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Intangibles and Participation in Global Value Chains in the EU: Evidence from the GLOBALINTO Input-Output Intangibles Database

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ORIGINAL ARTICLE

Intangibles and Participation in Global Value Chains in the EU: Evidence from the GLOBALINTO Input-Output Intangibles Database

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Abstract

The scope of this paper is to provide empirical evidence regarding intangible inputs, global value chains (GVCs) participation and their linkage with exports in the EU and the UK, utilizing data from WIOD and the newly constructed GLOBALINTO Input-Output Intangibles Database for the period 2000−2014. GVC participation metrics are calculated based on a production-based decomposition framework and include backward and forward participation indices. Intangible inputs follow a breakdown by origin into domestic and imported intangible inputs. Our empirical results suggest that GVC participation (both backward and forward) is a significant driver for exports and highlight the importance of intangibles' origin in the exporting activities of the EU economies, especially in the case of the non-Euro Area economies.

Keywords: Global value chains, Input-Output analysis, Intangible capital, Exports, Competitiveness

JEL classification: F14, O30, O52

Introduction and theoretical background

Global Value Chains (GVCs) have been placed in the epicentre of economic research as the global economy is rapidly moving towards regional and international production and trading clusters where countries no longer act as individual trade partners but rather embed themselves in supply networks that function as a unified entity in international markets. The European Union (EU) can be considered as a predominant example of this type of cluster, with EU members constantly trading with each other and forming the concept of '*the most regionalized region in the world*' (Daudin et al., 2011). Accordingly, EU is no stranger to GVCs as well, with Amador et al. (2015) stating that the EU's GVC participation is currently overcoming the US and Eastern Asian economies. Benkovskis and Karadeloglou (2015) further elaborated on the matter, highlighting its linkages with competitiveness and growth for the EU economies. In the same vein, participation in GVCs is further acknowledged as a driver for growth in the global economy as well (see global studies by Pahl and Timmer (2019) and Constantinescu et al. (2019)).

Another point of interest in recent literature streams is the role of intangible assets in the productivity puzzle. Intangibles-related research faces two main issues that have yet to find a univocal answer in academia, which involve i) the definition of intangible assets, and ii) their quantification. Corrado et al. (2009) provided the first formal definition, according to which intangibles can be grouped into three major categories: a) computerized information (including computer software and related activities), b) innovative property (including research and development output, entertainment, design, and intellectual property), and c) economic competencies (branding, marketing, training, and organizational capital). According to their nature,

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intangibles are pivotal in the production and diffusion of innovation and an alternative characterization for them is knowledge-based capital (Jona-Lasinio et al., 2019). This definition provided a solid theoretical foundation for empirical efforts towards the quantification of intangibles and the construction of relevant empirical databases. The common baseline among these efforts is the treatment of intangibles as capital approximations and thus the quantification procedures included the estimation of capital formation from dedicated expenditure data and specific components of fixed capital (see for example INTAN-Invest by Corrado et al., 2018; INNODRIVE by Piekkola, 2011) and the most recent release of the EU-KLEMS database (Stehrer et al., 2019). These databases provided the empirical data to support several investigations regarding the effect of intangibles to growth, with Roth and Thum (2013), Niebel et al. (2017) and Piekkola (2018) providing evidence of strong and positive relationship between intangible capital and productivity growth. Intangibles are also connected with participation in GVCs, as intangible intensive activities appear to accumulate maximum shares in VA appropriation along the production chain (OECD, 2013). In support of this claim, Jona-Lasinio et al. (2019) provided evidence of the importance of intangible capital as a driver for GVC participation.

