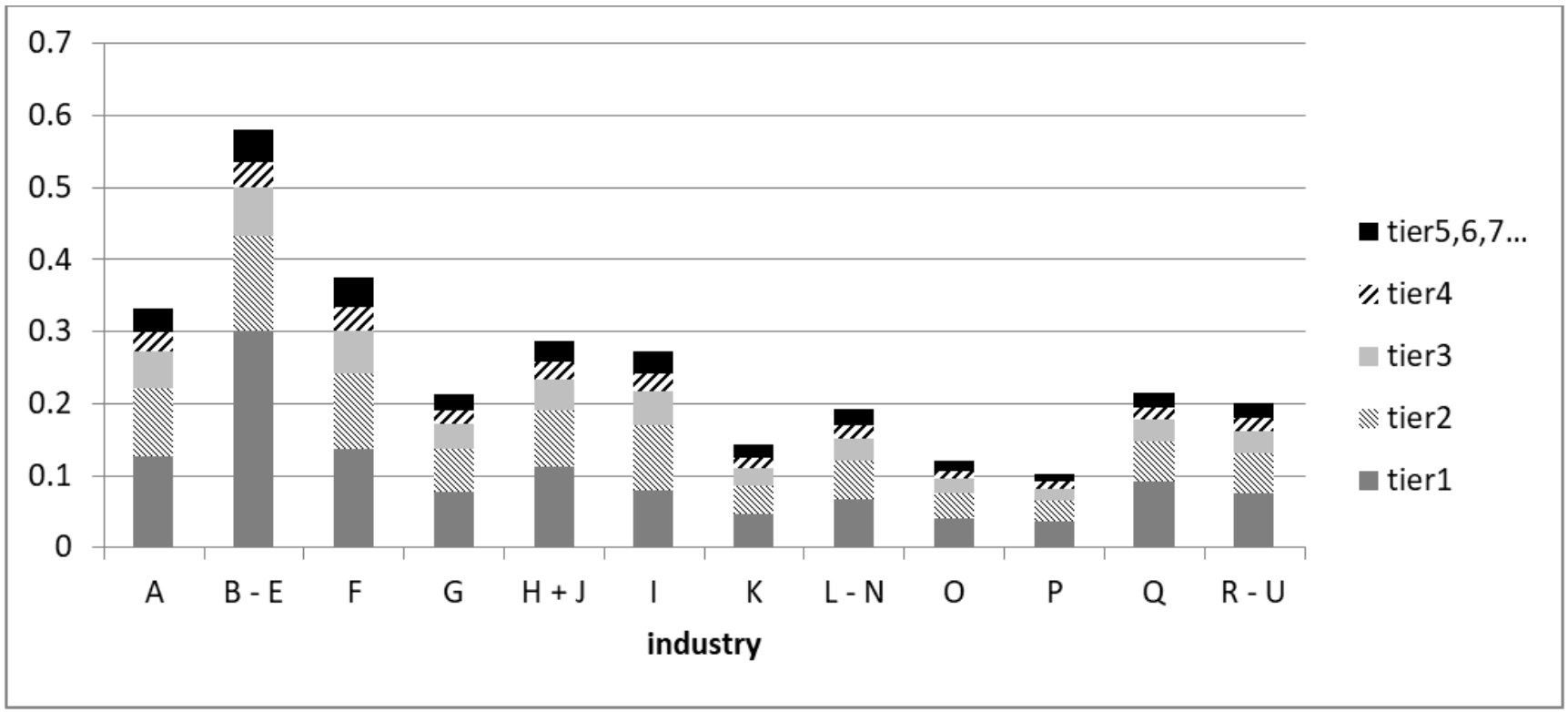
$$M_{ij}^{Int} = M_{ij}^{tier1} + M_{ij}^{tier2} + M_{ij}^{tier3} + ... = T * \left[A\overline{[(I - A)^{-1}z]} \right]$$

where :

- $M_{ij}^{tier\_n}$ corresponds to imports on nth stage of production
- A - matrix of intermediate input requirements
- I - identity matrix
- z - column vector with 1 for sector i in country j and zeros elsewhere
- T - trade selection matrix

As a ratio of GVC imports to value of a final product, GII can be interpreted as a dollar amount of imports related to the production of one dollar in ij.

