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Combining Micro and Macro Aspects of GVCs: A tale of selected European countries

Draft version

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Abstract

The macro and micro approaches to measuring GVCs have advanced on parallel tracks, headed in the same direction, but with limited overlap (Johnson, 2017). Can micro-data improve the input-output approach and/or input-output analysis strengthen micro-quantification exercise? Our work tries to provide an answer to the above question by combining data from two different databases: the World Input Output Database that provides global input-output tables at country and sector level and the EU-EFIGE dataset, that includes data from a survey of manufacturing firms in selected EU countries.

We first test a set of preliminary patterns of correlation between firms' productivity and trade in value added components/GVCs indicators by taking advantage of the available panel data from firms' balance sheet (for the period 2008-2014). We then look at the micro-macro linkages, by assessing the relationship between backward and forward GVCs indicators and firms' modes of internationalization. Our preliminary findings underline that: 1) more intense GVC backward and forward participation is, on average, associated with a higher firm productivity; 2) backward participation is as relevant as (if not more) forward participation; 3) sectoral level GVCs participation indicators derived from ICIO tables are consistently associated with specific firms' modes of internationalization derived from firm level surveys; 4) there is a strong correlation between firms' internationalization characteristics at the starting date and the subsequent GVCs performances; 5) single mode of internationalization is characterized by lower average productivity than dual or triple mode.

Keywords: Global value chains; firms' internationalization; trade in value added; inter-country input-output tables; EU countries.

JEL codes: F14; F60; D22; L22; O52.

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1. Background and motivations

The global value chain (GVC, henceforth) paradigm has been recently applied and linked to the study of international trade (Grossman and Rossi-Hansberg, 2008; Baldwin, 2012, 2014; Antràs et al. 2012; Costinot et al., 2013; Baldwin and Nicoud, 2014; Baldwin and Venables, 2013).

One of the main topics of the current research analysis focuses on data and methods for measuring GVC linkages. Researchers have struggled to develop a coherent empirical portrait of GVCs: at both the macro and micro levels, conventional data sources lack the information needed to map out the entire global production process and measure GVC linkages.

From a macro point of view, a new and growing literature has emerged which aims to describe the competitiveness of a country and/or its industries by looking at their production of value added as well as their level of integration into GVCs (see, inter alia, Hummels et al., 2001; Yi, 2003; Johnson and Noguera, 2012a,b; Miroudot and Ragoussis, 2009; Daudin et al, 2011; Koopman et al., 2011; 2014; Backer and Miroudot, 2013; Wang et al., 2013; De La Cruz et al., 2011; Stehrer, 2013; Cattaneo et al., 2013; Timmer et al., 2015).

Inter-country input-output tables and a full matrix of bilateral trade flows are now used to determine the trade in value added data and calculate new indicators (GVC participation and position).

By decomposing gross trade flows into added value components (Koopman et al. 2011, 2014; Wang et al., 2013; Nagengast & Robert Stehrer, 2016; Borin and Mancini, 2017), it is now possible to get a measure of real involvement of countries and sectors in the international fragmentation of production.

Most of the existing works are aggregate analyses or are centered on the manufacturing sector. This is mainly due to the larger availability of data at the aggregate level or related to the manufacturing sector compared to other sectors. But new insights are emerging also on agriculture and food (Liapis and Tsigas, 2014; Greenville et al., 2017; Balié et al., 2017).

From a micro point of view, researchers have been engaged in investigating two aspects. The first one concerns how to measure a firm participation to GVC and, tied to this one, firm's positioning along the GVC, i.e., whether a firm acts as supplier by selling to other firms (upstream) or as a final firm (downstream) , selling on the market of final goods. The second one investigates the impact of participation and positioning along the GVC on firm's performance. Both aspects have been constrained by the relative lack of appropriate data³.

At a firm level, GVC participation can be proxied through the several ways a firm can be engaged in the production fragmentation of a final good. Baldwin and Yan (2014), working on Canadian firms, define GVC participation as a firm involvement in both importing and exporting, i.e. "a value chain

³ We are not taking into consideration here definition and findings coming out from case -studies literature

that crosses international boundaries” (p. 7). To take account of the variety of modes of internationalisation associated with the operation of GVCs, Veugelers et al. (2013) and Agostino et al. (2016), working on a sample of European firms (the Efige survey, cfr. Altomonte and Aquilante, 2012), enlarge such a definition by adopting a “single,” “dual” and “triple” GVC participation modes.

Single participation embraces pure importers of components/services, or pure exporters, or pure international producers (through FDI or international outsourcing). Dual mode comprises firms involved in any two of the foregoing modes (imports and exports, or imports plus international production, or exports and international production). Triple mode means the firms engaged in all three modes (imports, exports and international production). Brancati et al. (2017), working on a sample of Italian firms (the MET survey) adopt a somewhat similar definition of a firm participation to a GVC. Giovannetti et al. (2015), working on a sample of Italian firms, rely on a firm’s self-assessment. Notwithstanding the lack of a unique definition of GVC participation at firm level, several studies show that GVC participation is associated with higher performance, such as labor productivity and/or TFP; sales growth; innovativeness (Veugelers et al., 2013; Baldwin & Yan, 2014; Agostino et al., 2015; Amador & Cabral, 2015; Brancati et al., 2015; Giovannetti et al., 2015; OECD, 2015; Montalbano et al., 2016; 2018).

There are several channels through which participating in a GVC might bring economic benefits i.e. being exporters, importers or both (two-way traders) and/or carrying out foreign direct investments (FDI). Exporting involves a number of potential advantages, since access to larger foreign markets may allow to: exploit scale economies; acquire new technologies abroad; learn by exporting; be exposed to stimulating international competition. Secondly, other benefits may accrue to firms in GVC through importing foreign inputs thanks to: cost saving; technology transfer; input quality improvement and possible complementarities with domestic inputs (Agostino M. et al., 2016). In addition, two-way trading permits to gain further advantage of inclusion in GVC by exploiting sunk cost complementarity and other positive interactions between export and import activities (Kasahara and Lapham, 2013). Especially for small firms and suppliers, relationships with large buyers and/or assemblers may be extremely fruitful in terms of upgrading their technical, relational and managerial capabilities (Humphrey and Schmitz, 2002; Gereffi et al., 2005; Agostino M. et al., 2015).