As the main body of intangibles-related literature focuses on their contribution to productivity growth, another main aspect regarding the scope and nature of intangibles is still absent from relevant research, namely the *origin* dimension of intangible assets. The recently developed GLOBALINTO Input-Output Intangibles Database-GIOID (Dimas et al., 2022) provides the proper framework and empirical tools to explore this dimension, as it sheds light to some missing dimensions that previous approaches failed to address, such as where the intangible assets come from and who produces them. Under this framework, the database investigates the origin dimension regarding intangibles in the EU, introducing a novel approach based on inter-industry trade of utilities and the treatment of intangibles as intermediate inputs/producer's services. The novel intangibles metrics are compatible with the traditional and advanced GVC participation indices and can be co-integrated in studies that focus on GVC trade in the EU and the investigation of the combined effect of intangibles (domestic and imported) and GVC participation (in all its aspects) to growth and competitiveness via traditional growth accounting exercises and novel empirical approaches.

This paper is embedded in the latter framework and aims to provide quantitative insights regarding GVC participation and intangible assets in the EU-27 plus the United Kingdom,[1] and empirically investigate their relationship and effects in competitiveness for the EU members. Our main research hypothesis indicates that both intangible assets and GVC participation are major determinants that drive the exporting performance of the EU economies. We empirically investigate this hypothesis through the calculation of the production-based GVC indicators following the innovative framework provided by Wang et al. (2017) and utilizing data at the country level from the World Input-Output Database (WIOD) (Timmer et al., 2015) and the newly constructed GIOID (Dimas et al., 2022; Tsakanikas et al., 2022) for the period 2000−2014. Furthermore, we test the calculated indicators in simple panel regressions as determinants of exports for the EU. In this line, we develop two separate sub-samples, distinguishing between Euro Area (EA) and non-Euro Area economies, and further introduce different intangible factors in the specifications to investigate different aspects of intangibles contribution to exports.

The structure of the remainder of this paper is as follows: At the first stage, we provide a description regarding the quantification of GVC participation indicators based on I−O analysis and the production-based decomposition approach applied in this paper. The second stage of this paper presents a short description of the GIOID, with details regarding the methodological approach, the data, and the key novelties that this database presents. The third stage of this paper provides the methodology and the main indicators utilized in the empirical part of this study and the fourth stage provides descriptive statistics and the regression results. The fifth and final part presents the conclusions of this study and discusses limitations and future research.

1 Input-Output frameworks of analysis for GVC participation

1.1 Methodological overview regarding Inter-Country Input-Output tables

The methodological basis of the present paper originates from Leontief's (1936) I−O framework,

[1] For abbreviation purposes, we will refer to EU-27 and the UK as EU-28 in the following sections of this paper.

which has since been a predominant tool for the quantitative analysis of production interdependencies and the modelling of economic systems. I–O models generally treat an economy as a set of interconnected sub-components, each requiring inputs of goods and services from the other components and producing goods and services that are then consumed by the other components for production or final use. These interdependencies are depicted in I–O tables and the framework relies on three main assumptions about the nature and structure of the economic system depicted in the table. Namely the system is completely internal (all output is eventually used – *consumed*), with no effects of production scaling, and finally, that every industry corresponds to a single product and vice versa (i.e., no substitute products exist).

While the I–O tables are usually compiled by statistical institutions at the national level (the economic system is the economy and the components are the different national industries and final uses) based on its supply and use tables, there exist differences in currency, accounting practices, trade balances and industry classifications among different countries that often pose difficulties in drawing meaningful comparisons. To overcome such issues, Inter-Country Input-Output Tables (ICIOTs) have been developed, with the most prominent ones being the World Input-Output Database (Timmer et al., 2015) and OECD's Inter-Country Input-Output (ICIO) Tables.

Assuming a hypothetical inter-national economy with N countries, with K industries each, an ICIOT follows the structure presented below in Table 1.

Table 1. Input-Output table framework for an international economy of N partner countries with K industries per country.