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



Notes: mean values over countries, observations weighted by value added. Sample: 10 CEECs Sample: 10 CEECs (BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK). Industries: A- Agriculture; B - E: Mining, manufacturing and electricity&water; F - Construction; G - Wholesale, H+J: Transportation and communication; I - Food& accomodation; K - Financial activities; L-N: Real estate, professional & scientific and administrative activities; O - Public administration; P - Education; Q - Health; R-U: Other services.
Source: own elaboration based on WIOD (2016)

Export based measures of fragmentation: export decomposition

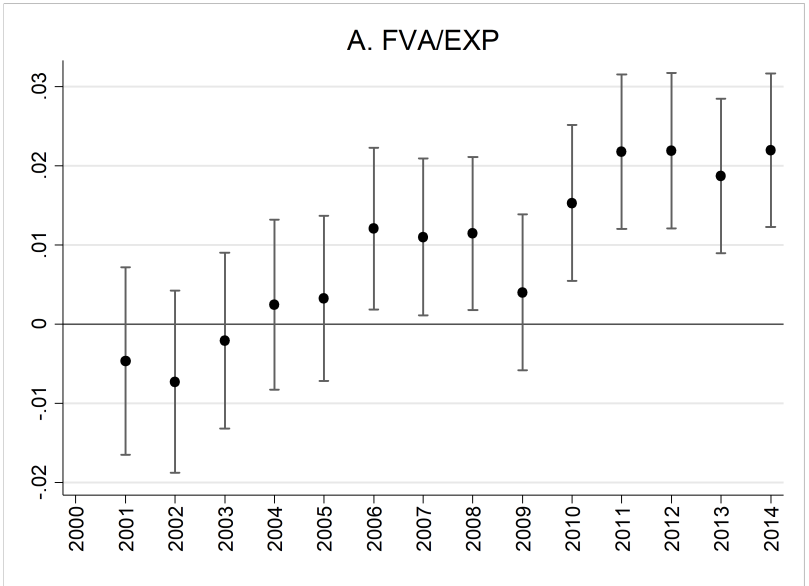
Wang, Wei and Zhu, 2013

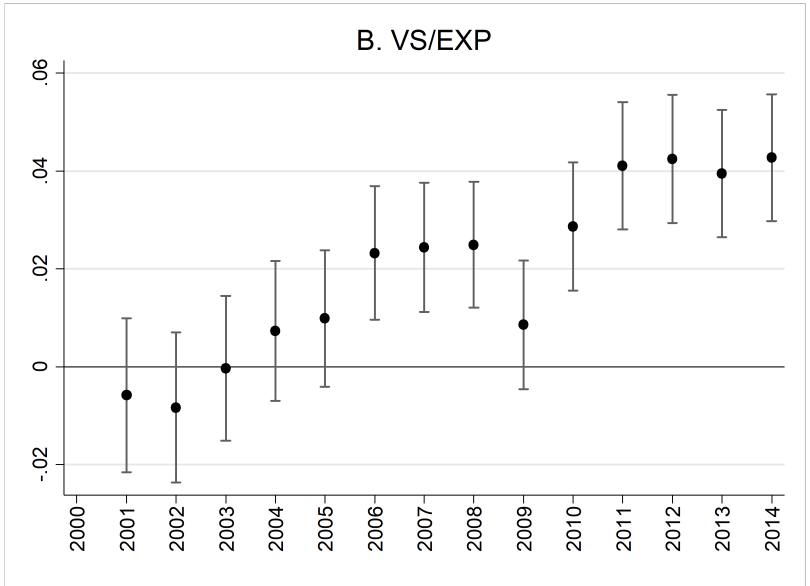
$$Gross\ exports = DVA + RDV + FVA + PDC =$$

$$= DVA + RDV + \underbrace{(FVA\_FIN + FVA\_INT) + (FDC}_{VS} + DDC)$$

- DVA - domestic value added
- RVA - returned value added
- FVA_FIN , FVA_INT - foreign value added embodied in exports of final goods / intermediates
- FDC , DDC - pure double counting from foreign / domestic sources
- VS - vertical specialization (import content of exports)

Trends in FVA and VS shares of exports, 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 FVA/EXP (VS/EXP) 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.

Measures of country-sector position in the production chain

Upstreamness (Fally, 2011; Antras et al., 2012, Hagemejer and Ghodsi, 2016)

$$U = (I - \Delta)^{-1} u$$

where :

- U - column vector containing upstreamness values for every country-sector
- I identity matrix
- Δ - matrix of elements δ_{ik} - output of i used by k as intermediates, divided by output of i
- u - summation vector

The higher the upstreamness, the further the industry's position with respect to the final demand.

Measures of country-sector position in the production chain

Length of GVC (Fally, 2012)

