# Pay-off to Participation in Global Value Chains: How Much are New EU Member States Lagging behind the Rest of EU Countries in Terms of Domestic Value Added in Exports?

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# Pay-off to Participation in Global Value Chains: How Much are New EU Member States Lagging behind the Rest of EU Countries in Terms of Domestic Value Added in Exports?

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**Abstract**

The phenomenon of global value chains highlighted the issue of domestic value-added in exports (DVA) and led to the development of alternative trade measures in value-added terms. These, *inter alia*, enabled an estimation that shows that New EU countries from Central and Eastern Europe (NMS-10) experience an approximately 5 percentage points lower DVA share as compared to old EU countries (EU-15). The lag is on average the highest in knowledge-intensive manufacturing sectors (8 percentage points) and the lowest in knowledge-intensive services (0.3 percentage points). However, this paper follows the assumption that NMS-10 have acquired new knowledge by participating in Global Value Chains (GVCs), and thus gradually started increasing their DVA. Based on the empirical application of the EU trade data, I found that convergence in terms of DVA in exports can be observed in manufacturing, and especially in the services sectors. Additionally, I find that for NMS-10 countries negative relationship between participation in GVCs and DVA in exports is slightly decreasing over time in both sectors.

JEL code: F02, F14, C67

Key words: global value chains, international trade, value added in exports

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# 1 Introduction

The new organization of world trade, known as global value chains, highlighted the problem of so-called 'double counting.' Namely, raw material, obtained in one country, can be exported for processing to affiliates in another country. This country then re-exports intermediates to a plant in the third country, which further exports finished products to the fourth country where final consumption takes place. Thus, the value of raw materials and intermediate products is counted in the value of world exports each time they cross a border (UNCTAD, 2013b, p. 122), and the full value is attributed to the last country and industry that shipped the product. This is reflected in the world exports data, expressed as a percentage of the total output, which has increased almost three fold since 1960. New EU member countries from Central and Eastern Europe (i.e. former transition economies, henceforth NMS-10) have doubled their export share from 1990, which in 2013 represented more than 60 per cent of the GDP.

Recognition of these features led to the development of alternative approaches for measuring trade in value-added terms (Daudin, Rifflart, & Schweisguth, 2011; Johnson & Noguera, 2012; Koopman, Powers, Wang, & Wei, 2010; Koopman, Wang, & Wei, 2014), that require detailed data on exports and imports of intermediate goods in different countries and industries. Trade in value-added terms may provide information about whether a country participates (and to what extent) in these new trading patterns created by the fragmentation of international trade (Dean, 2013, p. 51), and may give insight into the position of a country's sectors within global value chains (Koopman et al., 2014, p. 485). The value or the part of exports created in the country is referred to as the 'domestic value-added (henceforth DVA)' and represents a part of exports which contributes to its GDP (UNCTAD, 2013b, p. 126).

Since the country's export success (by volume of exports) is not necessarily reflected in its economic growth, the question is whether export restructuring of NMS-10 countries is reflected in the increase of DVA in exports. Based on the empirical application of the EU trade data, I intend to examine the following issues: (1) Do NMS-10 create lower domestic value-added in exports compared to old EU member states (henceforth EU-15)?; (2) Do these differences diminish over time, i.e. does the gap between NMS-10 and EU-15 close over time?; and (3) What are the differences in the levels and trends at the sectoral level? This will enable the provision of more insights into the issue whether EU-15 countries gain more in terms of DVA from participation in GVCs than NMS-10, and as well whether and why this gap closes over time (or not).

This paper's contribution lies in the analysis of possible evidence of convergence in terms of domestic content in exports between NMS-10 and EU-15 countries. Since GVCs, as stated by Baldwin (2011), represent the way of cross-border dispersion of advanced know-how, I follow the assumption that NMS-10 have acquired new knowledge by participating in GVCs, and thus gradually started increasing their DVA. Since participation in GVCs is characterized by increased use of foreign inputs, this

paper also explores the difference in the gains from GVC integration for these two groups of countries. The main methodology used in the paper represents the decomposition of gross exports into value-added exports, as developed by Koopman et al. (2010).

Since NMS-10 states represent former transition economies (in the past relatively isolated from international trade), I expect their domestic value added in export is on average smaller than in EU-15. At the beginning of transition in 1990s, NMS-10 were mostly selected for routine offshoring activities due to lower labour costs and real estate prices. Since EU accession, these costs have increased (compared to countries from Asia and Latin America), however they have remained below those in Western economies (Gál, 2014). Consequently, NMS-10 countries started to attract high value-added activities, especially due to skilled labour and strategic location, so I expect that the initial differences will diminish over time. Relying on data from the World Input-Output Database, my regression analysis confirms these expectations. However, it has to be mentioned that the share of DVA overall is declining due to higher integration in GVCs. Even so, when focusing on individual countries, this is not always the case.