	Intermediate Consumption					Final Uses			Total Output
	Country	C_1	C_2	[…]	C_N	C_1	[…]	C_N	
Intermediates Supply	C_1	$X_{1,1}$	$X_{1,2}$	[…]	$X_{1,N}$	$F_{1,1}$	[…]	$F_{1,N}$	Y_1
	C_2	$X_{2,1}$	$X_{2,2}$	[…]	$X_{2,N}$	$F_{2,1}$	[…]	$F_{2,N}$	[…]
	[…]	[…]	[…]	[…]	[…]	[…]	[…]	[…]	[…]
	C_N	$X_{N,1}$	$X_{N,2}$	[…]	$X_{N,N}$	$F_{N,1}$	[…]	$F_{N,N}$	Y_N
Value Added		VA_1	[…]	[…]	VA_N				
Total Input		I_1	I_2		I_N				

In Table 1, X is the global matrix of intermediate consumption, with each sub-matrix $X_{i,j}$ being a $K \times K$ sized block containing the flows of intermediate goods and services from the sectors of country C_i to the sectors of country C_j for intermediate consumption. $F_{i,j}$ is a $K \times D$ matrix regarding the consumption of the D final users from the production of country C_i to country C_j, VA_i is a $1 \times K$ vector of the value added per sector of production from country C_i, and Y_i, I_i are $K \times 1$ and $1 \times K$ vectors containing the total gross output and the total requirements for inputs per sector and country pair. Following the core assumptions of the framework, total output must equal total input: $Y_i = I_i'$. The global coefficients of production can then be estimated[2] as $A = XY'^{-1}$, resulting in a $NK \times NK$ matrix. Following these formulations, total output of the economy can be written as $Y = AI' + F$, or as $Y = (I_{id} - A)^{-1}I$, with $(I_{id} - A)^{-1} = L$ being the familiar Leontief inverse matrix for the global economy and I_{id} an $NK \times NK$ identity matrix.

Since the seminal work of Hummels et al. (2001), the quantification of GVC participation has been based on various metrics that derive from ICIOTs, such as exports of intermediates and various value-added (VA) decomposition approached developed by different research groups at both industry and country levels. The foundations for GVC research were set through the construction of global ICIOTs such as the aforementioned WIOD (Timmer et al., 2015) and OECD's ICIOTs. Koopman et al. (2014) provided a formal framework for the decomposition of gross exports into two major components that defined the GVC empirical research; *domestic value added* (DVA) and *foreign value added* (FVA) embodied in gross exports. This framework paved the way for the development of backward (focused on FVA) and forward (focused on DVA) participation indices that were utilized widely in empirical growth research by both academia and economic research institutions (see for example Amador et al., 2015; Benkovskis & Karadeloglou, 2015; Constantinescu et al., 2019; Tsakanikas et al., 2022; World Bank, 2020).

[2] In the context of the present study the apostrophe (A') denotes the transpose matrix of A and the hat accent ($\widehat{A}$) the diagonal matrix of line/column vector A.

These indicators were exports-driven and calculated based on a country's/sector's gross exports. In this study, we adopt an alternative approach towards the quantification of GVC participation, that is production-based and relies on the decomposition of value-added into domestic and foreign components, as introduced by Wang et al. (2017). Our indicators are constructed utilizing available data from WIOD for the period 2000–2014. The detailed procedure towards the construction of the production driven backward and forward GVC participation indices is described in the following section.

1.2 Tracing of value added in inter-country trade following a production-based approach

In an ICIOT, the flows of goods and services between the different sectors and countries are immediately identifiable and can be traced along the production chains. However, information about the traded value added that is incorporated in those flows requires further elaboration. The first step is to estimate the share of value added embodied in the total output of each sector and country:

$$VA_{to} = VAY'^{-1} \tag{1}$$

Multiplying VA_{to} by the global Leontief matrix and the vector of gross final uses per industry and country of origin, the global matrix of value-added traded by partner industry–country pair can be formed:

$$VA_{tr}^{oc,\,oi,\,pc,\,pi} = \widehat{VA_{to}}\widehat{LF_{to}} \tag{2}$$

This matrix can then be further decomposed to form the country-industry network of value-added flows by partner of destination or partner of origin and by type of use (for intermediate or final uses). The present paper follows the decomposition method described by Wang et al. (2017), which utilizes the domestic and foreign submatrices of production coefficients and final demand due to bilateral trade from the ICIOTs to separate VA that is consumed in its country of origin from VA that is exported and then consumed abroad or is further embodied in other partner countries exports:

