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What drives the differences in domestic value added in exports between old and new E.U. member states?

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ABSTRACT

Domestic value added in exports has lately become a key measure of a country's global competitiveness. This paper analyses the potential drivers of the differences in domestically generated value added in exported goods between 'new' (CEE-10) and 'old' (EU-15) countries. The analysis focuses on the role played by intangible investments, human capital and foreign direct investment. By studying export performance at the industry level for the period 2000–2011, this paper finds that differences in the share of domestically generated value added depend on investments in intangible capital, in particular investments in research and development. CEE-10 countries suffer from a distinct lack of investments in intangible capital, which is currently only sufficient to enable their mere participation in global value chains. Further, inward F.D.I. causes a reduction in demand for domestic inputs for both groups of countries and hence lowers D.V.A. in exports, while CEE-10 countries are also found to be upgrading global value chains by undertaking outward F.D.I.

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1. Introduction

With the emergence of global value chains (henceforth G.V.C.s), different countries in the production chain add value before final consumption. Consequently, most of today's exports are not fully or originally produced in the exporting country since it incorporates a certain share of imported intermediate goods (Cheng & Fukumoto, 2010). Therefore, around one-fifth of a country's exports represents other countries' value added in imported intermediates.

Domestic value added (henceforth D.V.A.) in a country's exports indeed represents an important measure of income from trade and thus acts as an important guideline for development policy (Caraballo & Jiang, 2016). Namely, the high country's volume of exports is not necessarily reflected in its economic growth as it was in the past, since only the domestic part of the country's total exports contributes to its G.D.P. (UNCTAD, 2013).

Focusing on the E.U. countries, some features of D.V.A. in export dynamics can be identified (Figure 1). First, in the period 1995–2011 a general downward trend in

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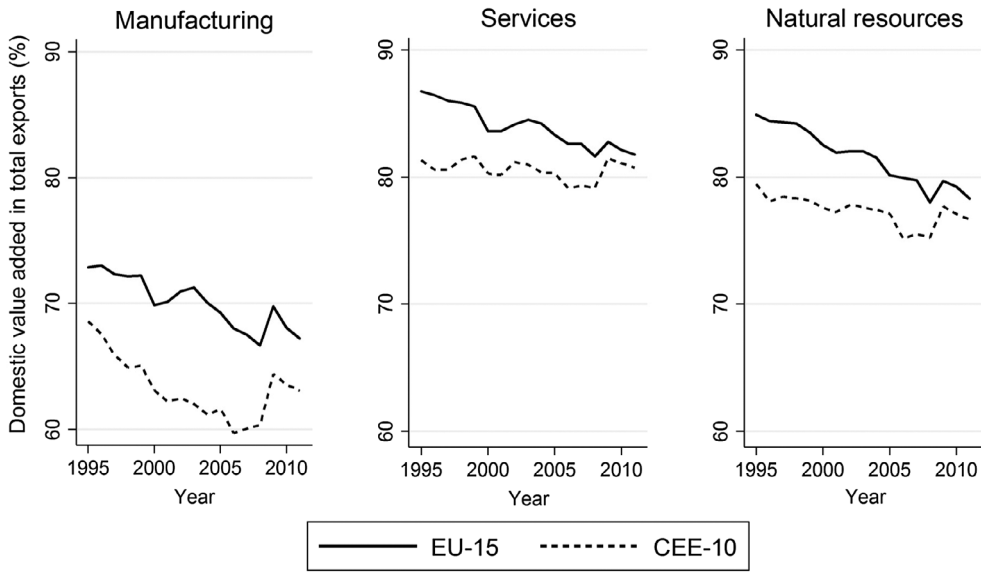


Figure 1. Share (%) of domestic value added in exports for core E.U. countries (EU-15) and E.U. countries from Central and Eastern Europe (CEE-10), 1995–2011, by sector groups. Source: W.I.O.D. tables, own calculations.

D.V.A. in exports in all sectors is evident, which may be seen using different measures of D.V.A. in exports (Daudin, Riffart, & Schweisguth, 2011; Dean, Fung, & Wang, 2007; Hummels, Ishii, & Yi, 2001; Johnson & Noguera, 2012; Koopman, Powers, Wang, & Wei, 2010; Koopman, Wang, & Wei, 2014). Second, the manufacturing sector has the lowest shares of D.V.A. in export shares compared to services and natural resources, which may indicate the greater fragmentation of cross-border production (Johnson & Noguera, 2012). Third, a structural break may be observed after 2009 when the trend value of D.V.A. in exports suddenly increased by a great margin. Regarding this sudden increase in D.V.A., Stehrer and Stöllinger (2013) argue that the crisis may have caused firms to start re-shoring part of their offshore activities, which led to higher D.V.A. in exports, especially if such re-shoring activities were present in sectors with relatively high foreign V.A. in exports. Fourth, although export restructuring within the CEE-10 countries caused the D.V.A. gap to decline relative to the EU-15 countries after 2003, the CEE-10 countries still have a systematically smaller share of D.V.A. in exports compared to the EU-15 countries.

Since many debates on global value chains ultimately converge on the question of how to upgrade or move up the value chain (Sydor, 2011),¹ it is becoming ever more important to understand the drivers of high-value activities that contribute to greater domestic content in exports. Besides the fact that higher domestic value added in exports is associated with larger or more developed countries (higher income per capita) and countries that are geographically farther from the ‘headquarter’ economies (Kowalski, Lopez Gonzalez, Ragoussis, & Ugarte, 2015; Stehrer & Stöllinger, 2015), research (OECD, 2013; Stehrer & Stöllinger, 2015) shows that progress in G.V.C. upgrading can be attributed to a larger stock

of knowledge-based capital (or intangible assets) and more sophisticated exports. Indeed, intangible assets represent crucial non-material resources that enable a firm's upgrading and are required for the creation of new or improved products and processes (Arrighetti, Landini, & Lasagni, 2014; OECD, 2013), while more sophisticated exports signal a country's greater accumulation of skills and capacities (Stehrer & Stöllinger, 2015).

This paper considers which factors may be relevant for countries to focus on in order to 'capture' more domestic value from their exports. Following the major findings of existing research and given the limitations on data availability, this paper's primary research question considers what is mainly driving the differences in D.V.A. shares between EU-15 and CEE-10 countries by exploring the roles of intangible investments, human capital and F.D.I. (the latter represents an important driver of participation in G.V.C.s). Although both groups (EU-15 and CEE-10) are very heterogeneous, this division, while nominally resulting from their later accession to the EU, is based on the fact that CEE-10 had relatively recently undergone the transition from socialist to market economies. This feature provides a common reference for these countries in particular vis-a-vis those of EU-15. To decompose each country's exports into domestic and foreign content, the Koopman et al. (2010) methodology and data from the World Input-Output Database (henceforth W.I.O.D. ; Timmer, Dietzenbacher, Los, & Stehrer, 2015) are used.