The rest of the paper is divided into four sections. The first section reviews the literature regarding the evolution of the concept of GVCs. The second section presents the methodological framework for analysing the share of domestic and foreign value-added content in exports by using the inter-country input-output tables. This paper uses the methodology that was applied in the World Input-Output Database, which is presented in the third section. The fourth section reports the results, while the last section summarizes the main findings and presents the conclusions.

## 2 Global value chains: Development of the concept and overview of the main research literature

GVCs became a channel through which countries (companies) gained access to global markets, and so discovered new opportunities for income and profits. They enabled new possibilities for the creation of jobs which may foster GDP growth and improve income. GVCs can represent an entrance for developing countries to form their productive capacity and enable long-term industrial upgrading through technology and skills improvement (UNCTAD, OECD, & WTO, 2013, p. 24–26). This chapter describes how GVCs emerged and the way researchers approached this new phenomenon which has changed many aspects of international trade relations.

### 2.1 Development of GVCs

As stated by Baldwin (2011), the 'second unbundling' in the mid-1980s, enabled by the advances in information and communication technology, opened a new industrialization

path. The ICT revolution allowed the coordination of complex activities at distance and wage differences between developed and developing nations made the separation profitable (Baldwin, 2012). Additionally, containerised shipping, standardisation, automation, and improved inter-modality of freight have all made the movement of goods in GVCs a lot easier task (OECD, 2013a), while many services that were formerly untradeable became tradable (Godart & Görg, 2011). Trade liberalisation in terms of capital flows that resulted in falling trade barriers supported the expansion of foreign direct investment (FDI) flows. In this context multinational companies presented the main actors (Amador & Cabral, 2014, p. 5) which shaped GVCs – therefore FDIs represented an important driver of GVC participation (Saito, Ruta, & Turunen, 2013).

Policies have played an important role in improving efficiency since trade liberalisation had an impact on further cost reduction, and has facilitated the extension of GVCs[1] beyond industrialised countries. Countries are now able to industrialize easier and faster by joining GVCs since different stages of production are dispersed across a number of locations in multiple countries, and have no need to build their own supply chain. Consequently, goods become bundles of productive factors, technology, social capital, and governance capacity from many parts of the world and nowadays, there is no country that would produce all components needed to construct for example an aeroplane, car, or electronic device (Daudin, Rifflart, & Schweisguth, 2011, p. 1404; Baldwin, 2011, p. 4–9).

Baldwin (2012, p. 7), as well as Gereffi and Luo (2014, p. 5), explain that advanced industrial countries usually represent 'headquarter economies' whose exports are characterized as having relatively little imported intermediates and countries where transnational corporations or 'lead firms' are situated. The transnational corporations coordinate GVCs on the basis of complex networks of supplier connections and different types of corporate governance which may take the form of direct ownership of foreign affiliates to contractual relationships or other forms (UNCTAD, 2013b, p. 141). Developing countries generally represent the "factory economies," whose exports contain a large share of imported intermediates and where the supplier companies are located (Baldwin, 2012, p. 7; Gereffi & Luo, 2014, p. 5).

The greatest change brought about by the second unbundling is that companies from advanced countries, motivated to lower their production costs (especially labour costs), started offshoring labour-intensive stages of their value chains to developing countries with favourable business environment and reliable workforce[2] (Baldwin, 2011, p. 9). The decisions of companies regarding the outsourcing were studied by Swenson (2000) who

[1] The structures of these new forms of trade have also been referred to as global commodity chains (Gereffi & Korzeniewicz, 1994), international production networks (Ernst, 1997; Borrus et al, 2000), global production networks (Henderson, Dickem, Hess, Coe & Yeung, 2002), or global supply chains (Baldwin, 2011, 2012; Baldwin & Lopez-Gonzalez, 2013).

[2] A country's decision to locate a part of its export production in another country is positively associated with a higher GDP level, lower distance, the presence of a common border and common language, lower tariffs, and a free trade agreement (Rahman & Zhao, 2013).

observed the effects of international cost changes on outsourcing of U.S. companies located in foreign trade zones, and found out that companies reduce the consumption of domestic inputs when their relative price increases compared to the price of imported inputs. Hanson, Mataloni Jr. and Slaughter (2005) analysed the trade in intermediate inputs for further processing between parent companies and their foreign affiliates and noticed that demand for imported inputs is higher in cases when lower trade costs, lower wages (for less skilled labour), and lower income taxes are experienced by foreign affiliates.