$$VA_{tr}^{oc,\,oi,\,pc,\,pi} = VA_{d\to d}^{cons} + VA_{d\to f}^{cons} + VA_{d\to f}^{exp/imp} \tag{3}$$

where $VA_{d\to d}^{cons}$ is the VA that is consumed in the country in which it firstly originates, $VA_{d\to f}^{cons}$ is the VA that is produced, then embodied in the final goods exports of a country–sector pair and then imported and consumed in another country–sector pair, and $VA_{d\to d}^{exp/imp}$ is the VA that is embodied in the intermediate exports or imports a country–sector pair. This last form of VA can then be either used in the partner country for production or be further re-exported.

To develop the measures of participation in GVCs at the country level, we adopt the net trade concept (Wang et al., 2017) with the necessary modifications to account for the higher aggregations. The share of a country's total VA that consists of domestic VA that originates through downstream activities ('*forward*' participation in GVCs) can be written[3] as

$$VA_{GVC,\,ds}^{oc} = \frac{\sum_{j=1}^{j=K}\sum_{i=1}^{i=N} VA_{d\to f}^{exp/imp}}{\sum_{j=1}^{j=K}\sum_{i=1}^{i=N} VA_{tr}^{oc,\,oi,\,pc,\,pi}} \tag{4}$$

while the share of foreign VA imported through intermediates in its final uses ('*backward*' participation in GVCs) is given at the country level by:

$$VA_{GVC,\,us}^{pc} = \frac{\sum_{i=1}^{i=K}\sum_{j=1}^{j=N} VA_{d\to f}^{exp/imp}}{\sum_{i=1}^{i=K}\sum_{j=1}^{j=N} VA_{tr}^{oc,\,oi,\,pc,\,pi}} \tag{5}$$

2 Intangibles inter-country trade: the GLOBALINTO Input-Output intangibles database

Most of the available intangible capital databases provide insightful information regarding investment in intangible capital and a breakdown among different categories of intangible assets in line with Corrado et al. (2009) definition. However, some important questions still remain unanswered, such as *Where do these investments go?* and *Who produces these intangible assets and where do the intangible assets come from*?

The GLOBALINTO I–O Intangibles Database provides the empirical insights to tackle these gaps in intangibles quantification literature, by treating intangibles as intermediate inputs in the production process of each industry/country. The database provided intangibles-related data for 56 2-digit NACE REV. 2 industries from all EU-27 countries including the UK, for the period 2000–2014. The framework of this novel database is constructed based on the Corrado et al. (2009) approach and key elements of the INNODRIVE methodology (Piekkola, 2011), and identifies certain knowledge-

[3] (i,j) along with (N,K) denote the summation direction (e.g., row wise for all countries first and column wise for all industries second, etc.).

intensive service sectors in the economy as intangibles producing sectors. The treatment of intangibles as inputs and more accurately as producer's services enables the quantification of trade-in-intangibles between industries and countries and goes beyond the level of established databases through the introduction of the origin dimension, as the user can distinguish between the intangibles that are produced domestically, and the intangibles purchased from abroad via imports.

The database is constructed drawing raw I–O data from the 2016 release of WIOD, which covers the inter-industry trade between 56 2-digit NACE Rev. 2 economic sectors from 43 countries (including all EU-28 members) and an estimate for the rest of the world. In the framework of the database, 4 knowledge-intensive services sectors are identified as intangibles producers, namely:

- J62-J63: Computer programming, consultancy, and related activities; Information service activities.
- M72: Scientific Research and Development (R&D).
- M73: Advertising and market research.
- N sector: Administrative and support service activities.

Under this scope, intangibles are quantified as producer services in the inter-industry and inter-country trade, a novel dimension that enables the study of trade-in-intangibles in the international markets and the globalized economy. The methodological framework regarding the identification of intangibles is embedded in the basic principles of I–O analysis and is centered around the intangibles-producing sectors. As a result, this approach can be further expanded into different ICIOTs that provide appropriate data regarding the inter-industry and inter-country trade.