The results provide a solid basis for understanding whether the CEE-10 countries can gain in terms of D.V.A. from higher investments in intangible capital and improved human capital as well as what is the possible different impact of F.D.I. investments in both the CEE-10 and EU-15. The paper goes beyond the analysis of Koopman et al. (2010) by exploring the determinants of D.V.A. in exports in E.U. countries and explaining the heterogeneity among two groups of E.U. countries in their D.V.A. in exports using industry-level data. Further, the existing empirical studies largely focus on evaluating the determinants that may facilitate the establishment of supply links, namely those: influencing foreign value added (F.V.A.) in exports (Rahman & Zhao, 2013; Stehrer & Stöllinger, 2015), of participation in G.V.C.s (Kowalski et al., 2015; Stehrer & Stöllinger, 2015; Van der Marel, 2015) and of trade in value added (Baldwin & Taglioni, 2011; Brooks & Ferrarini, 2012; Cheng & Fukumoto, 2010; Choi, 2013; Noguera, 2012).

The rest of the paper is structured as follows. Section 2 presents the existing empirical research evidence on the determinants of D.V.A. (F.V.A.). Section 3 describes the regression specification and presents the results, while section 4 concludes.

2. Potential factors of value added in exports

Although the theoretical and empirical literature regarding G.V.C. trade is developing very quickly, the G.V.C. literature is mainly empirical. Stehrer and Stöllinger (2015) research potential factors that foster or hinder the further economic integration of the manufacturing sector. Assuming Germany to be the 'anchor' of the Central European supply chain, this enables them to use the classical gravity model (country-level version) and thus to introduce 'distance to Germany' and 'relative G.D.P. to Germany' as control variables. They find that greater inward F.D.I. is associated with higher foreign content in gross exports and that larger countries tend to have, *ceteris paribus*, a lower F.V.A., but they do not find a

statistically significant result between outward F.D.I. and F.V.A. in exports. Similarly, using TiVA data for 57 countries Kowalski et al. (2015) find a positive and significant correlation between F.V.A. and revealed openness to F.D.I. (measured as a share of inward F.D.I. stock as a percent of G.D.P.). As they explain in their analysis, in the observed countries inward F.D.I. is likely to be more related with imports of foreign intermediates for export processing. They also find that the larger the distance from the main manufacturing hubs, the lower the F.V.A. in exports.

Regarding the skill structure of the workforce, Stehrer and Stöllinger (2015) find a negative coefficient for medium-skilled labour, suggesting that more medium-skilled labour (including an important group of skilled production workers) reduces F.V.A. Surprisingly, they do not find any correlation of F.V.A. in exports with the share of high-skilled labour. They also determine a negative correlation for export sophistication since, as they explain, the more sophisticated a country's export base is, the greater the country's skills and capacities. Hence, the country uses fewer imported inputs and thus decreases the F.V.A. share in exports.

An important function of promoting an upgrade in G.V.C.s can be attributed to investment in knowledge-based capital (or intangible assets), which is also an essential source of competitiveness (De Backer & Miroudot, 2014). Intangible assets represent the set of resources that promote a firm's upgrading of its G.V.C. activities (OECD, 2013) or the crucial non-material resources required for new or improved products and processes to be created or sold (Arrighetti et al., 2014). Strategic resources define a firm's capacities which are compared to the capacities of the firm's competitors, and provide a platform for the creation of greater value added in G.V.C.s (OECD, 2013). Following Corrado, Hulten, and Sichel (2005), intangible assets are classified in three main groups: (1) Computerised information; (2) Innovative property; and (3) Economic competencies. The first group includes software and databases, the second encompasses science and engineering R&D, non-science innovation efforts such as product design, copyrights and trademarks, while the third group relates to brand equity, firm-specific technological and managerial skills, networks and organisational structure. The importance of economic competencies for competitiveness is pointed out by a survey of Japanese firms, with manufacturing skills, brand and customer recognition and agile and flexible organisation being the crucial ones (OECD & World Bank Group, 2015). The survey results suggest that globalised firms' advantage lies in their larger distribution of knowledge-based capital forms that are more difficult to copy or imitate (OECD, 2013).

The OECD (2013) studies the role of knowledge-based capital (proxied by intangible capital stock) in G.V.C. upgrading. Using data from the Intan-Invest database for 14 European countries (where only two countries in the sample belong to the CEE-10 group), they find that a larger stock of knowledge-based capital stimulates greater value added in exports (measured in V.A.X. terms). They find notable differences in size and significance when they observe estimated coefficients among the three subgroups of intangible capital (computerised information, innovative property and economic competencies). Among all subgroups, the coefficient on economic competencies appears to be the largest and most significant, while for computerised information it is considerably smaller and non-significant. Jona-Lasinio, Manzocchi, and Meliciani (2016) use the same data for 14 European countries and find that intangible assets contribute positively to both forward and backward participation.² R&D and training and organisational capital seem to be more important for forward participation while market and

advertising seem to be more relevant for backward participation. They also find that intangible assets positively affect value appropriation (higher D.V.A. relative to F.V.A.).

Caraballo and Jiang (2016, p. 294) focus on the determinants that may explain the 'value-added erosion' and find that an increase in the foreign high-skilled labour share embodied in a country's imports has a negative impact on the share of value added generated by exports. In addition, they find a positive correlation between the tariffs applied to manufactured products and the D.V.A. share, suggesting that countries which practise greater protectionism or have strong industrial policies are likely to increase their D.V.A. share in exports. Albeit with smaller significance, Caraballo and Jiang (2016) also find a positive correlation between the number of patent applications made by residents and the D.V.A. share.

However, for firms seeking to upgrade their role in G.V.C.s based on the formation of knowledge-based capital access to finance is vital in this process. As noted by Manova and Yu (2012, 2016), strengthening capital markets represents an important precondition since, as presented in their study, credit-constrained exporting firms from China are likely to conduct pure assembly with low value added (thereby earning low profits) compared to less financially constrained firms which conduct import and assembly or even normal trade. However, as explained by the O.E.C.D. (2013) financial development might have a more significant contribution to D.V.A. (in V.A.X. terms) in emerging economies. Namely, its study sample includes European economies that have relatively developed (advanced) financial institutions which may explain the insignificant coefficient on the measure of financial development when D.V.A. is regressed on the financial development indicator.