Even if manufacturing stages were offshored, key employees still had to travel among factories and opportunity costs of time still existed, so the distance still represents an important factor (Baldwin, 2011, p. 28). Consequently, the value chains are mostly formed within large regional economic blocks (e.g. European Union) rather than between them. But still, the example of two important inter-regional value chains represent Asia's trade links to the EU and North America (Gereffi & Lee, 2012, p. 26).

The falling trade costs (e.g. tariffs, transport and communication costs) brought benefits to those sectors of the EU and US economies which have the highest comparative advantage, while sectors with the lowest comparative advantage were unable to compete with cheap labour abroad (van der Ploeg & Poelhekke, 2008, p. 483). Textiles, electrical products, and other manufacturing sectors which were relying on low-skilled labour in Europe were among those primarily affected by the process of globalisation in the early 1990s. Later in the same decade, the process rapidly expanded to other sectors, and connected companies from many developing countries (Nicita, Ognivtsev, & Shirotori, 2013).

But GVCs contain more than just trade in goods and services. As Taglioni & Winkler (2014, p. 19) explain, foreign originated intellectual property, trademarks, managerial and business practices, marketing expertise, and organizational models can also represent a benefit for developing countries. Industry in developing countries can thus be completely transformed almost overnight with firm-specific technology that is usually lent to foreign factories (Baldwin, 2011). The basic difference between GVCs and other types of trade and investment are the cross-border flows of know-how (Taglioni & Winkler, 2014).

## 2.2 GVCs in Research Literature

As Grossman & Rossi-Hansberg (2008, p. 1978) state, for centuries international trade has represented only an exchange of goods, but now it can be regarded as a trade in tasks. Simply, value is added in many different locations across the globe and countries are more specializing in specific business functions than in specific industries (Backer & Miroudot, 2013, p. 9). The rapid expansion in offshoring of manufacturing and other business tasks in countries where some production factors may be hired at much lower

prices than at home, called into question the traditional Ricardian and Heckscher-Ohlin models (i.e., 'old trade theory'), where each country specializes in types of products with a comparative advantage (Escaith, Lindenberg, & Miroudot, 2010, p. 79).

### *2.2.1 Fragmentation of production process*

The offshoring/outsourcing[3] of activities and the fragmentation of the production process doesn't represent a new phenomenon. Already in 1933 trade economist Bertil Ohlin stated that in many cases production is divided into more than just raw materials and finished goods (Backer & Miroudot, 2013, p. 8). Nicita et al. (2013, p. 4) claim that lead firms have used foreign suppliers even several decades previously, but it was no earlier than in late 1980s, that the business models were characterized by outsourcing of the production process.

Different researchers used different names to describe the same phenomenon of breaking production processes up within many different countries. In 1980s Fröebel, Heinrichs and Kreye (1980) studied a phenomenon where firms in advanced industrial countries used cheap labour in less developed countries. They presented the case of textile and garment industries in Federal Republic of Germany portrayed as the main example of the field they referred to as the *new international division of labour*. Dixit and Grosman (1982) discussed about *multi-stage production*, where the pattern of production specialization by stages across countries is determined by comparative advantage. They created a model of trade in intermediate goods and studied how changes of endowment and policy changes move the margin of comparative advantage.

The GVCs more frequently appeared in literature during 1990s when the studies were driven by the need to get better insight into how manufacturers dealt with the process of globalization and its impacts on the development of production capacity. Gereffi (1994) distinguished between producer-driven and buyer-driven commodity chains. Producer-driven chains are found in industries where international corporations or other large integrated industrial enterprises control the production system. According to Backer & Miroudot (2013, p. 8) these are especially common in capital and technological intensive industries (automobiles, computers, aircraft, electrical machinery). Since the mentioned industries are heavily dependent on technology and R&D, lead firms are positioned on the upstream side of the chain, and control the product design process and most of the assembly stages which are fragmented across different countries. Conversely, buyer-driven chains are characterized by a pattern of labour-intensive, consumer goods industries (garments, footwear, toys, etc.). Production which can be completely outsourced is controlled by retailers and branded marketers. As Gereffi (1994, p. 99)

[3] Although this is often used as a synonym, 'outsourcing' means that company relocates its activity (e.g. production process) to an outside provider (at home or in foreign country), while 'offshoring' represents the geographic relocation of activity that can take the form of relocation to independent contracted providers abroad or relocation of particular tasks to company's foreign affiliates (De Backer & Yamano, 2012).

explains, companies in buyer-driven chains are merchandisers that design and market, but they do not produce the products they sell.