There are two important qualifications to this almost univocal finding. On one hand, performance gains seem to be ordered: the more complex the mode of a firm GVC participation, the greater the performance gain. On the other hand, it comes out that positioning along the GVC matters. The performance premium shows in fact to be less for upstream firms in comparison with downstream firms.

The macro and micro approaches to measuring GVCs have advanced on parallel tracks, headed in the same direction, but with limited overlap. There is scope for convergence: micro-data can improve the I/O approach and I/O type analysis can strengthen micro-quantification exercise (Johnson, 2017).

To tie the input-output and micro-data approaches together, the optimal way would be measuring firm-to-firm international transactions and then build a global input-output table at the firm level. This hypothetical firm-level data would then aggregate up to industry-level input-output tables. Unfortunately, such data are not available yet (except for Feenstra and Jensen (2012) for US firms)⁴.

The second-best way is enabling disaggregation of I/O tables, thus tracking GVC linkages at higher resolution. Among proxy methods that combine macro and micro-approaches are Crespo and Jansen, 2014; Blaum et al., 2015; Montalbano et al., 2016; 2018; Del Prete et al., 2017. We move along this vein.

In this work we investigate the relationship between GVCs participation and firms' productivity. We explore GVCs' micro-macro linkages by combining information at firm and sector level for some selected European countries. We do this by matching firm level data (from the EFIGE dataset) to sector level data (from the WIOD tables), using a conventional empirical methodology and well-known data sets.

Preliminary findings show that:

- More intense GVC backward and forward participation is, on average, associated with a higher firm productivity;
- Backward participation is as relevant as (if not more) forward participation;
- Sectoral level GVCs participation indicators are consistent with firms' modes of internationalization;
- A strong correlation between firms' internationalization characteristics at the starting date and the subsequent GVCs performances;
- Single mode of internationalization is characterized by lower average productivity than dual or triple mode.

2. Data and GVC indicators

Our analysis focuses on the following European countries: France, Germany, Italy and Spain⁵. We combine data from two different databases - the EU-EFIGE dataset and the World Input Output Database (WIOD) - over the period 2008-2014 (to avoid the influence of likely structural breaks because of the economic crisis).

The EU-EFIGE dataset includes data from a survey among manufacturing firms in seven EU countries (Austria, France, Germany, Hungary, Italy, Spain and the United Kingdom) with ten or more employees. Information mostly collected as a cross-section for the year 2008.

⁴ Feenstra and Jensen (2012) attempt to construct an industry-to-industry import input-output table using the US Linked/Longitudinal Firm Trade Transaction Database. They find that the resulting import input-output coefficients are positively correlated with existing published data from the BEA. Thus, existing import IO tables may not be so bad after all. On the other hand, there are deviations between the two data sets, which implies that there may be additional information in the micro-data that could be profitably be combined with existing input-output data sources to yield a better composite (reconciled) table.

⁵ We did not include United Kingdom since its productive structure - based on financial and knowledge-intensive business services - is quite different from that of France, Germany, Italy and Spain. Hungary and Austria are excluded since they are much smaller economies and comparisons may not be particularly significant.

Survey data are integrated with balance sheet information from the Amadeus database for the years 2001-2009. A recent update of the EFIGE dataset extends the panel-level balance sheet data until the year 2014. We use this dataset to calculate firm labour productivity in value added and different modes of internationalization.

The WIOD provides global input-output tables for 43 countries⁶ and 56 sectors of activity (2-digit, according to the ISIC nomenclature, Rev. 4), including 19 manufacturing sectors, for the period 2000-2014. We use this dataset to calculate trade in value added components and GVCs indicators. Value-added reflects the value that is added by industries in producing goods and services and it is equivalent to the difference between industry output and the sum of its intermediate inputs. Within GVCs, value is added in different countries throughout the production process, and countries' exports therefore include both domestic and foreign value added. Looking at trade from a value added perspective better reveals how upstream domestic industries contribute to exports, as well as how much (and how) participate in GVCs. Economies participate in GVCs both as users of foreign inputs and as suppliers of intermediate goods and services used in other economies' exports. One indicator of the participation of countries in GVCs is the percentage of a country's exports that are part of GVCs: either looking back along the value chain and measuring foreign inputs/value added included in a country's exports – or measuring the domestic inputs/value added of the country contained in the exports of other countries by looking forward along the value chain. This participation indicator also provides an insight into the position of countries in GVCs: economies can be positioned upstream (providing input) or downstream (using foreign input) in GVCs. GVC participation at sector level is measured as both *backward integration* (i.e., the use of foreign inputs for exports) and *forward integration* (i.e., the supply of domestic inputs for other countries' exports).

Using the new input-output data combined with bilateral trade statistics allows us to allocate the value added embedded in trade flows to the countries and sectors of origin and destination and decompose gross exports into various components (Koopman et al., 2014), namely:

- the domestic value added (i.e., value added exported in final goods or in intermediates absorbed by direct importers);
- the foreign value added (i.e., other countries domestic value added in intermediates used in exports);
- and the “pure double counting” term, that arises when intermediate goods cross borders back and forth multiple times.⁷

In this work, we apply the methodology developed by Wang et al. (2013) (hereafter WWZ)⁸ to calculate measures of GVC *backward* and *forward participation* at industry level. In the WWZ

⁶The EU-28 countries plus Australia, Brazil, Canada, China, Norway, India, Indonesia, Japan, Korea, Mexico, Russia, Switzerland, Taiwan, Turkey, USA.

⁷Some of the terms in the “pure double counting” bucket double count value added originated in the home country, while other terms in the double count value added originated in foreign countries (WWZ, 2013).