The key ideas from the existing research findings suggest that the main factors that could improve firms' movement towards the upper levels of the global value chain are more sophisticated exports, a larger stock of knowledge-based capital, an increase in patent applications and better financial development. In addition, lower F.V.A. in exports can be found in larger or more developed countries (higher income per capita) and countries that are geographically farther from the 'headquarter' economies.

The next section follows the main findings while analysing the impact of possible D.V.A. determinants in exports in each group of E.U. countries.

3. Empirical strategy

3.1. Regression specification

If a conclusion is drawn based solely on the observations and findings already presented, one could say there is a significant difference in the share of D.V.A. in exports between the CEE-10 and the EU-15. This paper attempts to explain these D.V.A. differences in exports between the two groups of countries by analysing possible determinants that are expected to drive the share of D.V.A. in exports. As mentioned by Kowalski et al. (2015), there is no common principle for exploring the determinants of G.V.C. trade so I rely on the theoretical predictions concerning upgrading within G.V.C.s and predominantly on the existing research findings. To distinguish between the two groups of E.U. countries, a dummy variable (*CEE*) is introduced in order to compare the partial elasticities. The

indicator variable is interacted with each of the selected variables and thus the following empirical specification is estimated:

$$DVA_{ijt} = \alpha + \delta CEE + (X_{ijt-1})\beta + (X_{ijt-1}xCEE)\gamma + \mu_i + \mu_j + \mu_t + \varepsilon_{ijt} \quad (1)$$

where *DVA* represents the estimated measure of D.V.A. in exports as a share of total exports relating to country *i*, industry *j* and time *t*. ε_{ijt} is the random error term, while μ 's are country-, industry- and time-fixed effects. X_{ijt-1} represents the vector of explanatory variables, $X_{ijt-1}xCEE$ represent interaction terms between the explanatory variable and the *CEE* dummy variable, where *CEE* = 1 if the observation belongs to the CEE-10 and *CEE* = 0 for the EU-15. All variables are transformed using a natural logarithm which allows the coefficients to be interpreted as elasticities. A unit of observation in the fixed-effect estimation is a country-industry pair.

The main explanatory variables (*X*) included in equation (1) are business enterprise research and development expenditure as a share of value added (*BERD*) as a form of intangible capital investments, human capital proxied by skill intensity (*SKILL*) measured as a share of hours worked by high-skilled workers in total hours worked, openness to F.D.I. as a share of inward F.D.I. stock in G.D.P. (*IFDI*), firms' capability of economic integration as a share of outward F.D.I. stock in G.D.P. (*OFDI*), the share of exports to the EU's five most developed countries (*EXPTOP5*) and the share of imports from the EU's five most developed countries (*IMPTOP5*), imports of intermediates from China as a share of total intermediates consumption (*IMintCHN*) and hourly wage as a proxy for productivity (*WAGE*).

All regression specifications are estimated with a fixed-effects model, which allows a correlation between the vectors of industry- and country-specific time-invariant effects (μ_{ij}) and the independent variable. The Sargan–Hansen test statistic confirms the fixed effects as more appropriate than the random-effects model, meaning that unobservable factors (i.e., shocks in business cycles, differences between industries, culture and history, participation in G.V.C.s) are important for determining D.V.A. in exports. In all regressions, standard errors are calculated using White's heteroscedasticity robust standard errors.

To reduce potential concerns with endogeneity and to allow for a deferred reaction of D.V.A., all explanatory variables are lagged by one year. Further, in the robustness check the explanatory variables are also lagged by two and three years. As an alternative method for estimating the regression model, I also employ the difference G.M.M. estimator in the robustness check.

However, when considering the effect of selected determinants on D.V.A. in exports, the fact that the causality can also operate in the other direction has to be taken into account. A possible endogeneity problem can exist between some independent variables and the dependent variable. For example, a higher share of R&D can lead to higher D.V.A., but the direction of causation may also be reversed, i.e., a higher share of D.V.A. can lead to higher R&D investments. The same problem can appear with *IFDI* and *WAGE*. The endogeneity problem could also arise due to the measurement error (regressors correlated with the regression error ε_{ijt}). In my case, the regression error can, for example, be correlated with *SKILL* due to the omission of ability and quality of education. In addition, there are other omitted and unobservable variables correlated with D.V.A. such as managerial skills or firm-specific investments. Thus, the purpose of my research is not to determine the existence

of a direct causal relationship between the selected determinants and D.V.A., but to examine the conditional correlations of individual factors with D.V.A.

3.2. Data and descriptive statistics

To undertake my analysis, I combine several datasets available at the industry level for EU-25 countries in the period 2000–2011. The main data used come from the World Input–Output Tables (W.I.O.T.), which serve as a basis for estimating the shares of D.V.A. discussed above.

Table 1 presents descriptive statistics for the variables used in the main regression. It includes averages at the industry level, separately for both groups of countries. Lower investments in intangible capital, a lower share of skilled labour, lower O.F.D.I. investments, a lower hourly wage etc. can be observed for the CEE-10 compared to the EU-15.

The greatest problem lies in gathering the data for intangible investments at the industry level. To capture the role of intangible capital investments, I rely on business enterprise research and development expenditure (*BERD*). This is the only available proxy for intangible investments on the industry level for all E.U. countries provided by Eurostat and can be used as a measure of innovation (Bogliacino, Piva, & Vivarelli, 2012; Klette & Førre, 1998). The bottleneck regarding the *BERD* data is the variety in the annual and sectoral availability of data for an individual country. *BERD* expenditure data are divided by value added generated in the same industry. Figure 2 shows the differences and variability of these values across countries. Among the EU-15 countries, these investments are highest in Denmark while for the CEE-10 they are highest in the Czech Republic. In manufacturing industries, the biggest investments are recorded in the industries Leather and Footwear, Electrical and Optical Equipment and Transport Equipment. The highest value of the *BERD* coefficient indicates that firms can benefit from greater investments in intangible capital in their process of upgrading within G.V.C.s.

The empirical literature offers no clear evidence on the relationship between innovation and involvement in a G.V.C. A country's participation in G.V.C.s may affect its innovation performance in either direction, as Felice and Tajoli (2015) explain. They refer to Eaton and Kortum (2001) when mentioning that the international fragmentation of production may increase the incentive for investment in R&D based on stronger foreign demand for domestic inputs. As participation's negative effect, they mention the decrease in the incentive

Table 1. Descriptive statistics of the variables used in the main regression, manufacturing (mean values 2000–2011).