Krugman (1995, p. 334–337) described new aspects of world trade which include the rise of trade of similar goods between similar countries (intra-trade), the trend in manufacturing to produce a good in a number of stages in a number of locations or *slicing up the value chain,* the emergence of countries with a high rate of trade to GDP (or supertraders), and the rapid growth of exports of manufactured goods from newly industrializing, low-wage economies. He developed a model of global trade, employment, and wages to show how wages and unemployment in advanced economies – and trade with the newly industrializing economies – might be contemporarily determined. In that period, the relationship between wages and employment changes have been studied, among others, by Lawrence (1994), Messerlin (1995) and Baldwin (1994). Goldberg & Campa (1997) studied the size and composition of external orientation of manufacturing industries in four countries (the United States, the United Kingdom, Canada, and Japan) using four measures: export share, import share, imported input share, and net external orientation.

Feenstra (1998), when discussing *disintegration of the production process*, compared several different measures of foreign *outsourcing* and examined the implication of globalization, especially the impact on employment and wages of low skilled workers. Hummels, Rapoport and Yi (1998) use the term *vertical specialization*[4], to describe a process when a country imports an input from another country, uses it to produce its own good, which is then exported to another country. The opposite term 'horizontal specialization' thus means that trade goods are produced in one country from start to finish. They presented an increasingly important role of vertical specialization in international trade, with the use of case studies and calculated the degree of vertical-specialization based trade with the use of OECD input-output tables for the period 1968–1990 Their results have shown that world's largest economies (e.g. the USA, Germany, Japan) are less likely to be involved in vertical trade than smaller ones (e.g. Netherlands), since it is easier for them (due to economies of scale) to keep every stage of production at home.

Since the early 2000s, the increasing process of international fragmentation of production started receiving more attention and has challenged traditional interpretation of trade. The main driver of this process was the technological progress accompanied with lower costs (Gereffi & Lee, 2012, p. 24; Ahmad, 2013, p. 85). As Baldwin & Venables (2013, p. 246) state, technology plays an important role in determining the connections between production stages that can take the form of 'snakes' (a sequence in which value is added at each stage) and 'spiders' (multiple connections join together to form a component or the final product).

[4] The papers of Balassa (1967) and Findlay (1978) were the first to note this phenomenon.

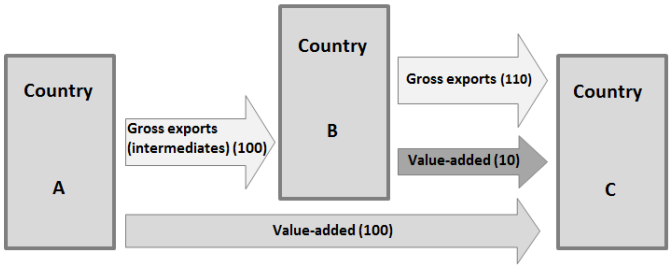
In the context of a production's fragmentation, the company's strategies of transferring a part of production process overseas (offshoring/outsourcing), also became an important subject of research, and so many studies focused on offshoring and outsourcing. Researchers presented several models of offshoring (Grossman & Rossi-Hansberg, 2008; R. Baldwin & Robert-Nicoud, 2007; Harms, Lorz & Urban, 2012) and outsourcing (Grossman & Helpman, 2005; Ornelas & Turner, 2008). Some were dealing with characteristics of countries/companies that engage in offshoring (Agnese & Ricart, 2009), others studied the influence of offshoring activities on chances for a firm's survival in a global economy (Coucke & Sleuwaegen, 2008), and the implications of offshoring on wages and unemployment (Mitra & Ranjan, 2010).

More and more research started to focus on value creation and GVC concept since the increased fragmentation of production questioned the traditional trade indicators in gross values. These give only a partial and less reliable picture of bilateral trade balances and were connected with issues of assigning production to wrong countries, misunderstanding of the relationship between imports and exports, double counting of trade flows, and as Koopman et al. (2010, p. 24) state, if the proper data on domestic value-added in exports are available, even a revealed comparative advantage can be considerably changed.

### *2.2.2 The issue of double counting*

The fragmentation of production causes different stages of production to be divided across different countries, and intermediates cross borders multiple times. Each producer purchases inputs and then adds value, which is included in the cost of the next stage of production. Existing statistical categories, developed for trade like it was during the first unbounding, quantify trade in gross terms. Figure 1 demonstrates a simple illustration of trade from the aspect of value-added. The example starts with country A which exports for 100 EUR of intermediates to country B, which further upgrades them (adds 10 EUR), and exports 110 EUR to country C. Although only 110 EUR of value-added has been produced in this process, official statistics show that total export and import is 210 EUR, that country C has a trade deficit with B that amounts to 110 EUR, and does not trade with A despite the fact that A represents a source country for that good (Ahmad, 2013, p. 86–87).