⁸The authors generalize the gross exports accounting framework proposed by Koopman et al. (2014) from a country-level perspective to one that decomposes gross trade flows at the sector, bilateral, or bilateral-sector level. The WWZ framework is particularly informative because it not only allows us to extract value added exports from gross exports, but

decomposition, the above main components are further disaggregated into sixteen value-added and double counting terms (see Figure 1A and Figure 2A in the Appendix). For the purpose of our analysis, we exploit some of these terms to retrieve the following components of value added exports at industry level:

- The *indirect domestic value added (DVX)*, that is, the domestic value added in intermediate goods further re-exported by the partner country (i.e., from T3 to T8 in Figure 1A). It measures the participation in a GVC since it contains the exporter's value added of a specific sector that passes through the direct importer for a (or some) stage(s) of production before it reaches third countries (or eventually returns home⁹). More specifically, it captures the contribution of the domestic sector to the exports of other countries and indicates the extent of involvement in GVC for relatively upstream industries. In our empirical analysis, we use this component as a measure of **Forward GVC participation**;
- The *indirect domestic value added in intermediates (DVXint)* that is the DVX net of the returned value added¹⁰ (calculated as the sum of the terms from T3 to T5 in Figure 1A) in order to trace only the value added in intermediates re-exported to third countries. We call this latter **Forward GVC_intermediates participation**;
- The *foreign value added (FVA)* used in the production of a country's exports, which consists of the value added contained in intermediate inputs imported from abroad, exported in the form of final or intermediate goods (that sums the terms T11, T12, T14 and T15 of the WWZ decomposition, see Figure 2A). It captures the extent of involvement in GVC for relatively downstream industries. We use this component as a measure of **Backward GVC participation**¹¹;
- The *foreign value added in intermediates (FVAint)* that is the value added contained in intermediate inputs exported in the form of intermediates (calculated as the sum of the terms T12 and T15 in Figure 2A). We call this latter **Backward GVC_intermediates participation**.

Using EFIGE, we also investigate the variety of firms' internationalization modes associated with the operation of GVCs in order to get a quite appropriate approximation of GVCs participation at firm level.

To do this, we take into consideration several possible modes of participation and their combinations: exporter only; both exporter and importer (of materials and services); exporter, importer (of materials and services) and international production (firms undertaking foreign

also to recover additional useful information on the structure of international production with a high level of disaggregation. In our work, we calculate the WWZ components at country-sector level by aggregating the bilateral-sector trade flows.

⁹The DVX component includes also the returned value added (RDV), that is the portion of domestic value added that is initially exported but ultimately returned home by being embedded in the imports from other countries and consumed at home.

¹⁰ See footnote above.

¹¹ Specifically, backward GVC participation is calculated including also PDC from foreign sources (the terms T13 and T16).

direct investments - FDI). Hence, we define “single,” “dual” and “triple” the following modes of GVC participation:

- a. **Single** when participation embraces pure exporters;
- b. **Dual** mode when firms are both exporter and importer (of materials and services);
- c. **Triple** mode if firms are engaged in exports, imports and international production through FDI.

We classify firms in the various categories based on qualitative information on the status of importer, exporter and international producer, as reported by the EFIGE survey.

3. A descriptive analysis

We first run a preliminary descriptive comparative analysis on firms’ productivity, GVCs indicators (both at aggregate and industry level), firms’ characteristics and modes of internationalization to check for heterogeneity.

First, we look at firms’ productivity and *GVCs participation indicators* at aggregate level (Tab.1).

Tab. 1 - firms' labor productivity and GVC indicators by country (averages 2008-2014)

country	firm productivity (*)	forward GVC	forward GVC intermediates	backward GVC	backward GVC intermediates	Pure double counting
FRA	52.04	0.19	0.18	0.28	0.11	0.09
GER	61.11	0.17	0.15	0.27	0.09	0.09
ITA	51.40	0.17	0.16	0.25	0.08	0.07
SPA	39.90	0.16	0.15	0.25	0.09	0.06
Total	48.21	0.17	0.16	0.26	0.09	0.07

(*) Labor prod computed as added value pere employee (in 1,000 EUR)

GVCs measures in percentages of gross exports

source: Authors' elaboration on EFIGE and WIOD

We then take into exam firms' characteristics and modes of internationalization (Tab.2).

Tab.2 -Firms' characteristics and modes of internationalization

country	exporter		imp. (services)		imp. (materials)		fdi		single(*)		dual (§)		triple (+)	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
FRA	986	0.65	445	0.29	978	0.65	72	0.05	181	0.12	739	0.49	66	0.04
GER	414	0.82	188	0.37	250	0.49	82	0.16	111	0.22	227	0.45	58	0.11
ITA	1562	0.74	469	0.22	946	0.45	64	0.03	604	0.29	895	0.42	56	0.03
SPA	1452	0.63	444	0.19	1137	0.49	51	0.02	461	0.20	943	0.41	44	0.02
Total	4414	0.68	1546	0.24	3311	0.51	269	0.04	1357	0.21	2804	0.43	224	0.03

(*) only exporter (not importer and/or internationalization of production)

(§) both exporter and importer of materials/services (no internationalization of production)

(+) exporter, importer (materials/services) and internationalization of production (fdi)

source: Authors' elaboration on EFIGE

We then analyse the same variables at country and industry level (Tables 3-6)

Tab. 3 Germany: firms' labor productivity, GVC indicators and firms' modes of internationalization by industry (2008)