The intangibles-related data in GIOID are further consolidated with export and competitiveness statistics calculated from the WIOD and R&D expenditure data from Eurostat. Furthermore, the database includes information about patent applications to the European Patent Office (EPO) per industry, at the NACE Rev.2 level, which derive from Eurostat.

A detailed description regarding the construction and the key elements of GIOID can be found in Dimas et al. (2022) and its conceptual and the methodological underpinnings are thoroughly discussed in Tsakanikas et al. (2022).

3 Empirical methodology and model specifications

To empirically assess the contribution of GVC participation and intangibles in the competitiveness of the EU,[4] we formulate two different sub-samples of the EA[5] and non-EA economies,[6] based on the assumption that a common currency enhances traditional trade and GVC-trade activities. We select a relevant export performance indicator from GIOID that is the share of gross exports to total output per country, as a proxy for competitiveness:

$$GX_{Y_{c,t}} = \frac{GX_{c,t}}{Y_{c,t}} \tag{6}$$

where $GX_{c,t}$ and $Y_{c,t}$ represent the gross exports and total output of country c at time t respectively.

To account for the effect of intangibles, we introduce the origin dimension as a key novelty in the intangibles-related studies, utilizing two separate indicators from GIOID, as described in the following equations:

$$dIntan_{c,t} = \frac{dom.\,intangible\,inputs_{c,t}}{I_{c,t}} \tag{7}$$

$$iIntan_{c,t} = \frac{imp.\,intangible\,inputs_{c,t}}{I_{c,t}} \tag{8}$$

where $dIntan_{c,t}$ stands for the share of domestically produced intangibles inputs in c at time t to its total intermediate consumption of utilities ($I_{c,t}$) and $iIntan_{c,t}$ stands for the share of imported intangibles inputs.

Previous empirical investigations regarding intangibles were directed towards exploring the overall effect of investment in intangible capital rather than trying to distinguish between the domestically purchased and imported assets. In order to provide an element of comparison and highlight the key novelties of the intangible inputs' indicators incorporated in GIOID, we also introduced an aggregate intangibles indicator in our specification, which does not account for intangibles origin, as described in equation (9):

[4] Cyprus, Luxembourg, and Malta are excluded from the study, due to the nature of their economies and their special characteristics regarding international trade and domestic economic activities.
[5] Euro Area members include Austria, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, and Spain.
[6] Non-Euro Area economies include Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, and the United Kingdom.

$$tIntan_{c,t} = \frac{total\ intangible\ inputs_{c,t}}{I_{c,t}} \quad (9)$$

The GVC participation indices utilized in the empirical analysis are the '*backward*' and '*forward*' participation in GVCs as described in detail in the previous section and are depicted in equation (10).

$$gvc_{b_{c,t}} = VA^{pc}_{GVC,\ us} \quad gvc_{f_{c,t}} = VA^{oc}_{GVC,\ \ ds} \quad (10)$$

We model the aforementioned variables into four separate specifications to study the effects of intangible inputs and GVC participation to exports for the EA and non-EA EU countries in the period 2000–2014. The specifications are presented in the following equations:

i. $GX\_Y_{c,t} = a_o + a_1 gvc\_b_{c,t} + a_2 gvc\_f_{c,t} + a_3 tIntan_{c,t} + \lambda_t + \varepsilon_{c,t}$

ii. $GX\_Y_{c,t} = \beta_o + \beta_1 gvc\_b_{c,t} + \beta_2 gvc\_f_{c,t} + \beta_3 dIntan_{c,t} + \beta_4 iIntan_{c,t} + \lambda_t + \varepsilon_{c,t}$

iii. $GX\_Y_{c,t} = \gamma_o + \gamma_1 gvc\_b_{c,t} + \gamma_2 gvc\_f_{c,t} + \gamma_3 dIntan_{c,t} + \lambda_t + \varepsilon_{c,t}$

iv. $GX\_Y_{c,t} = \delta_o + \delta_1 gvc\_b_{c,t} + \delta_2 gvc\_f_{c,t} + \delta_3 iIntan_{c,t} + \lambda_t + \varepsilon_{c,t}$