*Figure 1: Trade in terms of value-added*




*Source: N. Ahmad, Estimating trade in value-added: why and how? In D. K. Elms & P. Low (Eds.), Global Value Chains in a Changing World (pp. 85–108), 2013, p.86.*

To address the issue of double counting in gross trade statistics (already pointed by Feenstra, 1998), researchers started to measure a country's flows related to the value that is added in the production process (labour compensation, taxes on production and operating surplus or profits) to any exported good or service. To deal with this issue, micro and macro approaches have been used in practice (Ahmad, 2013, p. 87).

A micro approach can generally be addressed on a specific product and explains only a part of the story how global value chains function. Such an example of a micro study is the manufacture of the iPod and notebook PCs (Dedrick, Kraemer, & Linden, 2010), the iPhone (Xing & Detert, 2010); Kraemer, Linden, & Dedrick, 2011), and the iPad (Kraemer et al., 2011). These studies present the example of China, which has specialised in the assembly of final products in the electronics industry (such as just mentioned) and has become the largest exporter of ICT products. However, the largest part of the product's value is still created by the producers of high value components (in the USA and Japan), and by the seller of the iPod/iPhone in the USA, while the Chinese part of the chain still represents the assembly of the these high value components and parts into final products, which are then re-exported (Stehrer & Stöllinger, 2013, p. 4–5).

Conversely, a macro approach, based on the construction of inter-country or world input output tables, provides an extensive description of a country's participation in cross-border production chains (Koopman et al, 2010, p. 2). Hummels, Ishii and Yi (2001) have presented the first empirical measures of participation in vertical specialized trade. The first of these measures determines the value of imported inputs embodied in exported goods, or in other words the foreign value-added embodied in exports (henceforth VS). With the use of input-output tables for 10 OECD countries and four at the time emerging market countries (for the period 1968 – 1990), they found that the USA, Japan, and Australia had VS shares of about 5 – 10 per cent, while Canada, Denmark, and the Netherlands had VS shares around 30 – 35 per cent. Their conclusion that smaller countries have higher VS shares was based on the correlation between the VS share of export and GDP. They also found that during the examined period the VS share had increased by about 30 per cent for the entire sample of countries. The second measure, marked as VS1, represented the value of exports embodied in a second country's export of goods. For the group of 10 OECD countries they found that the share of VS1 was 4 – 5 per cent.

The number of studies adopted and improved measures presented by Hummels et al. (2001), since the inter-country input-output tables (Asian I-O tables from IDE-JETRO, OECD/WTO TiVA Database, GTAP, WIOD, UNCTAD EORA database) that reflect inter-industrial trade linkages, enabled more global analyses. As Koopman et al., (2010, p. 3) explain, these databases support the analysis of bilateral trade flows on a global scale and enable a comparison of production networks in various regions.

Daudin, Rifflart and Schweisguth (2011) used a similar method to that of Hummels et al. (2001), but the use of the GTAP database (for 66 regions and 55 sectors in 1997, 2001, and 2004) allowed them to compute the share of imported inputs in exports (VS) and the share of exports used as inputs intended for further exports (VS1). They proposed a third measure (VS1*) for the share of exports that are embodied in goods which are further used as inputs for the production of final products that are shipped back to home country for consumption.

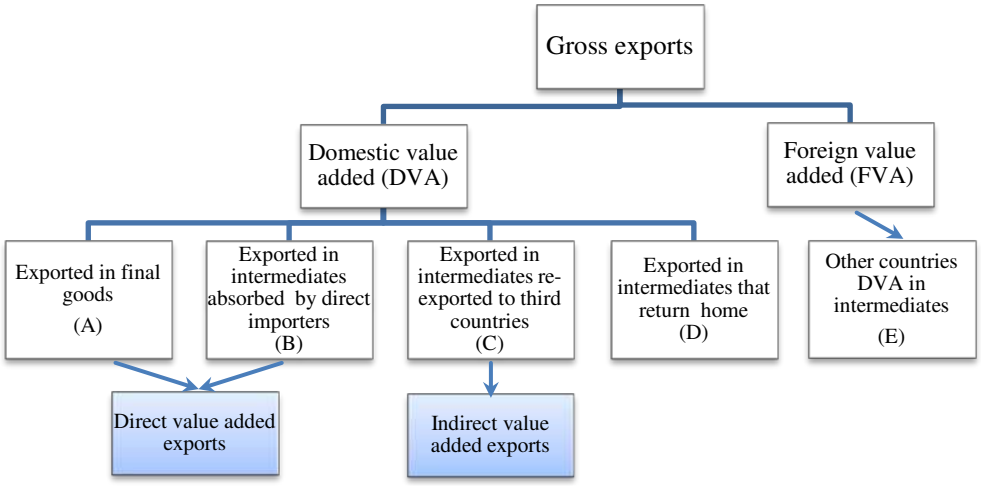
Johnson and Noguera (2012) similarly softened the assumption of Hummels et al. (2001) that a country's exports are completely consumed by final demand abroad (which excludes cases where country exports intermediates which are then used in production of final goods at home). They defined the 'VAX ratio' as a measure of the value-added content in trade (value-added in exports divided by gross exports), which can represent the 'domestic content of exports.' The VAX ratio includes two components: the first represents the equivalent to a measure of domestic content[5] presented by Hummels et al. (2001), while the second represents exported intermediates for the production of goods at the end consumed at home. With the use of GTAP database for 94 countries and 57 sectors in 2004, they found that value-added exports (across all countries) account for 73 per cent of gross exports. At the regional level, the lowest VAX ratio was recorded in Central and Eastern Europe (68 per cent) and East Asia (62 per cent).