wiod codes	wiod_industry	firm productivity (*)	GVCs Participation				Firms' modes of internationalization		
			forward GVC	forward GVC intermediates	backward GVC	backward GVC intermediates	single	dual	triple
C10_C12	Food products, beverages and tobacco products	54.74	0.05	0.04	0.23	0.03	0.30	0.28	0.06
C13_C15	Textiles, wearing apparel and leather products	47.74	0.15	0.13	0.32	0.07	0.18	0.50	0.14
C16	Wood and of products of wood and cork	42.97	0.21	0.19	0.25	0.17	0.27	0.55	0.00
C17	Paper and paper products	55.59	0.23	0.20	0.32	0.18	0.17	0.58	0.00
C18	Printing and reproduction of recorded media	60.63	0.26	0.23	0.22	0.14	0.40	0.10	0.00
C20	Chemicals and chemical products	73.36	0.27	0.24	0.33	0.15	0.23	0.36	0.23
C21	Basic pharmaceutical products and pharmaceutical preparations	56.78	0.12	0.10	0.19	0.05	0.50	0.50	0.00
C22	Rubber and plastic products	59.06	0.25	0.22	0.30	0.14	0.34	0.36	0.16
C23	Other non-metallic mineral products	56.74	0.15	0.13	0.23	0.16	0.15	0.31	0.00
C24	Basic metals	63.00	0.30	0.26	0.40	0.18	.1875	0.38	0.06
C25	Fabricated metal products, except machinery and equipment	58.14	0.24	0.21	0.26	0.11	0.34	0.39	0.07
C26	Computer, electronic and optical products	62.10	0.18	0.16	0.27	0.06	0.21	0.50	0.13
C27	Electrical equipment	58.18	0.19	0.17	0.25	0.09	0.20	0.48	0.20
C28	Machinery and equipment n.e.c.	68.20	0.12	0.11	0.27	0.05	0.13	0.61	0.14
C29	Motor vehicles, trailers and semi-trailers	50.63	0.09	0.08	0.30	0.04	0.15	0.46	0.23
C30	Other transport equipment	53.69	0.13	0.12	0.32	0.06	0.00	0.75	0.25
C31_C32	Furniture; other manufacturing	57.11	0.06	0.06	0.22	0.03	0.15	0.41	0.15
C33	Repair and installation of machinery and equipment	63.77413	0.17	0.15	0.27	0.07	0.14	0.53	0.11
Total		59.77003	0.17	0.15	0.27	0.09	0.22	0.45	0.11

(*) Labor prod computed as added value pere employee (in 1,000 EUR)

GVCs measures in percentages of gross exports

source: Authors' elaboration on EFIGE and WIOD

Tab. 4 - France: firms' labor productivity, GVC indicators and firms' modes of internationalization by industry (2008)

Tab. 5 - Italy: firms' labor productivity, GVC indicators and firms' modes of internationalization by industry (2008)

Tab. 6 - Spain: firms' labor productivity, GVC indicators and firms' modes of internationalization by industry (2008)

We detect :

- Heterogeneity across countries in terms of (labour) productivity at aggregate level
- Heterogeneity across countries in terms of GVCs participation indicators

4. Empirical analysis

After the descriptive statistics we impose more structure on the analysis and estimate simple regression models.

We first provide a preliminary test of the empirical relationship between *firm level productivity* and *various GVCs backward and forward participation indicators* (both at aggregate and industry level). We also provide estimates focused only on intermediates.

We then assess the relationship between firms' modes of internationalization and GVCs backward and forward indicators at the industry level. To this end, we provide both OLS, matching and MNL estimates.

Finally, we replicate the latter empirical exercise by looking at the rate of change of GVCs backward and forward indicators during the crisis period 2008-2014.

4.1 Firm level productivity and GVCs backward and forward participation

We take advantage of the availability of panel data for the entire period (2008-2014) – we avoid to include the structural break of the crises - taken from the balance sheets of the firms sample by the update of EFIGE (Amadeus) and regress the various indicators of GVCs backward and forward participation on labor productivity in VA (VA/employees) controlling for country and time effects.

We first run this at aggregate level:

$$\theta_{ijt} = \beta_0 + \beta_1 \text{BackGVC}_{jt} + \beta_2 \text{ForGVC}_{jt} + \eta_c + \gamma_t + \epsilon_{it}$$

Where i denotes firms, j industry and t time, θ is log of firm labor productivity¹², *BackGVCs* denotes Backward GVC participation indicators (once calculated on both final and intermediates products and the other one on intermediates products only), *ForGVCs* is for Forward GVC participation indicators (once calculated on both final and intermediates products and the other one on intermediates products only) and η_c and γ_t are respectively country and time fixed effects; ϵ_{it} is the error term. β_1 and β_2 are the coefficient of interest.

¹² We use labor productivity as a proxy of firm productivity. We acknowledge this is not the only (and probably also not the best) measure.

Table 7 - Panel estimates of the relationship between Labor productivity, backward and forward GVCs (2008-2014)

	labor prod_VA (averages by industry)		Firm level labor prod_VA (by firm)		Firm level labor prod_VA (fixed effects)		Firm level labor prod_VA (random effects)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Back_GVC	0.868*** (0.0528)		0.807*** (0.0435)		0.510*** (0.183)		0.663*** (0.0736)	
For_GVC	0.344*** (0.0385)		0.319*** (0.0362)		0.586* (0.354)		0.373*** (0.0683)	
Back_GVC_INT		0.183** (0.0892)		0.494*** (0.0784)		-0.655 (0.445)		0.440*** (0.139)
For_GVC_INT		0.583*** (0.0622)		0.347*** (0.0542)		-0.219 (0.322)		0.325*** (0.0970)
cons.	3.760*** (0.0163)	3.945*** (0.0114)	3.767*** (0.0156)	3.952*** (0.0113)	3.561*** (0.0972)	3.897*** (0.0727)	3.771*** (0.0264)	3.932*** (0.0179)
N	40387	40387	40387	40387	40387	40387	40387	40387
country fe	yes	yes	yes	yes	yes	yes	yes	yes
year fe	yes	yes	yes	yes	yes	yes	yes	yes
R-sq	0.104	0.099	0.105	0.098	0.013	0.012	0.1035	0.0971

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance. Robust standard errors in parentheses.

Tab, 7 shows the correlation patterns between firm productivity and GVCs indicators at aggregate level. Specifically, we denote:

- higher backward and forward GVCs integration is associated with higher firm productivity (and the effect looks stronger in the case of backward participation);
- the same outcomes are confirmed also focusing only on intermediates (except in the fixed effect specification).