Our specifications follow a reverse approach. At first, we introduce a model with GVC participation indices and total intangible inputs to account for the effects of GVC participation and intangibles in exports. Subsequently, we distinguish between domestic and imported intangibles to identify to which type (or both) of intangibles the previously identified effect is attributed to. Furthermore, we provide specifications that account for the intangibles origin dimension separately to corroborate our results. The econometric approach includes simple Fixed Effects (FE)[7] panel regressions to account for the country-specific effects with time dummies to account for unobserved time effects via λ_t, while $\epsilon_{c,t}$ represents the error term. We further turn to Driscoll and Kraay (1998) robust standard errors to account for heteroskedasticity, serial autocorrelation and contemporaneous autocorrelation (cross sectional dependence) present in the results.[8]

Table 2. Summary descriptive statistics for the variables of the adjusted EU-28 sample for the period 2000–2014.

	Obs.	Mean	Standard Dev.	Min	Max
GX_Y	375	0.227	0.085	0.054	0.514
gvc_b	375	0.196	0.059	0.103	0.372
gvc_f	375	0.180	0.059	0.059	0.351
dIntan	375	0.062	0.025	0.018	0.146
iIntan	375	0.016	0.029	0.002	0.218
tIntan	375	0.078	0.039	0.020	0.253

4 Results and discussion

The main descriptive statistics regarding the sample of the EU-28 economies utilized in this study is presented in Table 2.

Table 3 presents the correlation matrix of the variables included in this study.

The backward and forward participation indices of the EU-28 economies at the start (2000) and end (2014) of the study's timeframe are reflected on the following scatterplots in Fig. 1. First, there is a notable upwards shift in the participation intensity for almost all countries, both via downstream and upstream production activities, as can be observed from the relative positions of the countries along the (x, y) axis. Even economies that were initially less involved in the backward participation in GVCs (notably Bulgaria, Greece, Portugal) have been increasing their shares of imported inputs used for final production purposes. Second, there has been a gradual and proportional increase in both forward and backwards participation, which is evident by the clustering of the observations along the diagonal line in 2014 compared to 2000. This pattern depicts a bidirectional GVC deepening for most of the European economies and relates with a positive relationship between forward and backward participation. This finding is further corroborated by the correlation statistics of Table 3, where forward and backward participation in GVCs are found to be positively correlated (Pearson stat. value of 0.776).

Furthermore, we document apparent clusters of countries with geographical proximity and economic conditions. For example, the Southern European economies (Greece, Portugal, Spain, Italy) move closer to each other and settle in the more forward-intensive part of GVC participation, while some central European countries (Hungary, Czech Republic, Slovakia, Slovenia) also tend to increase

[7] Random Effects and Pooled OLS were also tested, and FE were selected based on the results of the Hausman specification test (Hausman, 1978).
[8] Heteroskedasticity was detected via the implementation of the modified Wald statistic for group heteroskedasticity (Greene, 2000), serial autocorrelation was detected via Wooldridge's (2010) test and contemporaneous autocorrelation/cross section dependence via Pesaran's (2007) diagnostic test.

Table 3. Correlation matrix for the variables of the adjusted EU-28 sample for the period 2000–2014.

	GX_Y	*gvc_b*	*gvc_f*	*dIntan*	*iIntan*	*tIntan*
GX_Y	1.000					
gvc_b	0.665***	1.000				
gvc_f	0.793***	0.776***	1.000			
dIntan	−0.080	−0.463***	−0.191***	1.000		
iIntan	0.540***	0.434***	0.470***	−0.028	1.000	
tIntan	0.357***	0.019	0.229***	0.650***	0.742***	1.000

Note. Pearson correlation statistics reported. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

their participation in GVCs (in this case, both forward and backward) and move closer together.