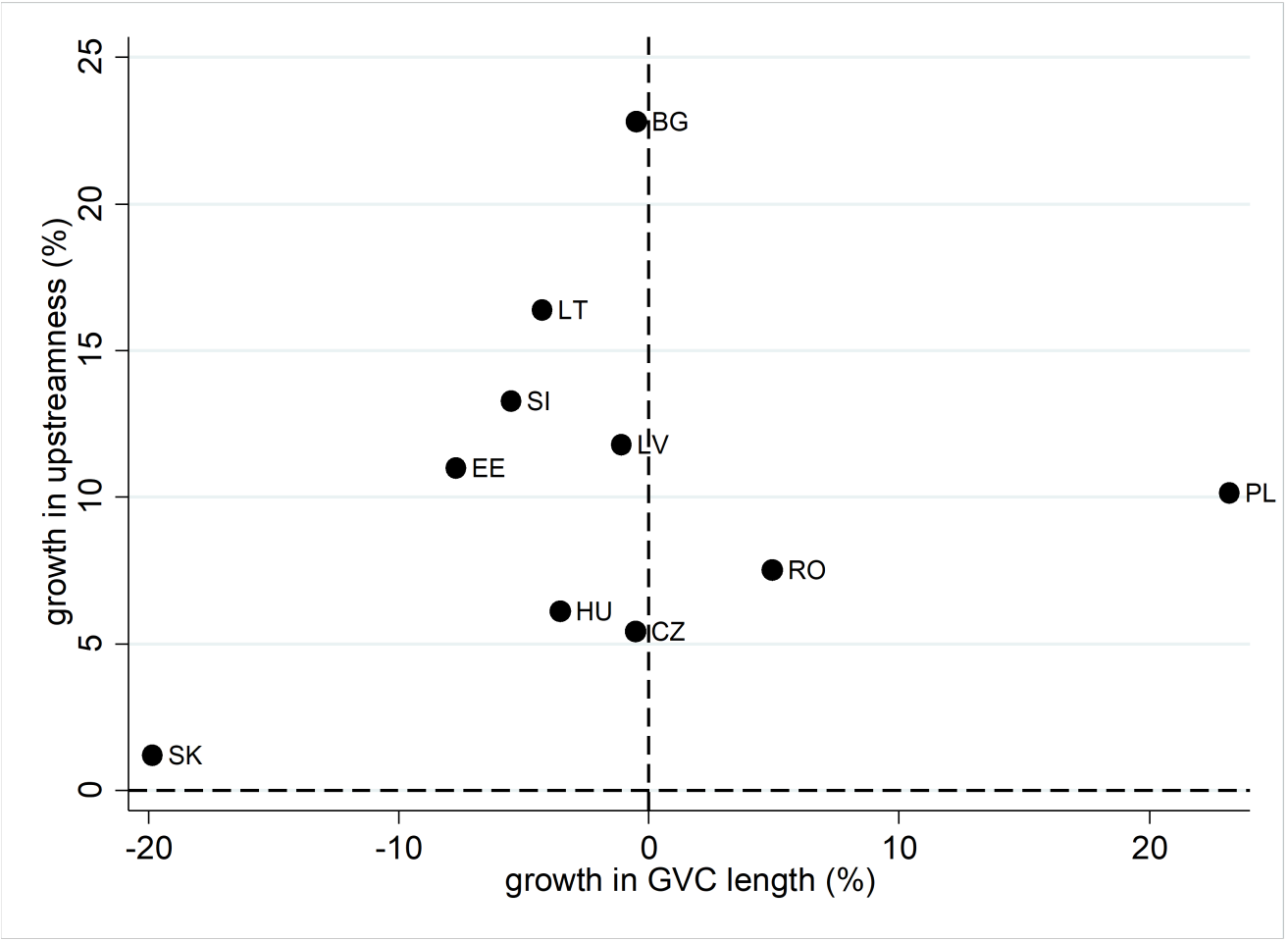
$$L = (I - M)^{-1}u$$

where :

- L - column vector containing GVC length values for every country-sector
- I identity matrix
- M - matrix of elements μ_{ik} - value of intermediates from industry k used to produce one dollar of industry i output
- u - summation vector

GVC length approximates the average number of production stages embodied in industry i production.

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)

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).

Model specification

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

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

where i - worker, j - sector, c - country, t - time and :