Fig. 1 - Labor productivity and forward GVCs (2008-2014) by industry

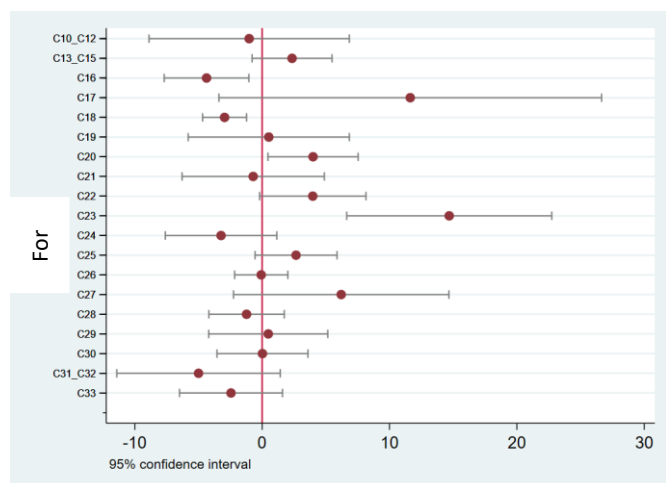
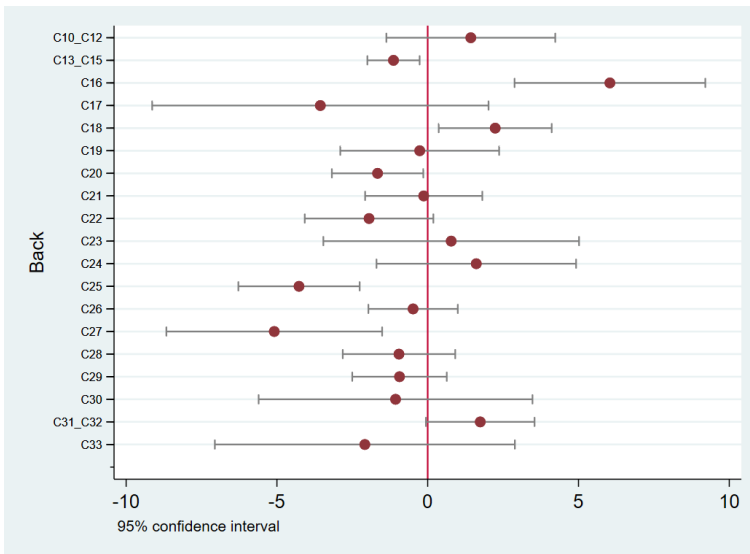


Fig. 2 - Labor productivity and backward GVCs (2008-2014) by industry



We confirm the presence of strong heterogeneity of correlation patterns between firm productivity and GVCs indicators at industry level, but some regularities are in place.

4.2 GVCs backward and forward participation and modes of internationalization

We then look at the micro-macro linkages, by assessing the correlation between backward and forward GVCs indicators and the corresponding modes (i.e., single, dual, triple) at firm level by sector. We use OLS, Propensity Score (PS)/Nearest-Neighbour Matching (NNM) and Multinomial Logit (MNL) estimators:

$$GVC_{ij} = \alpha_0 + \alpha_1 single_i + \alpha_2 dual_i + \alpha_3 triple_i + \eta_c + \epsilon_{ij}$$

$$\Pr(GVC_{ij}) = \frac{e^{(\alpha_0 + \alpha_1 single_i + \alpha_2 dual_i + \alpha_3 triple_i + \eta_c + \epsilon_{ij})}}{\sum_j^k e^{(\alpha_0 + \alpha_1 single_i + \alpha_2 dual_i + \alpha_3 triple_i + \eta_c + \epsilon_{ij})}}$$

Table 8 - Backward and forward GVCs & modes of firm internationalization -OLS

	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT
single	0.00116 (0.00269)	0.00580*** (0.00174)	0.000967 (0.00252)	-0.00515*** (0.00171)	-0.000110 (0.00267)	0.00463*** (0.00172)	-0.000244 (0.00250)	-0.00613*** (0.00170)
dual	0.00520** (0.00219)	0.0144*** (0.00153)	0.00484** (0.00204)	-0.00548*** (0.00142)	0.000468 (0.00220)	0.00971*** (0.00154)	0.000371 (0.00206)	-0.00918*** (0.00143)
triple	0.00237 (0.00506)	0.0139*** (0.00361)	0.00229 (0.00468)	-0.0108*** (0.00319)	-0.00408 (0.00517)	0.00627* (0.00368)	-0.00381 (0.00478)	-0.0170*** (0.00321)
ln_labprodVA					0.0199*** (0.00228)	0.0130*** (0.00165)	0.0191*** (0.00213)	0.0130*** (0.00147)
qual_cert					0.0131*** (0.00194)	0.0133*** (0.00133)	0.0124*** (0.00181)	0.0115*** (0.00124)
for_group					-0.000508 (0.00365)	0.0113*** (0.00281)	-0.000877 (0.00337)	0.00155 (0.00238)
_cons	0.167*** (0.00363)	0.257*** (0.00242)	0.146*** (0.00323)	0.0910*** (0.00235)	0.0793*** (0.00968)	0.196*** (0.00687)	0.0623*** (0.00899)	0.0317*** (0.00623)
N	6339	6339	6339	6339	6320	6320	6320	6320
R-sq	0.028	0.136	0.024	0.047	0.050	0.167	0.048	0.078
adj. R-sq	0.027	0.135	0.023	0.046	0.049	0.166	0.046	0.077

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

Tab.8 shows that dual mode firms are significantly associated with both backward and forward GVCs participation at the industry level, while single and triple modes are only significantly associated to backward participation. However, if we add controls (e.g., labor productivity, quality certification and membership to foreign groups) also dual modes significant correlates only with backward GVC participation. This is consistent with the relevant role of foreign inputs for exports in both cases and reinforces our hypothesis that modes of internationalization have some kind of relation with GVC participation, net of the productivity effects. To be noted that if we focus only on backward participation in intermediates, the number of dual firms (but also of single and triple firms) falls.