Koopman et al. (2010) provided a model which incorporates all previous measures of vertical integration[6] for complete decomposition of gross exports into its value-added components (Figure 2). With decomposition results at the country-sector level, Koopman et al. (2010, p. 22), among other things, pointed out that in many sectors the old EU members (EU15) generate higher domestic value-added and are positioned at the upstream end, while the new members are positioned at the downstream end of the value chain. Moreover, they emphasized that decomposition results (use of value-added terms instead of gross terms) can lead to different results of a country's revealed comparative advantages and bilateral trade balances.

[5] Domestic content of exports equals one minus foreign value-added embodied in exports.

[6] 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);
- sum of (A),(B) and (C) divided by gross exports represent the VAX ratio defined by Johnson & Noguera (2012).

*Figure 2: 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.*

Comparative analysis presented in the rest of the paper is based on the mentioned methodology, which is described in detail in the next section.

## 3 Methodology

This paper follows the mentioned methodology of measuring value-added in exports developed by Koopman et al. (2010, p. 5-21). This methodology requires the use of inter-country input-output tables, which contain information on the source and destination country of all transaction flows by industry, separately for the use of intermediates, and the use of final products (Koopman et al., 2014, p. 485).

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):

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

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 x 1* gross output vector of country *m* and each block matrix $A_{gh}$ represents *n x 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 x 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

$$X = (I - A)^{-1}Y = BY \tag{2}$$

where $B_{gh}$ represents an *n x 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)

$$\mathrm{E}_{g*\_} = \sum\nolimits_{h \neq g} E_{gh} = \sum\nolimits_{h \neq g} (Y_{gh} + A_{gh}X_h). \tag{3}$$

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

$$V_g = u(I - \sum\nolimits_h A_{gh}) \tag{4}$$

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

$$DVA_g = V_g B_{gg} E_{g*} \tag{5}$$

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

Finally, the gross export $\mathrm{E}_{gh}$ can be broken down in two main categories, domestic value added in exports (DVA) and foreign value-added in exports (henceforth FVA). The DVA 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 country as presented before in Figure 2:

$$\begin{aligned} E_{g*} &= DVA_g + FVA_g = \\ &V_g B_{gg} \textstyle\sum_{h \neq g} Y_{gh}\ (A) + V_g B_{gg} \sum_{h \neq g} A_{gh} X_{hh} (B) + V_g B_{gg} \sum_{h \neq g} \sum_{t \neq g,h} A_{gh} X_{ht}\ (C) \\ &+ B_{gg} \textstyle\sum_{h \neq g} A_{gh} X_{hg}\ (D) + FVA_g\ (\mathrm{E}) \end{aligned} \tag{6}$$

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). A more detailed description is provided in Appendix 2. To analyse the differences between NMS-10 and EU-15 member states, the paper follows the presented decomposition.

To address the issue whether differences of DVA in exports between NMS-10 and EU-15 countries diminish over time, I intend to perform the following regression analysis, separately for the manufacturing and services sectors:

$$DVA_{ijt} = \alpha + \beta_1 NMS + \beta_2 t + \beta_3 t^2 + \beta_4 NMS * t + \beta_5 NMS * t^2 + u_{ij} + \varepsilon_{ijt} \quad (7)$$

where $t$ represents a trend variable (t=1,…,17), $NMS$=1 for NMS-10 countries and $NMS$=0 for EU-15, $\mu_{ij}$ is a country-industry fixed effect and $\varepsilon_{ijt}$ is random error term. The variables in the model relate to country $i$, industry $j$ and year $t$. I decided to use a quadratic trend in the model since the difference in DVA between NMS-10 and EU-15 in the observed period shows a nonlinear trend (in particular in manufacturing sector).