Another observation that can be drawn relates to the differences in GVC participation between our two separate sub-groups, the EA (shown in bold font in the graphs) and non-EA economies (rest of the sample of the EU-28). There has been a significant shift towards backward participation for EA economies, regardless of their generally perceived statuses as either '*mainly exporting*' or '*mainly importing*' countries. This showcases the gradual increase of share the foreign VA content of the goods and services that are consumed in final uses, as the EU becomes more strongly interconnected in terms of trade for production purposes and is gradually deepening its bidirectional participation in GVCs.

Following the descriptive analysis, the main empirical results of the model specifications are presented in Table 4.

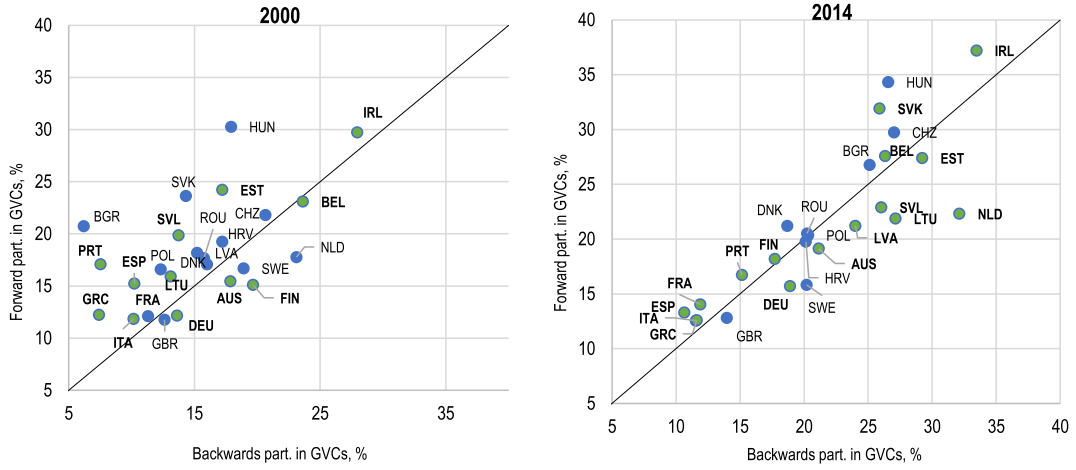

Fig. 1. Backward and forward participation in GVCs for all EU-28 counties in 2000 and 2014. Note. EA economies are presented in bold font and green markers. Source: Authors' calculations based on WIOD.

Table 4. Fixed effects panel regression results with Driscoll and Kraay (1998) robust standard errors.

	Euro-Area				Rest of the EU-28			
GX_Y	(i)	(ii)	(iii)	(iv)	(i)	(ii)	(iii)	(iv)
gvc_b	0.37***	0.33**	0.42**	0.28**	0.36***	0.29***	0.36***	0.28***
	(0.09)	(0.11)	(0.15)	(0.10)	(0.07)	(0.08)	(0.08)	(0.08)
gvc_f	1.12***	1.13***	1.14***	1.15***	1.03***	1.04***	1.03***	1.04***
	(0.09)	(0.08)	(0.07)	(0.08)	(0.04)	(0.04)	(0.04)	(0.04)
tIntan	0.34***				0.16			
	(0.11)				(0.12)			
dIntan		0.25*	0.06			0.07	0.06	
		(0.13)	(0.12)			(0.11)	(0.12)	
iIntan		0.37***		0.30**		1.43**		1.42**
		(0.12)		(0.12)		(0.54)		(0.53)
constant	−0.07**	−0.06*	−0.06	−0.03	−0.06***	−0.05***	−0.05***	−0.04**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)
Time dummies	✓	✓	✓	✓	✓	✓	✓	✓
Observations	240	240	240	240	135	135	135	135
within R^2	0.79	0.80	0.78	0.79	0.96	0.96	0.95	0.96
No. of groups	16	16	16	16	9	9	9	9

Note. Driscoll and Kraay (1998) robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

The empirical results indicate that GVC participation − both backward and forward − is vital for the exporting activities of the EU-28 members with a positive and statistically significant impact on exports in all specifications and sub-samples.