Variables	EU-15	CEE-10
DVA_{ijt} (%)	69.06	61.98 ^a
$BERD_{ijt}$ (%)	4.76	1.82 ^a
$IFDI_{ijt}$ (%)	1.09	1.10
$OFDI_{ijt}$ (%)	1.14	0.09 ^a
$SKILL_{ijt}$ (%)	17.88	10.76 ^a
$WAGE_{ijt}$ (\$)	28.74	5.88 ^a
$IMintCHN_{ijt}$ (%)	1.30	1.38
$EXPTOP5_{ijt}$ (%)	42.38	38.17 ^a
$IMPTOP5_{ijt}$ (%)	41.16	37.10 ^a

^aThe difference between EU-15 and CEE-10 is significant at $p < 0.001$.

Source: Author's calculations.

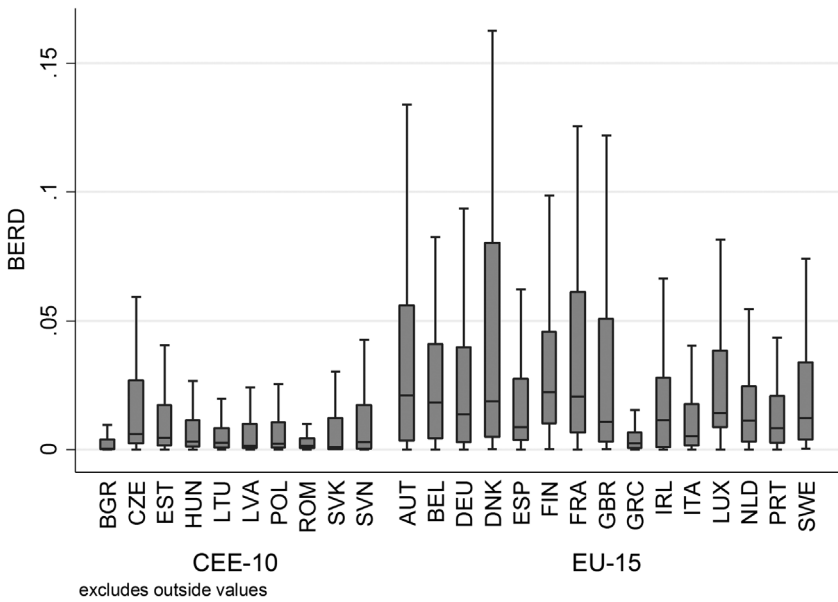


Figure 2. Heterogeneity of business enterprise research and development expenditure (BERD) across countries. Source: Eurostat, OECD, author's calculations.

for innovation and patenting due to possibility of accepting an alternative strategy (based on lower costs or the use of foreign technology) for competing in international markets.

Data on inward and outward F.D.I. stocks (*IFDI* and *OFDI*) are acquired from Eurostat combined with O.E.C.D. data and are available for 11 out of 13 manufacturing industries and for all service industries. Kowalski et al. (2015) note that openness to F.D.I. can be related to the type and extent of G.V.C. participation. Firms can integrate into G.V.C.s through F.D.I. based on mergers and acquisitions by foreign MNEs which can result in foreign markets entry, use of new technology, development of new products but also in an increase in intermediate imports. However, firms seeking new markets can access host countries through F.D.I. with the aim of servicing local markets (Kowalski et al., 2015). In exploring the impact of *IFDI* on D.V.A., a positive value of the inward F.D.I. coefficient would indicate that the recipient countries indeed did not increase imports from the countries of origin of the F.D.I.s.

As a proxy for international outsourcing (offshoring), I use the outward F.D.I. activities (*OFDI*) indicator devised by Kleinert (2003). The measure only comprises the production of intermediates within a firm's or firm group's boundaries and, as such, is not appropriate for measuring offshoring in the case where a firm purchases intermediates from suppliers outside the firm's or firm group's boundaries (Pilat & Wölfl, 2005). Another indicator by Feenstra and Hanson (1999) measures foreign outsourcing as imported intermediates that are acquired from the same two-digit industry. However, it does not consider the situation where outsourced services that were separated from the firm group are not classified in the same industry as they were outsourced from (Feenstra & Hanson, 1999; Pilat & Wölfl, 2005).

The data source for hourly wages (*WAGE*) and share of skilled labour (*SKILL*) is the W.I.O.D. Socio-Economic accounts and is available for all industries and countries. For the share of skilled labour, I use data of hours worked by high-skilled persons engaged as a share of total hours worked. I also included data regarding imported intermediates from China (*IMintCHN*) given that China has become the E.U.'s biggest supplier of intermediates.³

In addition, I introduced the geographical concentration of trade (by observing the share of exports to the EU's five most developed countries (*EXPTOP5*) and the share of imports⁴ from the EU's five most developed countries (*IMPTOP5*)) calculated from World I-O Tables available for the entire period and for all industries.⁵

Table 2 presents the correlation matrix for the manufacturing sector, which reveals the high correlation of *WAGE* with *SKILL* and especially *OFDI*. This may lead to multicollinearity problems which I address by separately including *WAGE* and *OFDI* in the regression. Other explanatory variables included in my regression are not highly correlated.

3.3. Results

3.3.1. Main results

The results for the manufacturing sector⁶ are presented in Table 3. All regressions include time, industry and country fixed effects. In column (1), I report a specification with the main variables of interest while in the following columns (2)–(6) I gradually add in variables. Due to the high correlation of *WAGE* with *SKILL* and *WAGE* with *OFDI*, I separately include in the regression *WAGE* (column (4)) or *OFDI* and *SKILL* (column (5)). I will use the specification shown in columns (4) and (5) as my main regression specification for the remainder of the analysis (robustness checks). Column (7) includes nominal *GDP* to control for the size of the country (and excludes *WAGE* because of high correlation), but there are no substantial differences in the main regression coefficients.

The estimates confirm that business enterprise research and development expenditure (*BERD*) is positively correlated with D.V.A. in the EU-15. The estimated association between

Table 2. Correlation matrix for the period 2001–2011 – manufacturing sector.

Variable	lnDVA	lnBERD _{t-1}	lnSKILL _{t-1}	lnIFDI _{t-1}	lnOFDI _{t-1}	lnEXP-TOP5 _{t-1}	lnIMP-TOP5 _{t-1}	lnIMintCHN _{t-1}
lnDVA	1							
lnBERD _{t-1}	-0.16***	1						
lnSKILL _{t-1}	0.10***	0.31***	1					
lnIFDI _{t-1}	-0.21***	-0.08**	-0.17***	1				
lnOFDI _{t-1}	0.28***	0.33***	0.38***	0.22***	1			
lnEXPTOP5 _{t-1}	-0.22***	0.01	-0.26***	0.13**	-0.01	1		
lnIMPTOP5 _{t-1}	-0.07***	0.08***	-0.31***	0.00	-0.06**	0.59***	1	
lnIMintCHN _{t-1}	-0.28***	0.32***	0.24***	-0.20	-0.03***	0.01	0.02	1
lnWAGE _{t-1}	0.17***	0.54***	0.61***	-0.07**	0.67***	0.05**	0.04**	0.18***

Note: Data for the manufacturing sector. All independent variables are lagged by one year.