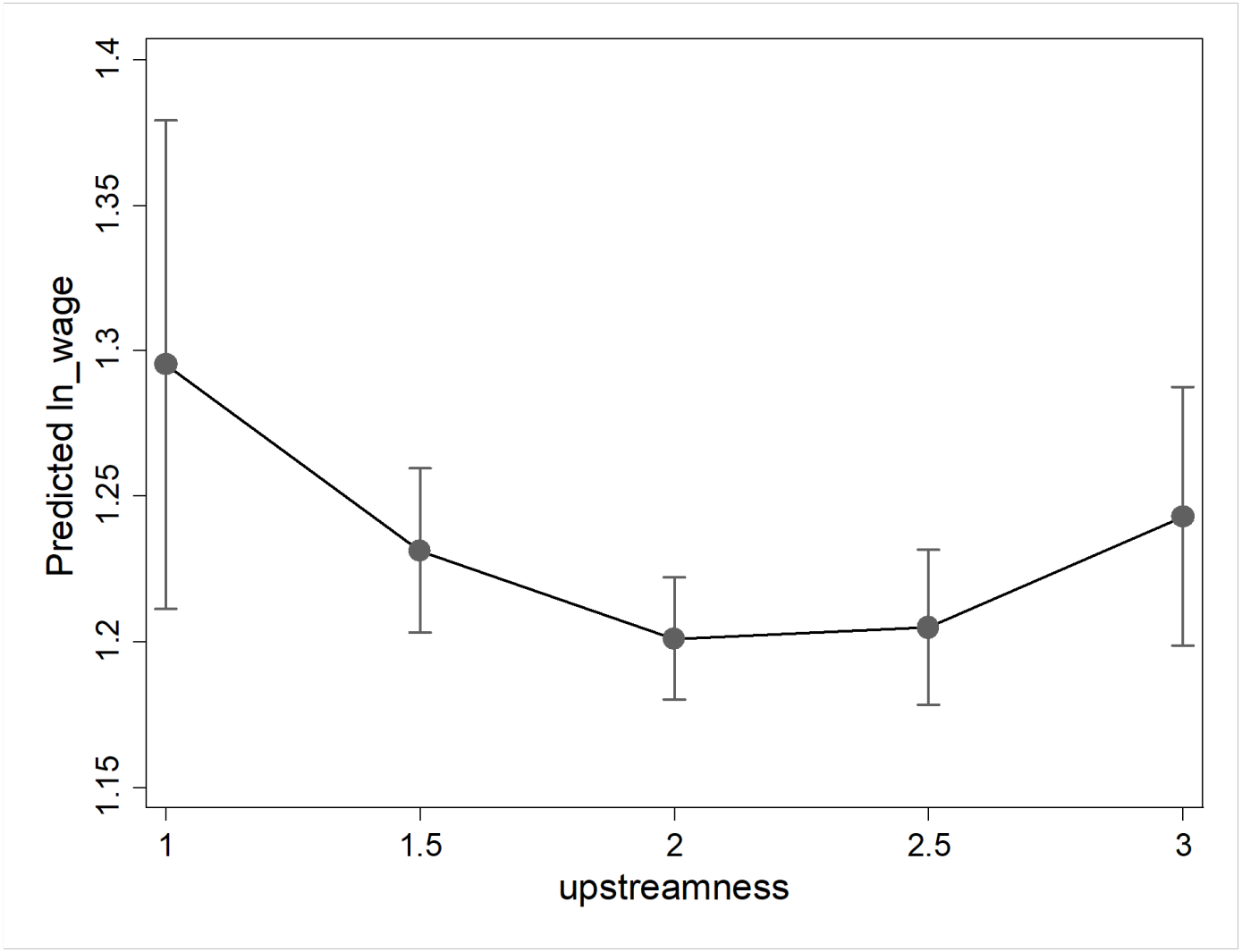
- ln *wage* - log of the gross hourly wage
- X - set of individual characteristics
- *Prod* - characteristics of industry
- *GVC* - information about production fragmentation, expressed by one of the measures
- *UP* - upstreamness (alternatively length of GVC)

Estimation results - wage regression, including the interaction between fragmentation and upstreamness

Dep.var.: ln*wage*	eq.1	Measure of *GVC* – eq.2							
		OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
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]
UP^2	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]
$GVC \times UP^2$			-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

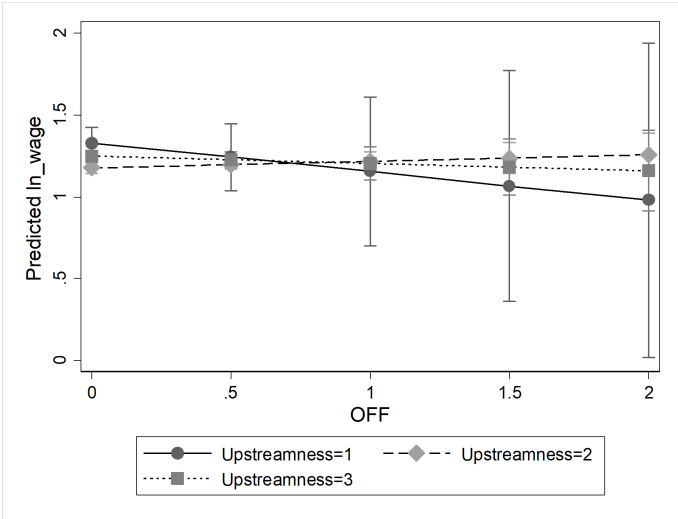
Notes: Personal controls (included, not reported): sex, age, age2, marital status, education, RTI. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included. Normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses), the weights are based on personal cross-sectional weights (from EU-SILC) normalised by the number of observation per country; *p .10, **p .05, ***p .01. Source: own elaboration based on data from EU-SILC and WIOD