Since we are aware that firms' productivity and modes of internationalization are highly correlated (this is confirmed both conceptually and empirically by most of the relevant literature), we refine our empirical test by matching only firms that are similar in terms of the above selected characteristics (labor productivity, quality certification and membership to foreign groups). To this end, we employ the traditional Propensity Score (PS) approach developed by Rosenbaum and Rubin (1983) and the Nearest-Neighbour Matching estimator (NNM) more recently proposed by Abadie and Imbens (2006, 2011). While the traditional PSM approach performs the matching on only one characteristic that synthetizes all the information available: the probability of the firm to be in one of the possible modes of internationalization conditional on the observable characteristics (labor productivity, quality certification and membership to foreign groups), the alternative NNM estimator matches each pre-treatment variable and adopts the technique of matching with replacement, allowing each firm to be used as a match more than once in order to form the control group. Compared to the first one, the latter has the advantage of relying on a more precise matching procedure (since it is not

based on a single reference indicator as in the propensity score) and increases the goodness of the matching outcome, but at the additional cost of managing the high dimensionality of the data.

Table 9 - Backward and forward GVCs & modes of firm internationalization – NNM and PS matching estimators

	ATE				ATT			
	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT
<i>NNM</i>								
single	.0000937 (.0024985)	-.0010344 (.001718)	-.0000363 (.0023248)	.000297 (.0015928)	-.0022301 (.0025655)	-.0014858 (.0017305)	-.0021415 (.0023994)	-.0018023 (.0016278)
dual	.0019311 (.0019789)	.0076247*** (.0013693)	.0017968 (.0018484)	-.0048143*** (.0012578)	.0019155 (.0021887)	.0086266*** (.0015475)	.0017681 (.002045)	-.0047677*** (.0013828)
triple	.0041363 (.0072337)	-.0010348 (.0054661)	.003494 (.006737)	-.0050651 (.0049207)	-.0055585 (.0058354)	.003314 (.003922)	-.005095 (.0053531)	-.0099969*** (.0036531)
<i>PS</i>								
single	-.005116 (.0025412)	-.0011622 (.0016766)	-.0006549 (.0023625)	.0003375 (.0015875)	-.0020491 (.0026002)	-.0012546 (.0017407)	-.0020542 (.0024326)	-.0012973 (.0016331)
dual	.0013016 (.0020108)	.008192*** (.0013911)	.0011959 (.0018783)	-.004283*** (.0012735)	.0010434 (.0022393)	.0082689*** (.001551)	.0010097 (.0020874)	-.0042077*** (.0013904)
triple	.0002917 (.005596)	-.0021963 (.0044601)	-2.27e-06 (.0052426)	-.0097834*** (.0038044)	-.0064218 (.0059785)	.0026378 (.0040771)	-.0060774 (.0055046)	-.0112742*** (.0037615)
N	6320	6320	6320	6320	6320	6320	6320	6320

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

Tab. 9 confirms that dual mode firms keep a significant correlation with both backward GVCs participation at the industry level, matching only firms with the same relevant characteristics. The same outcome is confirmed by both PS and NNM matching exercises. Tab. 9 also confirms that the number of dual and triple firms actually falls in correspondence of backward participation in intermediates.

Table 10 - Backward and forward GVCs & modes of firm internationalization: MNL

	Multinomial Logit											
	2nd quartile				3rd quartile				4th quartile			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
<i>Modes</i>	For_GVC	For_GVC_INT	Back_GVC	Back_GVC_INT	For_GVC	For_GVC_INT	Back_GVC	Back_GVC_INT	For_GVC	For_GVC_INT	Back_GVC	Back_GVC_INT
single	0.150+	0.133	0.0828	-0.0422	-0.158+	-0.152+	0.114	-0.188**	0.221*	0.186+	0.481***	-0.254***
	(0.104)	(0.103)	(0.0934)	(0.119)	(0.0971)	(0.0968)	(0.102)	(0.0904)	(0.116)	(0.120)	(0.116)	(0.0972)
dual	0.396***	0.408***	0.0226	0.282***	-0.216***	-0.209***	0.356***	-0.401***	0.466***	0.490***	1.054***	-0.152*
	(0.0864)	(0.0862)	(0.0830)	(0.0957)	(0.0809)	(0.0809)	(0.0840)	(0.0777)	(0.0960)	(0.0980)	(0.0946)	(0.0793)
triple	0.468**	0.480**	0.0322	0.0549	-0.238	-0.306+	0.0838	-0.851***	0.286	0.394*	1.076***	-0.425**
	(0.202)	(0.198)	(0.227)	(0.202)	(0.212)	(0.211)	(0.231)	(0.219)	(0.222)	(0.229)	(0.217)	(0.193)
_cons	-1.213***	-0.808***	1.617***	0.548***	-0.810***	-0.466***	1.941***	-0.372**	-0.451***	-1.001***	1.686***	0.333**
	(0.153)	(0.137)	(0.252)	(0.141)	(0.146)	(0.133)	(0.245)	(0.175)	(0.131)	(0.148)	(0.246)	(0.145)
country fe	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339
Ps.R-sq	0.0333	0.0285	0.0999	0.0357	0.0333	0.0285	0.0999	0.0357	0.0333	0.0285	0.0999	0.0357

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

If we order our measures of GVC participation into quartiles and apply a MNL estimator, we consistently find a straight correlation with firms' dual mode and the industries in the upper quartiles in terms of both Forward and Backward GVC participation (Tab.10). To be noted that the negative correlation between the number of internationalized firms and backward participation in intermediates is confirmed also in this MNL exercise.

4.3 GVCs backward and forward participation (rate of change) and modes of internationalization

In this section, we look at the relationship between firms' modes of internationalization at the eve of the economic crisis and the rate of change of our various measure of GVC participation at the industry level. Table 1A in the Appendix shows the overall performance of backward and forward GVC participation by industry in the period 2008-2014.