*** $p < 0.001$; ** $p < 0.05$; * $p < 0.1$.

Source: Author's calculations.

Table 3. Determinants of domestic value added in exports in the manufacturing sector – comparison between CEE-10 and EU-15 countries, F.E. estimation results.

Dependent variable: ln D.V.A. in exports							
VARIABLES	F.E. (1)	F.E. (2)	F.E. (3)	F.E. (4)	F.E. (5)	F.E. (6)	F.E. (7)
$\ln BERD_{t-1}$	0.0215** (0.00762)	0.0206*** (0.00629)	0.0179* (0.00937)	0.0129* (0.00608)	0.0110 (0.00676)	0.0100 (0.00680)	0.0139** (0.00549)
$\ln BERD_{t-1} \times CEE$	-0.0264** (0.00928)	-0.0271** (0.00878)	-0.0258** (0.00991)	-0.0151** (0.00598)	-0.0126* (0.00668)	-0.0126* (0.00662)	-0.0126* (0.00670)
$\ln SKILL_{t-1}$	-0.108** (0.0443)	-0.0840* (0.0383)	-0.0843*** (0.0251)		-0.140*** (0.0306)	-0.117** (0.0424)	
$\ln SKILL_{t-1} \times CEE$	0.0754* (0.0348)	0.0119 (0.0363)	0.0226 (0.0215)		0.110** (0.0413)	0.0908* (0.0454)	
$\ln OFDI_{t-1}$	-0.0204*** (0.00493)	-0.0152** (0.00575)	-0.0188*** (0.00439)	-0.0129* (0.00637)	-0.0104* (0.00475)	-0.0105 (0.00709)	-0.0136** (0.00468)
$\ln OFDI_{t-1} \times CEE$	0.0104 (0.0121)	0.00639 (0.0155)	0.0142 (0.0118)	0.00123 (0.0139)	-0.000478 (0.0163)	-0.00306 (0.0183)	0.00367 (0.0121)
$\ln OFDI_{t-1}$		0.00167 (0.00264)	-1.64e-05 (0.00256)		0.00038 (0.00220)	0.000757 (0.00240)	
$\ln OFDI_{t-1} \times CEE$		0.0139* (0.00626)	0.0137*** (0.00375)		0.0148*** (0.00408)	0.0141*** (0.00367)	
$\ln EXPTOP5_{t-1}$			0.00360 (0.0212)	0.000239 (0.0158)	0.0067 (0.0191)	0.00296 (0.0171)	0.00260 (0.0180)
$\ln EXPTOP5_{t-1} \times CEE$			-0.0819*** (0.0131)	-0.0752*** (0.0131)	-0.0796*** (0.0161)	-0.0724*** (0.0162)	-0.0751*** (0.0141)
$\ln IMPTOP5_{t-1}$			0.0667 (0.0572)	0.0684 (0.0449)	0.0674 (0.0525)	0.0695 (0.0559)	0.0357 (0.0414)
$\ln IMPTOP5_{t-1} \times CEE$			0.0742 (0.0748)	0.0922 (0.0581)	0.100 (0.0661)	0.0998 (0.0674)	0.129** (0.0521)
$\ln \text{MintCHN}_{t-1}$				-0.00742 (0.00593)	0.0013 (0.0044)	0.0021 (0.0049)	0.00424 (0.00600)
$\ln \text{MintCHN}_{t-1} \times CEE$				-0.0358 (0.0216)	-0.0500** (0.0224)	-0.0491* (0.0231)	-0.0522** (0.0207)
$\ln WAGE_{t-1}$				0.0150 (0.0306)		0.0437 (0.0367)	
$\ln WAGE_{t-1} \times CEE$				0.0409 (0.0267)		0.0026 (0.0311)	
$\ln GDP_{t-1}$							0.103* (0.0465)
$\ln GDP_{t-1} \times CEE$							0.0825* (0.0416)
Constant	-0.690*** (0.116)	-0.596*** (0.110)	-0.592*** (0.0731)	-0.506*** (0.134)	-0.694*** (0.0779)	-0.769*** (0.215)	-1.652** (0.551)
Observations	1,240	1,084	1,084	1,386	1,084	1,084	1,386
R-squared (within)	0.666	0.676	0.739	0.744	0.762	0.765	0.754
Number of industries	11	11	11	11	11	11	11
Number of countries	23	23	23	23	23	23	23
Country FE	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y

Note: Robust standard errors in parentheses; All variables are in natural logarithm. Explanatory variables are lagged by 1 year. $CEE = 1$ if the observation belongs to the CEE-10. $CEE = 0$ if the observation belongs to the EU-15. Data included in the regression cover the period 2000–2010. All regressions include a constant term. Estimation is set up in a way that estimation fixed effects appear at the country-year-industry level.

*** $p < 0.001$; ** $p < 0.05$; * $p < 0.1$.

Source: Author's calculations.

D.V.A. and BERD for the EU-15 is 0.018 and significant (column (3)), which indicates that a 10 percent rise in business enterprise R&D investments in the manufacturing sector is, *ceteris paribus*, correlated with a 0.18 percent increase in D.V.A. The coefficient for the CEE-10 is 0.026 percentage points lower and statistically significant, which results in a slightly negative and significant coefficient for the CEE-10 (joint significance verified by an F-test). A possible explanation is that higher investments in intangible capital reduces the need for imported inputs in the EU-15, however in the CEE-10 a specific level of investments⁷ in intangible capital is required in order to integrate into a G.V.C.⁸

Surprisingly, the coefficient on high-skill labour (*SKILL*) is statistically significant and negative, which suggests that, *ceteris paribus*, in the EU-15 countries firms with a greater share of non-production workers negatively affect D.V.A. in exports and that high-skilled labour does not contribute (at least not directly) to G.V.C. upgrading in the EU-15. For the CEE-10 countries, the effects are smaller, but the overall correlation remains negative. These results may also suggest that hours worked by high-skilled employees (relative to total hours worked) are not an appropriate measure for the quality of human capital as the same level of investment in education can result in diverse sets of skills or skills with a different value in the labour market. Further, education can be used as a labour market indicator of capability rather than the skills supply source. Since the competencies of an individual are difficult to identify and measure, the economic literature commonly uses educational attainment or acquired level of education as the estimate (Borghans, Green, & Mayhew, 2001).