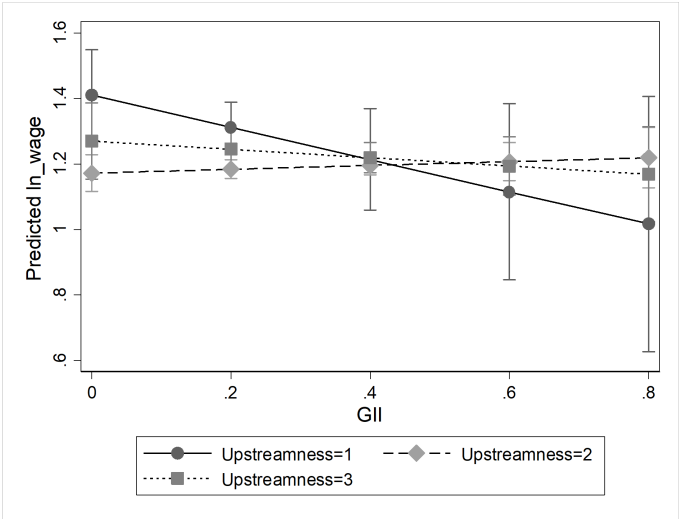
Smile curve - wages along the GVC

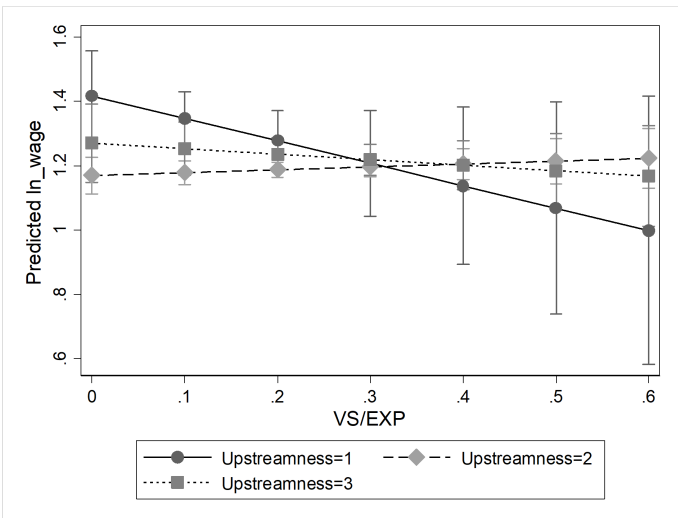


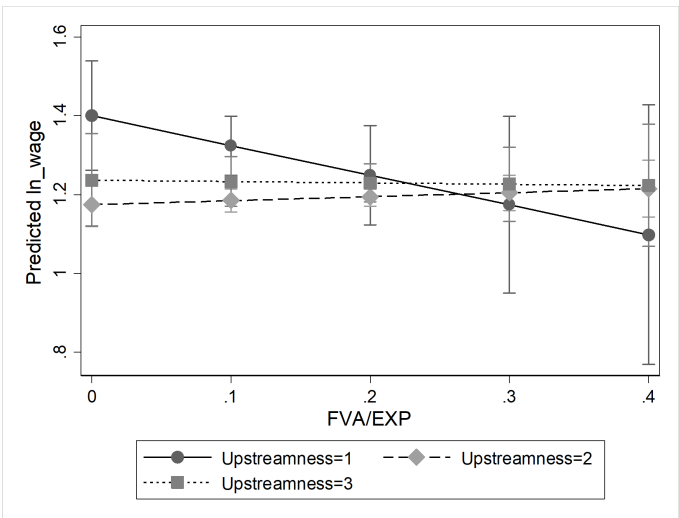
Note: Sample of 10 CEECs (2005-2014)
Source: own elaboration based on the estimation results of specification (1) reported in Table 1