Table 11 - OLS rate of change of GVCs participation (2008-2014) and firms' modes of internationalization

	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT
single	-0.0000304 (0.0000418)	0.000175*** (0.0000602)	0.0000145 (0.0000534)	0.0000948*** (0.0000332)	-0.0000507 (0.0000417)	0.00000238 (0.0000533)	0.000167*** (0.0000604)	0.0000876*** (0.0000332)
dual	-0.000314*** (0.0000358)	0.000471*** (0.0000516)	-0.000315*** (0.0000466)	0.000222*** (0.0000285)	-0.000379*** (0.0000371)	-0.000350*** (0.0000474)	0.000426*** (0.0000526)	0.000185*** (0.0000288)
triple	-0.000425*** (0.0000920)	0.000472*** (0.000152)	-0.000538*** (0.000112)	0.000481*** (0.0000743)	-0.000526*** (0.0000922)	-0.000602*** (0.000114)	0.000399** (0.000155)	0.000411*** (0.0000744)
ln_labprodVA					0.000194*** (0.0000408)	0.0000342 (0.0000452)	0.000113** (0.0000545)	0.0000871*** (0.0000279)
qual_cert					0.000254*** (0.0000337)	0.000232*** (0.0000412)	0.0000188 (0.0000460)	-0.00000379 (0.0000248)
for_group					-0.0000234 (0.0000485)	-0.000120* (0.0000680)	0.000335*** (0.000105)	0.000369*** (0.0000512)
_cons	0.00121*** (0.0000551)	0.00303*** (0.000100)	0.00132*** (0.0000729)	0.00120*** (0.0000470)	0.000274+ (0.000173)	0.00103*** (0.000192)	0.00254*** (0.000235)	0.000821*** (0.000118)
N	6339	6339	6339	6339	6320	6320	6320	6320
R-sq	0.031	0.019	0.024	0.025	0.047	0.029	0.022	0.036
adj. R-sq	0.030	0.018	0.023	0.025	0.046	0.028	0.020	0.035

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

Table 12 - PS and NNM rate of change of GVCs participation (2008-2014) and firms' modes of internationalization

	ATE				ATT			
	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT
<i>NNM</i>								
single	.0001626*** (.0000379)	-.0000595 (.000608)	.0002098*** (.00005)	-.0000401 (.0000354)	.0001574*** (.0000439)	-.000098 (.0000625)	.0001998*** (.0000531)	-.0000287 (.0000328)
dual	-.0003142*** (.0000353)	.0003235*** (.0000504)	-.0003013*** (.0000432)	.0001291*** (.000026)	-.0002827*** (.000034)	.0002888*** (.0000552)	-.0002694*** (.000046)	.0001104*** (.0000298)
triple	-.00028 (.0001995)	.0001263 (.0002969)	-.0003365 (.0002548)	.0001524 (.0001282)	-.0003284*** (.0000962)	.0001875 (.0001743)	-.0003735*** (.0001229)	.0002646*** (.0000848)
<i>PS</i>								
single	.0001621*** (.0000379)	-.0000699 (.0000587)	.0002141*** (.0000507)	-.0000401 (.0000347)	.0001516*** (.0000441)	-.0000754 (.0000639)	.0001981*** (.0000534)	-.0000324 (.0000325)
dual	-.0003217*** (.0000351)	.0003504*** (.0000503)	-.0003041*** (.0000431)	.000143*** (.0000257)	-.0003058*** (.0000337)	.0003355*** (.000055)	-.000279*** (.000046)	.00013*** (.000029)
triple	-.0004385* (.0002278)	.0002673 (.0002909)	-.0004883* (.0002553)	.0001943* (.0001171)	-.0003349*** (.0000939)	.0001634 (.0001727)	-.0004097*** (.0001228)	.0003*** (.0000853)
N	6320	6320	6320	6320	6320	6320	6320	6320

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

Table 13 - MNL rate of change of GVCs participation (2008-2014) and firms' modes of internationalization

	Multinomial Logit					
	2nd quartile		3rd quartile		4th quartile	
	(1)	(2)	(1)	(2)	(1)	(2)
<i>Modes</i>	For_GVC	For_GVC_INT	For_GVC	For_GVC_INT	For_GVC	For_GVC_INT
single	0.155 (0.113)	0.208** (0.105)	-0.159 (0.114)	-0.124 (0.107)	-0.221* (0.120)	-0.260* (0.158)
dual	-0.199** (0.0929)	0.248*** (0.0919)	-0.657*** (0.0929)	-0.0935 (0.0878)	-0.522*** (0.0905)	-0.374*** (0.127)
triple	-0.508** (0.212)	0.0518 (0.241)	-0.901*** (0.214)	-0.290 (0.243)	-0.955*** (0.214)	-0.401 (0.294)
_cons	0.682*** (0.151)	1.674*** (0.223)	0.777*** (0.157)	2.173*** (0.218)	0.506*** (0.161)	1.715*** (0.237)
country fe	yes	yes	yes	yes	yes	yes
N	6339	6339	6339	6339	6339	6339
Ps.R-sq	0.1014	0.2519	0.1014	0.2519	0.1014	0.2519

Notes: * Coefficient is statistically significant at the 10% level; ** at the 5% level; *** at the 1% level; no asterisk means the coefficient is not different from zero with statistical significance.

Robust standard errors in parentheses.

5. Conclusions

- We find evidence of correlation patterns between firm productivity and GVCs indicators at aggregate level:
- Higher backward and forward GVCs participation is associated with higher firm productivity
- But strong heterogeneity by industries.

- By combining macro and micro datasets we find consistency between the observed heterogeneity in backward and forward GVCs indicators and firms' modes of internationalization;
- Hence, dual/triple modes are good proxies for GVCs backward and forward participation
- At least for the selected EU countries GVCs participation seems to be less consistent with the learning by supplying hypothesis