Furthermore, I intend to explore the impact of participation in GVCs on DVA in exports separately for both groups of countries and changes in the relationship through the observed years. For that purpose I will estimate the following regression (separately for manufacturing and services sector)*:*

$$DVA_{ijt} = \alpha + \beta_1 Part + \beta_2 Part * t + \beta_2 Part * NMS + \beta_3 Part * NMS * t + u_{ij} + \varepsilon_{ijt} \quad (8)$$

where *Part*[7] represents an estimated measure for participation rate in GVCs, $t$ represents a trend variable (t=1,…,17), $NMS$=1 for NMS-10 countries, $\mu_{ij}$ is a country-industry fixed effect, and $\varepsilon_{ijt}$ is a random error term. The variables in the model relate to country $i$, industry $j$ and year $t$.

## 4 Data description

The data used to analyse the value-added in exports were obtained from publicly available World Input-Output Tables (henceforth WIOT), and from the World Input-Output Database (henceforth WIOD), which was developed to enable the analysis of the effects of globalization on trade patterns, environmental pressures, and socio-economic development across a wide set of countries. WIOD data contains information for 27 EU countries and 13 other major countries, which account for approximately 85 per cent of the world's GDP. To complete the WIOD, a region denoted 'Rest of the world' was added as a proxy for all other countries in the world.

For the purpose of calculating the value-added in exports, WIOT were used at the current basic prices. The calculation included complete bilateral data for all 40 available

[7] Participation rate identifies the extent to which countries are involved in GVCs and is defined as a share of (1) foreign inputs in gross exports plus (2) domestically produced inputs used in third countries' exports (forward participation) in gross exports (see equation (15) in Appendix 2).

countries (Appendix 3) and 'Rest of the world,' 35 sectors[8] (Appendix 1) for all 17 available years (for the period from 1995 to 2011), therefore each studied year contained 2,059,225 observations. After finishing the calculation of value-added by countries and sectors using the described method, each year contains 1,435 observations and thus after the data 'transformation' the entire time period accounts for 24,395 observations. The main characteristics of the used data are presented in Table 1.