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



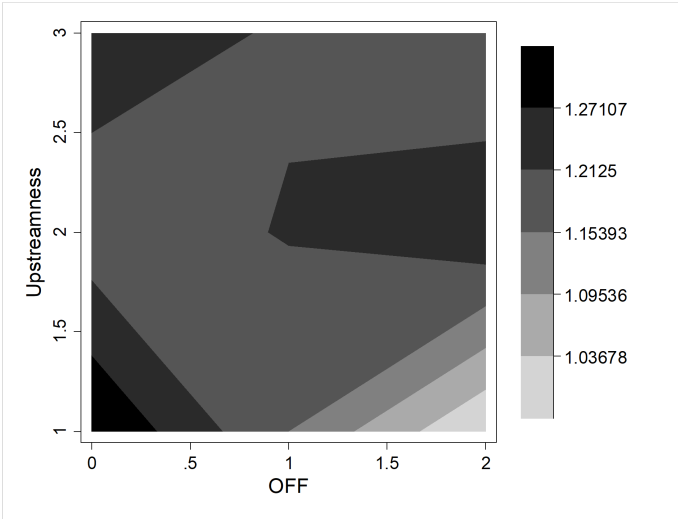


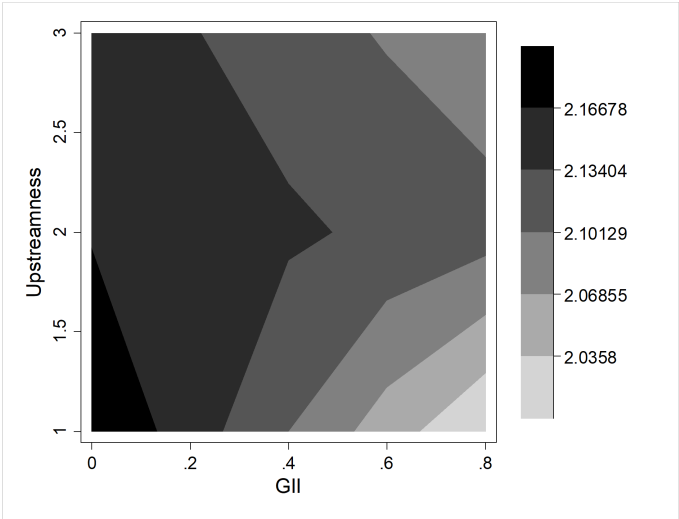


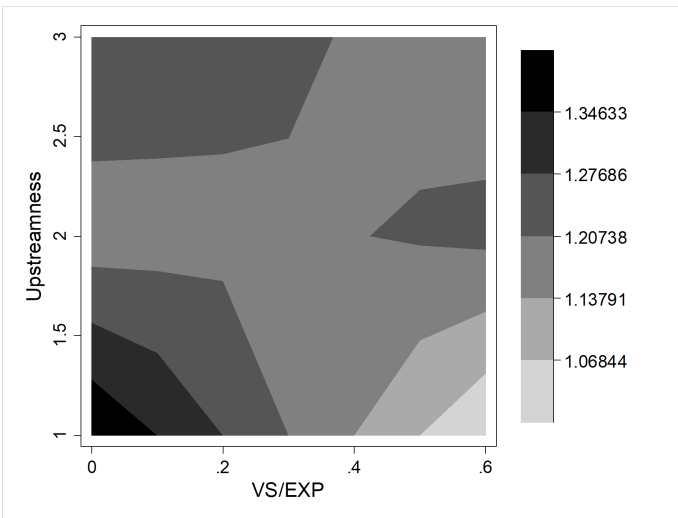


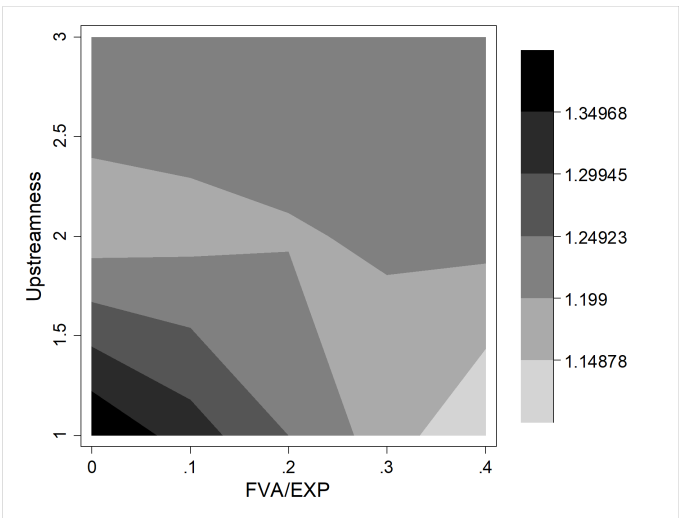
Source: own elaboration based on data from EU-SILC and WIOD

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









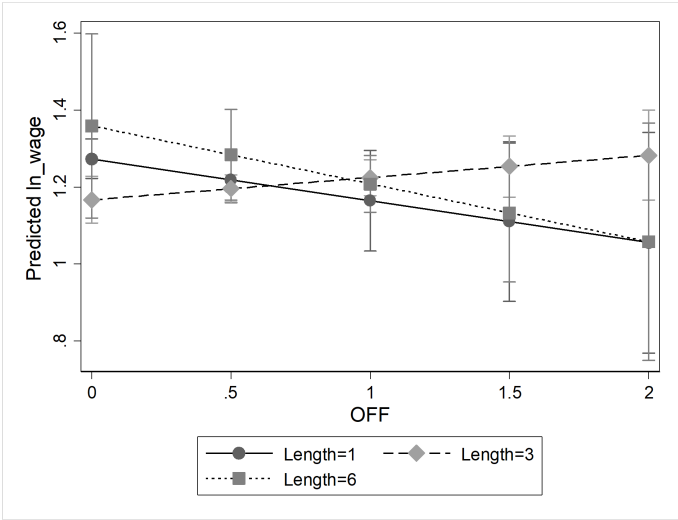
Source: own elaboration based on data from EU-SILC and WIOD