I.F.D.I. has a negative sign for the EU-15 in all specifications, as expected. Inward F.D.I. can be associated (particularly in the initial stages) with a higher volume of a destination country's imports from the country of origin of F.D.I.s due to increased imports of intermediates and capital goods related to the offshoring of production (Aminian, Fung, & Iizaka, 2007). In manufacturing, inward F.D.I. is, as already found by Stehrer and Stöllinger (2015), positively correlated with the share of foreign value added. Interestingly, the difference for the CEE-10 in terms of the impact of inward F.D.I. is not statistically different from zero, indicating that inward F.D.I. generally leads to reduced demand for domestic inputs and hence lower D.V.A. in exports.

In a general sense, outsourcing can support G.V.C. upgrading since it enables firms to focus on their core competencies (Mudambi, 2008; Ylömäki, 2016). As noted by Pietrobelli and Rabellotti (2011), firms commonly outsource previously internally managed activities and retain those activities that represent the source of their core competencies. The estimation results show, however, that O.F.D.I. is not significant for the EU-15, while the difference for the CEE-10 is significant and positive. This means that G.V.C. upgrading by undertaking O.F.D.I. is primarily an issue within the CEE-10 countries.

Other variables also reveal some interesting results. The geographical structure of exports (the share of exports to the EU's five most developed countries) seems to be important as well, but again only for the CEE-10. As predicted, the higher share of exports from the CEE-10 to the EU's most developed countries is negatively correlated with D.V.A. The results remain robust in all specifications. Higher imports of intermediate shares from China are, as expected, negatively correlated with the D.V.A. share, but only in the CEE-10. Taglioni (in World Bank 2016) investigated China's G.V.C. upgrading and observed that the availability of Chinese intermediate inputs of higher quality enables its trade partners to gain from China's upgrading process, particularly when imported Chinese intermediates are complements to their domestic production instead of substitutes. The negative relationship between D.V.A. and imports from China most likely implies that intermediates from China

are more substitutes than complements for the CEE-10, although more research on the topic is required. Contrary to my expectations, no significant (positive) effects of wage on D.V.A. are revealed for either the EU-15 or the CEE-10.

3.3.2. Robustness checks

In order to deal with inherent endogeneity, I employ the difference G.M.M. estimator (Arellano & Bond, 1991). As an alternative transformation to the common differencing, I

Table 4. Determinants of domestic value added in exports in the manufacturing sector – comparison between CEE-10 and EU-15 countries, difference G.M.M. estimation results.

Dependent variable: ln D.V.A. in exports				
	Diff-2	Diff-2	Orth Dev-2	Orth Dev-2
VARIABLES	G.M.M. (1)	G.M.M. (2)	G.M.M. (3)	G.M.M. (4)
$\ln BERD_{t-1}$	0.0123* (0.00678)	0.0198* (0.0102)	0.0220*** (0.00668)	0.0473*** (0.0104)
$\ln BERD_{t-1} \times CEE$	-0.0137* (0.00825)	-0.0247** (0.0106)	-0.0166 (0.0105)	-0.0384*** (0.0134)
$\ln SKILL_{t-1}$		-0.0544** (0.0221)		-0.116*** (0.0273)
$\ln SKILL_{t-1} \times CEE$		0.00999 (0.0290)		0.0654* (0.0363)
$\ln IFDI_{t-1}$	0.0108*** (0.00370)	0.00387 (0.00594)	0.00627 (0.00544)	0.00281 (0.00740)
$\ln IFDI_{t-1} \times CEE$	-0.0547*** (0.0142)	-0.0336** (0.0158)	-0.0433*** (0.0136)	-0.0435** (0.0172)
$\ln OFDI_{t-1}$		0.00301* (0.00164)		0.00131 (0.00171)
$\ln OFDI_{t-1} \times CEE$		-0.00457 (0.00300)		-0.00103 (0.00334)
$\ln EXPTOP5_{t-1}$	-0.0185 (0.0309)	0.00973 (0.0278)	0.0213 (0.0334)	-0.0125 (0.0268)
$\ln EXPTOP5_{t-1} \times CEE$	-0.0111 (0.0356)	-0.0250 (0.0292)	-0.0356 (0.0379)	-0.0134 (0.0326)
$\ln IMPTOP5_{t-1}$	0.0160 (0.0266)	0.00948 (0.0361)	0.0301 (0.0237)	-0.00508 (0.0312)
$\ln IMPTOP5_{t-1} \times CEE$	0.0388 (0.0434)	0.000546 (0.0450)	0.0812* (0.0430)	0.0867* (0.0505)
$\ln IMintCHN_{t-1}$	-0.0243*** (0.00678)	-0.0190** (0.00805)	-0.0261*** (0.00645)	-0.0325*** (0.00651)
$\ln IMintCHN_{t-1} \times CEE$	0.0409*** (0.0113)	0.0381*** (0.0110)	0.0214* (0.0119)	0.0397*** (0.0119)
$\ln WAGE_{t-1}$	-0.0331*** (0.0127)		-0.0566*** (0.0133)	
$\ln WAGE_{t-1} \times CEE$	0.00832 (0.0188)		0.0659*** (0.0193)	
# observations	1,057	811	1,153	873
# country \times industry	178	161	210	188
# instruments	280	197	256	179
Hansen test	169.6 (1)	144.6 (0.983)	206.9 (0.959)	177 (0.247)
AR(1) test	-2.097 (0.0360)	-2.610 (0.00906)	-2.972 (0.00296)	-3.056 (0.00225)
AR(2) test	-2.218 (0.0266)	-0.554 (0.580)	-2.470 (0.0135)	-1.390 (0.165)

Notes: Estimates from difference G.M.M. models with time-fixed effects. Second- to fourth-level lags of the endogenous variables (*BERD*, *IFDI*, *SKILL* and *WAGE*) were used as instruments in the G.M.M. style. The *p*-values of the Hansen J test of overidentifying restrictions and *p*-values of the Arellano and Bond (1991) test of *q*th order serial correlation are reported in brackets. Robust standard errors in parentheses.

*** $p < 0.001$; ** $p < 0.05$; * $p < 0.1$.

Source: Author's calculations.

used forward orthogonal deviations as proposed by (Arellano & Bover, 1995) which entails subtracting the average of available future observations and not the previous observation as in the first-difference transformation. The loss of data is minimised since the sample size is preserved (Roodman, 2006). To detect any serial autocorrelation problems, autocorrelation tests were performed. A first-order correlation, but therefore no higher-order autocorrelation, supports the assumption of a lack of autocorrelation. The suitability of the instrumental variables is examined by Hansen's J test for overidentifying restrictions where an insignificant p -value of the test is preferred.