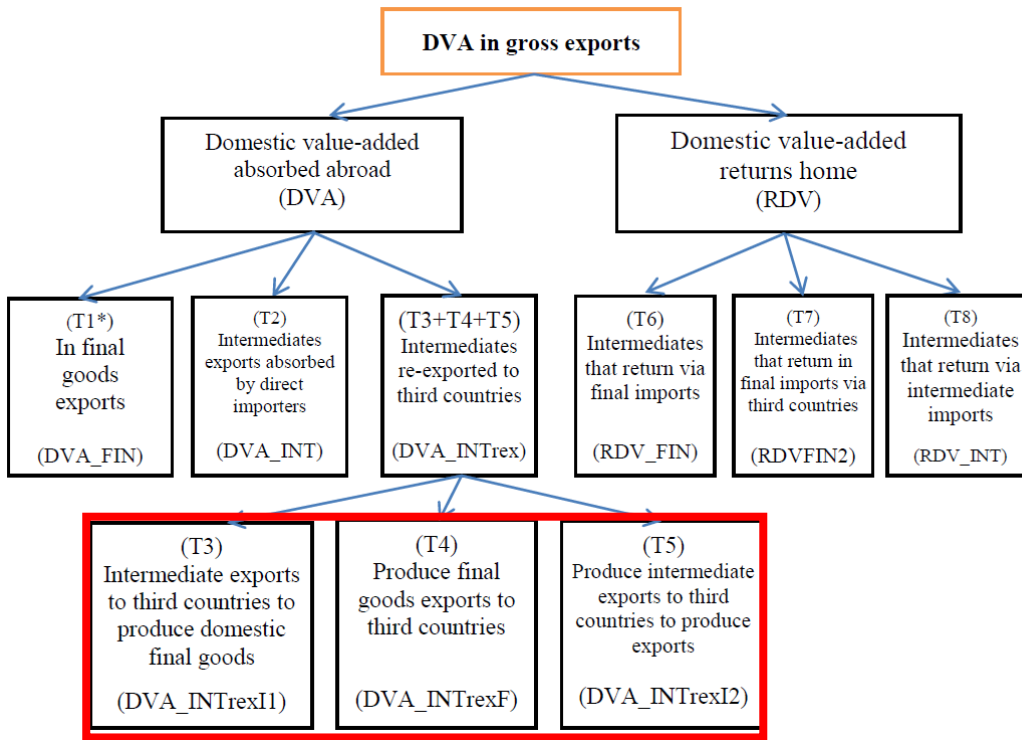
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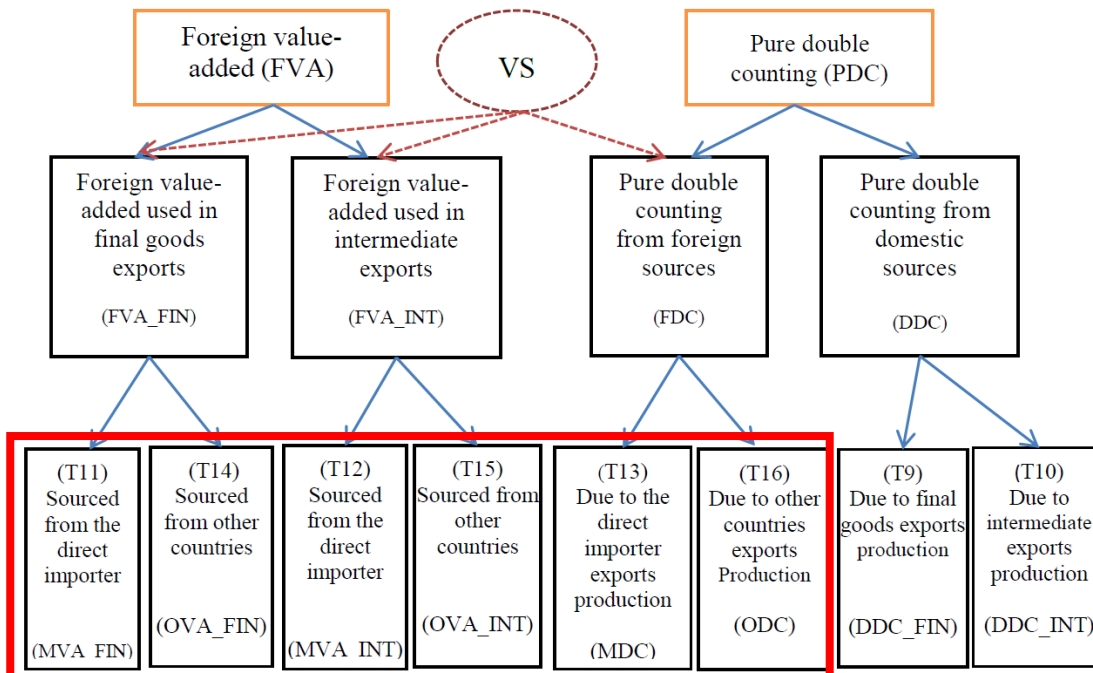
7. Appendix

Figure 1A - Domestic Value-Added decomposition and Forward GVCs Participation indicator



Source: WWZ, 2013

Figure 2A – Foreign Value-Added, Pure Double Counting and Backward GVCs Participation indicator



Source: WWZ, 2013

Table 1A - Annual rate of change (2008-2014)

wiod56	For_GVC	Back_GVC	For_GVC_INT	Back_GVC_INT
C10_C12	0.0009828	0.0016342	0.0034338	0.0004655
C13_C15	-0.0021154	-0.0009004	0.0052257	0.0011442
C16	0.0026876	0.0036366	0.000676	-0.0001457
C17	0.0017959	0.0019285	0.0037115	0.0007894
C18	0.0013817	-0.0018023	0.0027863	0.0027753
C19	-0.0001504	0.0027283	0.0096067	-0.0064342
C20	-0.0001409	-0.0012279	0.0078126	0.0026347
C21	0.000903	-0.0012355	0.0071065	0.0052665
C22	0.0011725	0.0014707	0.0049036	0.0015265
C23	0.0007599	0.0018359	0.0040125	0.0020591
C24	-0.0007638	-0.0003143	0.0076646	0.000899
C25	0.0019621	0.0027241	0.0026924	0.0003426
C26	0.0008155	0.0001436	-0.0006489	0.002405
C27	0.0007079	0.0010737	0.004711	0.0027964
C28	0.0011375	0.0015087	0.0034642	0.0015752
C29	0.0015228	0.0014116	0.0058521	0.0027354
C30	-0.001731	-0.0051565	0.0023309	-0.0004332
C31_C32	0.0023441	0.0023684	0.0015632	0.0012261
C33	0.0004975	-0.0003507	0.0019326	0.0012363
E37_E39	0.0056191	0.0061729	-0.0010584	-0.0019528
J58	0.0008547	0.0005664	0.0005834	0.0002574
J59_J60	0.0036213	0.0068238	-0.0001397	-0.0008678
R_S	0.0016401	0.0028335	0.0007616	0.000511
Total	0.0010717	0.001337	0.0033551	0.0011805