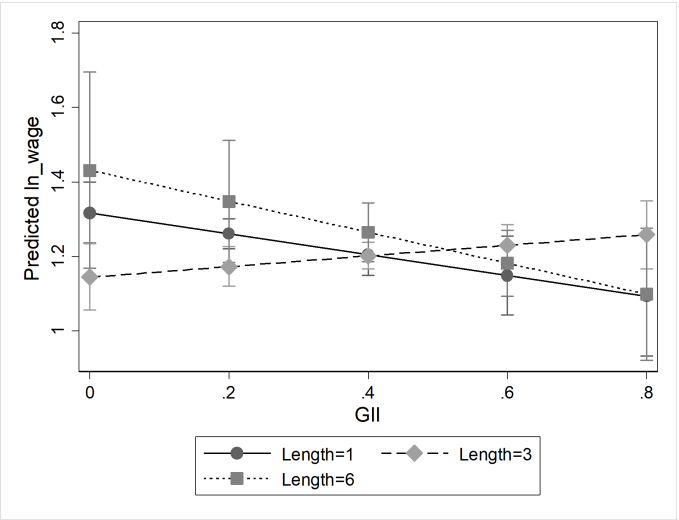
Estimation results - wage regression, including interaction between fragmentation and length

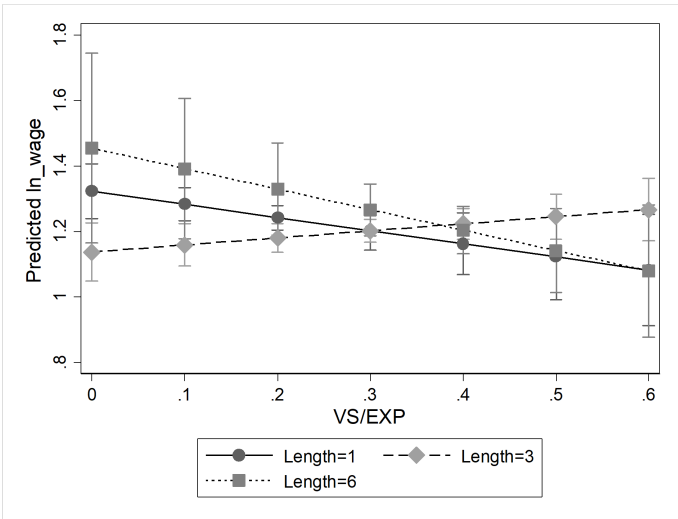
Dep.var.: ln*wage*	Measure of GVC – eq.2							
	OFF		*GII*		*FVA/EXP*		*VS/EXP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L	-0.043	-0.147**	-0.023	-0.233***	-0.026	-0.253***	-0.025	-0.251***
	[0.039]	[0.064]	[0.039]	[0.087]	[0.040]	[0.096]	[0.039]	[0.090]
L^2	0.006	0.023**	0.003	0.037**	0.004	0.041**	0.004	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

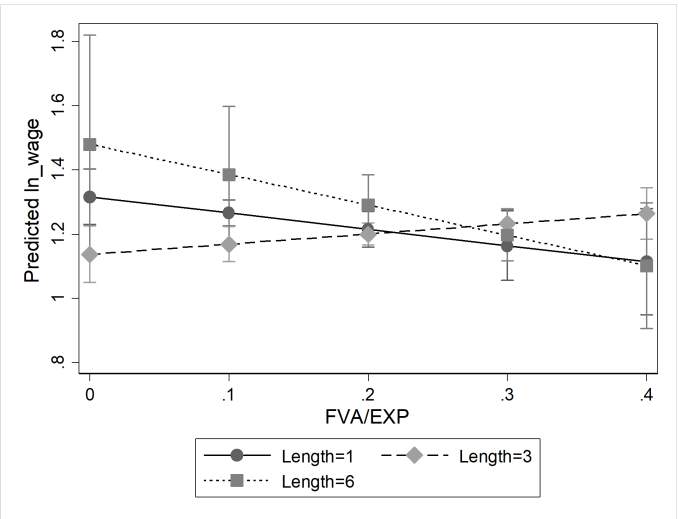
Notes: normalised weighted regression with robust standard errors clustered at the country-sector level (in parentheses); *p .10, **p .05, ***p .01. Personal controls (included, not reported): sex, age, age2, marital status (=1 if married), education (high, default category=medium and low), routinisation 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