Table 4 presents the estimation results of the baseline model. All estimations include year-fixed effects. Second- to fourth-level lags of the endogenous variables (*BERD*, *IFDI*, *SKILL* and *WAGE*) were used as instruments in the G.M.M. style. The autocorrelation tests of the residual show there is a significant first-order autocorrelation, but no significant second-order autocorrelations. The Hansen test confirms the validity of the instruments. To sum up, the test statistics confirm an appropriate specification. Columns (1)–(2) report the two-step difference G.M.M., columns (3)–(4) report the estimation results for the two-step difference G.M.M. with a forward orthogonal deviation.

The main results in Table 4 are generally consistent with the fixed-effects model estimates. Business enterprise research and development expenditure (*BERD*) demonstrates a positive and significant impact on D.V.A. in exports for the EU-15. The difference for the CEE-10 is also statistically significant albeit lower, but it does not result in a statistically significant coefficient for the CEE-10. The coefficient of high-skilled labour (*SKILL*) for the EU-15 is negative and significant as in the basic specification, while for the CEE-10 the negative effects are different and smaller only in specification (4).

The results suggest a slightly positive or no effect of *IFDI* on D.V.A. in exports in the EU-15 countries, but a significantly negative effect of *IFDI* on D.V.A. for the CEE-10 countries. Empirical evidence shows that *OFDI* is positive and significant for the EU-15 (column (2)), while there is no significant difference for the CEE-10. This suggests that G.V.C. upgrading by undertaking *OFDI* may indeed be generally the case.

4. Conclusions

In this paper, I rely on the recent methodology for decomposing gross exports into value-added exports provided by Koopman et al. (2010) and recent research findings regarding the potential factors of value added in exports (Caraballo & Jiang, 2016; Kowalski et al., 2015; O.E.C.D., 2013; Stehrer & Stöllinger, 2015). I particularly focused on: (1) D.V.A. in exports, which represents an important measure of income from trade and can thus be recognised as a crucial guideline for development policy (Caraballo & Jiang, 2016); and (2) E.U. countries. The main contribution of my research compared to previous work is the distinction between CEE-10 and EU-15 countries in order to explain the main drivers of the differences in D.V.A. in export shares between EU-15 and CEE-10 countries using industry-level data.

Fixed-effects and G.M.M. regression analysis is used to examine whether the selected main economic indicators influence D.V.A. in exports differently in each of the two groups of E.U. countries. Estimates based on industry- and country-level data show that investments in intangible capital play an important role in G.V.C. upgrading for the EU-15 countries, while the results are negative for the CEE-10. A possible explanation is that

the CEE-10 lack investments in intangible capital which are mainly sufficient to enable their participation in a G.V.C., but not above the G.V.C. upgrading threshold. Further investigation is required to determine the exact level of the critical threshold of intangible investments beyond which the CEE-10 can gain from intangible investments in terms of higher D.V.A. in exports. I found that most of the other determinants (O.F.D.I., exports to the EU's most developed countries and imports from China) have different effects on the domestic content of exports in CEE-10 than in EU-15 countries. The results, by and large, remain robust under alternative specifications.

Based on the presented results, it follows that investments of CEE-10 in intangible capital are only sufficient to enable their participation in a G.V.C., but not above the G.V.C. upgrading threshold. Further investigation is required to determine the exact value of the critical threshold of intangible investments beyond which the CEE-10 can gain from intangible investments in terms of higher D.V.A. in exports.

Finally, it has to be acknowledged that the subjects which participate in G.V.C.s and that should represent the units of analysis are not countries, but firms. However, due to the lack of data and methodology, country-industry analysis is still the traditional approach used in the literature. Nevertheless, considering the limitations the results presented in this paper offer an insight into the possible determinants of E.U. countries' domestic content of exports from the value-added perspective. Most of all, one could improve the methodology for decomposing exports into value added terms and use a different source of input-output tables to compare the estimated results. Moreover, instead of using industry-level data one could extend this research and use firm-level data.

Notes

1. Upgrading can be described as a process in which firms (economies) move to (production) activities with higher valued added in order to increase their gains and profits resulting from G.V.C. participation (Gereffi, 2005 in Barrientos, Gereffi, & Rossi, 2011).
2. Backward participation refers to the foreign value-added content of gross exports. Forward participation refers to domestic value-added embodied in foreign exports (Jona-Lasinio et al., 2016).
3. For example, in 1995 the E.U. imported 6 percent of its intermediates from sources outside the EU, mainly represented by the USA and the Rest of the world. In 2009, the share increased to 9 percent and China became a significant supplier to the E.U. with over 1 percent of its total intermediates (Gasiorek et al., 2014).
4. Due to the data unavailability of total imports at the industry level, I use data for imports of intermediates.
5. The decision to include these variables is based on the non-negligible importance of the development and size of the economy (country) which an individual country is trading with. Countries with high-skilled labour that performs more complex tasks in later stages of production usually specialise in products based on costly intermediates, while countries with low-skilled labour mainly specialise in basic production. Thus, in a very generalised view, the 'rich' or skilled countries produce more advanced goods with a high value while the 'poor' countries chiefly focus on basic production, raw materials and goods with a low value (Felipe, Kumar, & Abdon, 2014). Although the CEE-10 cannot be classified as poor countries, Cieřlik, Biegańska, and Środa-Murawska (2016) noted that in post-communist countries high-tech products still account for a low share of their exports.
6. In the services sector *BERD* and *SKILL* do not play an important role in the share of D.V.A. Estimations show negative and significant elasticities with D.V.A. for *IFDI* and imports of intermediates from China for EU-15 countries, while these results are not significantly

different for the CEE-10. Imports from the EU's most developed countries are positively correlated with D.V.A. in exports for EU-15 countries, with no significant difference for the CEE-10. Interestingly, in services compared to manufacturing, wage is positively correlated with D.V.A. for the CEE-10 countries.

7. Similarly to *relationship-specific investments*. These represent investments made by suppliers in the value chain in order to obtain a certain required level of compatibility of their components with the components of other suppliers (Alfaro, Antràs, Chor, & Conconi, 2015)
8. The explanation is based on the findings of Stehrer and Stöllinger (2015) for export sophistication.
9. Koopman et al. (2010) provided parallels with measures in previous literature:
 - (E) is denoted as VS and (C) + (D) is denoted as VS1 by Hummels et al. (2001).
 - (D) is indicated as VS1* by Daudin et al. (2011).
 - the sum of (A), (B) and (C) divided by gross exports is the V.A.X. ratio defined by Johnson and Noguera (2012).