Focusing on intangibles, we observe a positive and statistically significant effect on exports for EA. Delving more into the matter through the breakdown of intangibles per origin to domestic and imported, we observe a stronger effect for the latter with domestic intangibles being a driver for exports only in the presence of imported intangibles. This finding is even more acute in the case of the rest of the EU-28 members that do not share a common currency. For the non-EA countries, intangibles appear to not affect exports in a statistically significant manner. However, when accounting for the intangibles' origin, we identify that the insignificance of total intangibles is related with the domestic intangibles as the imported share appears to be a statistically significant driver for exports in the respective sub-sample of economies.

5 Conclusions

This paper provides insights regarding intangible inputs and GVC participation (backward and forward) in the EU utilizing available data from WIOD and the novel GLOBALINTO I−O Intangibles Database for the period 2000−2014. Furthermore, we investigate the effect of GVC participation and intangible inputs in the exporting activities of the EU countries via simple panel regressions in order to highlight different dimensions related with intangibles that were previously unexplored in relevant literature.

In the timeframe of this study (2000−2014), we observed an increase in both forward and backward participation intensity for almost all countries, with further shifts towards incorporating more foreign value added in their consumption and exports of goods and services, especially for the EA countries. Furthermore, a clustering pattern emerges for economies with relatively comparable production characteristics and overall macroeconomic conditions, most notably in the case of the Southern European and most Central European economies.

The key empirical findings regarding the contribution of intangible inputs and GVC participation in exports are summed below:

i. GVC participation − both backward and forward − is a driver for the exporting performance of the EU members.
ii. Intangible inputs appear to be a driver for exports for the EA economies.
iii. Intangibles' origin does matter for the non-EA economies, as imported intangibles appear to be a significant driver for exports, whereas domestically produced intangibles are not related with exports in a statistically significant manner.

The empirical evidence of this study highlights the importance of the origin dimension in intangible assets, as imported intangibles appear to be a driver for exports for all EU-28 economies. Especially in the case of the non-EA economies, imported intangibles outperform domestic intangibles in terms of contribution to exports. This dimension was previously unexplored in the intangibles-related research and constitutes a key novelty of the GIOID compared to the existing databases. Furthermore, the producer services approach on intangible assets adopted by GIOID provides a framework for the quantification and study of trade-in intangibles between industries and across countries, a dimension that the empirical evidence of this study highlights as a significant factor that defines the exporting activities of the EU-28 economies.

The results of this study are in line with Tsakanikas et al. (2020) where intangibles and GVC participation (via a different approximation) appear to be drivers for productivity performance in the EU at the country level. Furthermore, the significance of the imported intangible inputs in the EU's competitiveness is also corroborated in Tsakanikas et al. (2022) at the industry level and with a special focus on manufacturing activities in the EU. The collective evidence that derives from research based on GIOID suggests that intangibles should be placed in the epicenter of future industrial policy frameworks in the EU, with special focus on trade-in intangibles and the intangible transactions between different EU members. Future policy frameworks should aim to establish and properly safeguard the intangibles trade in the EU, as it appears to be a crucial beneficial factor for the EU's economies and its overall competitiveness.

As stated above, the focus of this paper is to explore the relationship among export activity, different types of GVC participation (forward and backward) and intangible assets. However, our approach remains agnostic to the actual ownership of these assets, an inherited shortcoming that stems from the nature of I−O models, which, in multiregional settings − as in the case of WIOD − can only provide information regarding the location of production. Despite this fact, this novel dataset provides fertile ground for future research that should

aim to distinguish among different types of intangibles and provide empirical evidence both per origin as well as per type of an intangible asset. We further encourage future endeavors to focus into industry and country-specific case studies and provide novel insights that correspond to regional and national determinants that shape export performance.

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