Predicted wages due to the changes in GVC at different values of chain length



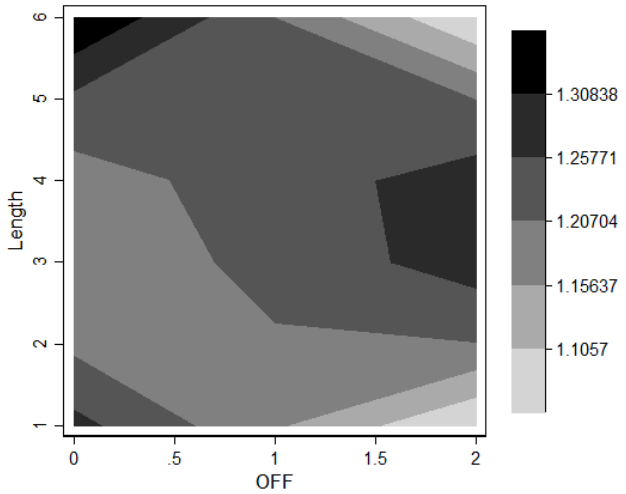


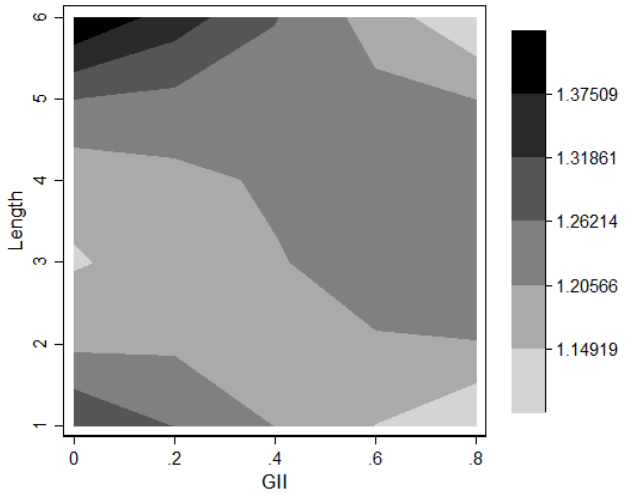


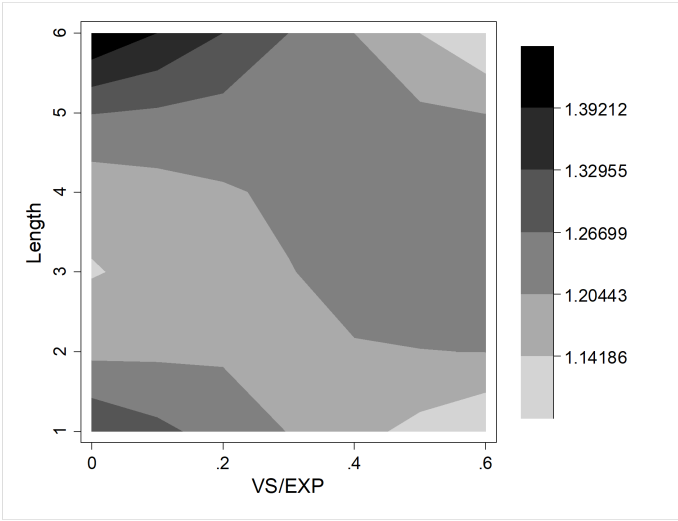


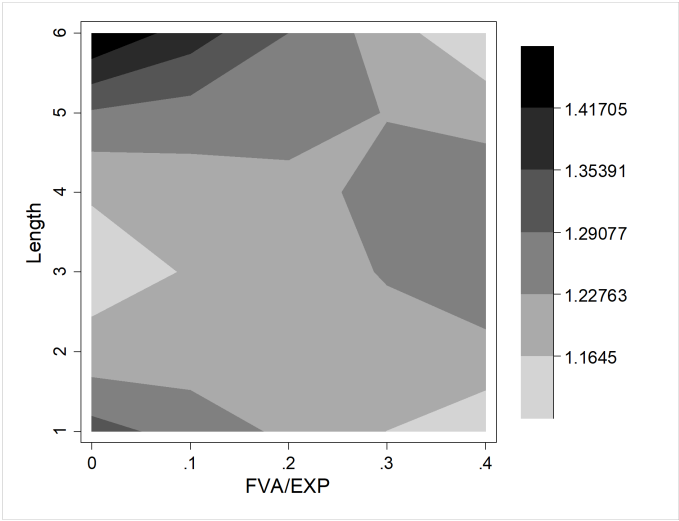
Source: own elaboration based on data from EU-SILC and WIOD

Contour plots with log hourly wage (for the model specification with chain length)









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

Estimation results manufacturing versus non-manufacturing sectors

Dep.var.: lnwage	Measure of GVC – eq. 2			
	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, education, RTI. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included. Source: own elaboration based on data from EU-SILC and WIOD

Estimation results - wage regression, including interaction between fragmentation and upstreamness

(production fragmentation with high income versus medium/low income countries)

Dep.var.: lnwage	Measure of GVC – eq.2							
	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, age2, marital status, education, RTI. Industry characteristics (included, not reported): sector productivity. Time, country and sector dummies included. Source: own elaboration based on data from EU-SILC and WIOD

Extensions and robustness checks

- different national labour market arrangements, additional variables: ICTWSS (Visser, 2016)
- adding other country- or sector-specific variables
- including additional firm level variables
- sector heterogeneity: to run the estimation eliminating one industry at a time

Conclusions

- The interaction between GVC intensity and position within the production chain is important.
- 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.
- Wage changes depend on the interplay between upstreamness and GVC intensity. For sectors that are near the final demand, an increase in production fragmentation is associated with a decline in wages. For those farther upstream, this effect is not observed.
- The effect is mainly materialised when production fragmentation measure either by GII or VS/EXP

Thank you for your attention

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