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Appendix 1. Methodology of measuring value-added in exports

This paper follows the mentioned methodology of measuring value-added in exports developed by Koopman et al. (2010, pp. 5–21). This methodology requires the use of inter-country input–output tables.

The model assumes an m -country world, where each country produces goods in n tradable sectors, and thus the m -country production and trade system can be presented in a block matrix structure as (Koopman et al., 2010; Rahman & Zhao, 2013):

$$\begin{bmatrix} X_1 \\ \vdots \\ X_m \end{bmatrix} = \begin{bmatrix} A_{11} & \dots & A_{1m} \\ \vdots & \ddots & \vdots \\ A_{m1} & \dots & A_{mm} \end{bmatrix} \begin{bmatrix} X_1 \\ \vdots \\ X_m \end{bmatrix} + \begin{bmatrix} Y_{11} + \dots + Y_{1m} \\ \vdots \\ Y_{m1} + \dots + Y_{mm} \end{bmatrix} \quad (\text{A1})$$

This structure shows that all gross output produced by country g is used as an intermediate or final good by the home country or by foreign countries (h). X_g thus represents the $n \times 1$ gross output vector of country m and each block matrix A_{gh} represents $n \times n$ I-O matrix of coefficients that stand for intermediate use in country h of goods produced in country g . Y_{gh} denotes the $n \times 1$ final demand vector, which represents a country's h demand for final goods produced in country g . By reorganizing the Equation (1), the gross output vector X can be expressed as

$$X = (I - A)^{-1}Y = BY \tag{A2}$$

where B_{gh} represents an $n \times n$ Leontief inverse matrix.

Further, the gross export E_{g^*} from country g to the world has to be defined by composing the final demand matrix Y_{gh} and intermediates $A_{gh}X_h$ (I-O matrix of coefficients multiplied by gross output vector)

$$E_{g^*} = \sum_{h \neq g} E_{gh} = \sum_{h \neq g} (Y_{gh} + A_{gh}X_h). \tag{A3}$$

For measuring domestic and foreign contents the direct value-added coefficient vector V_g ($1 \times n$) is defined as one minus the intermediate input share from all countries (with domestically produced intermediates counted in), where u is $1 \times n$ unity vector:

$$V_g = u(I - \sum_h A_{gh}) \tag{A4}$$

After certain procedures involving matrix calculations domestic value-added can be expressed as:

$$DVA_g = V_g B_{gg} E_{g^*} \tag{A5}$$

where V_g represents the direct value-added coefficient vector, B_{gg} stands for diagonal elements of an $n \times n$ Leontief inverse matrix, and E_{g^*} is an export matrix.

Finally, the gross export E_{gh} can be broken down into two main categories, domestic value added in exports (D.V.A.) and foreign value-added in exports (henceforth F.V.A.). The D.V.A. is further divided in several other sources, depending on the stage of production process, whereby (A) represents a final good, (B) denotes an intermediate product not prepared for further exports, (C) stands for intermediates produced for re-export to third countries, and (D) denotes an intermediate that returns to the home:

$$E_{g^*} = DVA_g + FVA_g = V_g B_{gg} \sum_{h \neq g} Y_{gh}(A) + V_g B_{gg} \sum_{h \neq g} A_{gh} X_{hh}(B) + V_g B_{gg} \sum_{h \neq g} \sum_{t \neq g, h} A_{gh} X_{ht}(C) + V_g B_{gg} \sum_{h \neq g} A_{gh} X_{hg}(D) + FVA_g(E) \tag{A6}$$

Complete decomposition of gross exports into its value added exports is also illustrated in Figure A3.⁹ As mentioned in Koopman et al. (2010), the sum of (D) and (E) represents a part of exports that is double counted in official trade statistics. The components (A) and (B) represent the exports of a country outside of the supply chain, while components (C), (D), and (E) regard to the exports related with the supply chain (Augustyniak, Ebeke, Klein, & Zhao, 2013, p. 9). As mentioned in Koopman et al. (2010), the sum of (D) and (E) represents that part of exports that is double counted in the official trade statistics, and the sum of (A), (B) and (C) divided by gross exports equals Johnson and Noguera's (2012) V.A.X. ratio. For more details see Koopman et al., 2010.

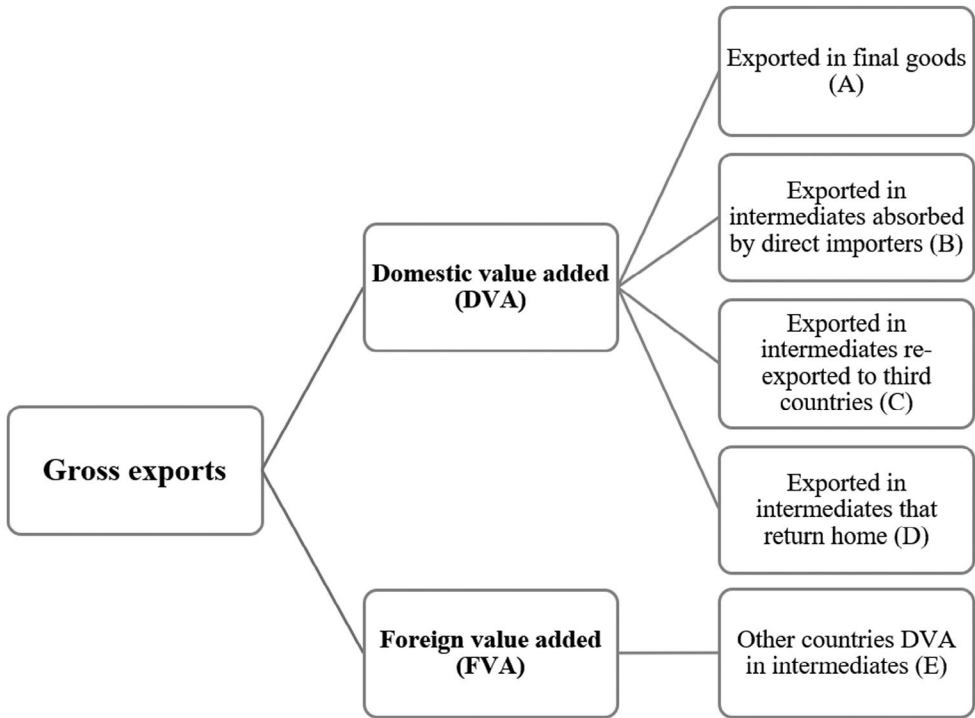


Figure A3. Decomposition of gross exports into value-added exports. Source: R. Koopman, W. Powers, Z. Wang, & S.-J. Wei, Give Credit Where Credit is Due: Tracing Value-Added in Global Production Chains 2010, p. 34.