*Table 1: Countries by structure of exports, 1995-2011 average share*

| | EXPORT | % of world | | Total | DVA (%) | | | |
|---|---|---|---|---|---|---|---|---|
| Country | Mio $ | exports | FVA (%) (E) | DVA (%) | (A) | (B) | (C) | (D) |
| AUS | 142319 | 1.40 | 13.1 | 86.9 | 26.2 | 44.7 | 15.7 | 0.3 |
| AUT | 125954 | 1.24 | 23.8 | 76.2 | 25.0 | 34.3 | 16.4 | 0.4 |
| BEL | 234608 | 2.31 | 31.5 | 68.5 | 22.2 | 30.5 | 15.3 | 0.5 |
| BGR | 12874 | 0.13 | 30.5 | 69.5 | 26.8 | 29.7 | 13.0 | 0.0 |
| BRA | 122758 | 1.21 | 8.4 | 91.6 | 22.4 | 46.4 | 22.5 | 0.3 |
| CAN | 354060 | 3.48 | 16.7 | 83.3 | 24.9 | 46.6 | 11.2 | 0.6 |
| CHN | 767222 | 7.54 | 13.9 | 86.1 | 34.7 | 37.2 | 13.2 | 1.0 |
| CYP | 3193 | 0.03 | 26.2 | 73.8 | 30.6 | 31.7 | 11.5 | 0.0 |
| CZE | 75936 | 0.75 | 28.5 | 71.5 | 23.3 | 31.6 | 16.3 | 0.4 |
| DEU | 971739 | 9.55 | 15.7 | 84.3 | 29.2 | 36.7 | 16.0 | 2.2 |
| DNK | 99915 | 0.98 | 22.0 | 78.0 | 27.7 | 34.2 | 15.8 | 0.4 |
| ESP | 218884 | 2.15 | 18.1 | 81.9 | 28.5 | 35.7 | 16.9 | 0.8 |
| EST | 6663 | 0.07 | 31.1 | 68.9 | 20.1 | 31.1 | 17.6 | 0.1 |
| FIN | 71531 | 0.70 | 20.6 | 79.4 | 24.9 | 36.9 | 17.4 | 0.3 |
| FRA | 469931 | 4.62 | 16.1 | 83.9 | 31.8 | 35.7 | 15.1 | 1.2 |
| GBR | 489037 | 4.81 | 14.6 | 85.4 | 27.6 | 39.5 | 17.0 | 1.5 |
| GRC | 29202 | 0.29 | 18.7 | 81.3 | 30.9 | 36.3 | 14.0 | 0.2 |
| HUN | 57514 | 0.57 | 30.9 | 69.1 | 23.1 | 31.1 | 14.7 | 0.1 |
| IDN | 96164 | 0.95 | 16.4 | 83.6 | 26.8 | 40.6 | 16.0 | 0.2 |
| IND | 140896 | 1.38 | 12.7 | 87.3 | 35.8 | 36.2 | 15.5 | 0.3 |
| IRL | 131109 | 1.29 | 33.3 | 66.7 | 23.1 | 31.1 | 12.7 | 0.2 |
| ITA | 390534 | 3.84 | 16.1 | 83.9 | 32.2 | 35.3 | 15.5 | 0.9 |
| JPN | 597068 | 5.87 | 9.3 | 90.7 | 27.7 | 44.9 | 17.4 | 1.6 |
| KOR | 296268 | 2.91 | 21.6 | 78.4 | 27.7 | 37.6 | 12.8 | 0.3 |
| LTU | 10211 | 0.10 | 25.5 | 74.5 | 27.0 | 32.1 | 15.2 | 0.1 |
| LUX | 46788 | 0.46 | 35.0 | 65.0 | 20.0 | 27.6 | 17.6 | 0.1 |
| LVA | 5691 | 0.06 | 25.9 | 74.1 | 25.9 | 32.1 | 15.9 | 0.1 |
| MEX | 193630 | 1.90 | 14.8 | 85.2 | 27.0 | 44.0 | 13.7 | 0.5 |
| MLT | 3545 | 0.03 | 30.8 | 69.2 | 25.4 | 30.8 | 13.2 | 0.0 |
| NLD | 318099 | 3.13 | 27.2 | 72.8 | 25.3 | 31.2 | 15.8 | 0.6 |
| POL | 101732 | 1.00 | 20.5 | 79.5 | 29.4 | 32.3 | 17.5 | 0.3 |
| PRT | 43002 | 0.42 | 21.2 | 78.8 | 25.8 | 37.2 | 15.5 | 0.3 |
| ROM | 26894 | 0.26 | 23.0 | 77.0 | 28.8 | 33.3 | 14.7 | 0.1 |
| RUS | 202069 | 1.99 | 9.5 | 90.5 | 26.4 | 44.5 | 19.2 | 0.5 |
| RoW | 1678834 | 16.50 | 23.1 | 76.9 | 22.0 | 40.2 | 11.6 | 3.2 |
| SVK | 32106 | 0.32 | 30.0 | 70.0 | 22.3 | 30.4 | 17.0 | 0.3 |
| SVN | 17102 | 0.17 | 25.5 | 74.5 | 26.1 | 32.9 | 15.4 | 0.1 |
| SWE | 153123 | 1.51 | 22.3 | 77.7 | 23.8 | 36.1 | 17.4 | 0.4 |
| TUR | 76364 | 0.75 | 13.9 | 86.1 | 34.1 | 35.1 | 16.8 | 0.3 |
| TWN | 202897 | 1.99 | 24.4 | 75.6 | 29.2 | 34.3 | 11.9 | 0.2 |
| USA | 1156020 | 11.36 | 9.3 | 90.7 | 25.5 | 45.9 | 13.0 | 6.3 |
| Total | 10173483 | 100 | | | | | | |
| Mean | | | 21.3 | 78.7 | 26.8 | 36.0 | 15.4 | 0.7 |

*Note*: Labels (A) - (E) represent individual components of gross exports as defined in the decomposition of gross exports into value-added exports provided by Koopman et al. (2010), presented in Figure 2.

*Source: WIOD tables, own calculation.*

[8] Two sectors are excluded from the following stages of the analysis: Coke, Refined Petroleum and Nuclear Fuel (since EU countries (except UK) do not have their own production) and Sector Private Households with Employed Persons (since the estimated DVA in the majority of countries has extreme values 0 or 1).

My analysis focuses on EU countries, especially on the comparison between NMS-10 and EU-15 countries. The decision to analyse the differences is based on the fact that NMS-10 represent former transition economies with political and economic predispositions, which influenced the development of international trade in a different way as compared to EU-15. Since GVCs, as already mentioned by Baldwin (2011), represent the way of cross-border dispersion of advanced know-how, I follow the assumption that NMS-10 have acquired new knowledge by participating in GVCs, and so started increasing their DVA. Cyprus and Malta are excluded from the analysis since they do not share a similar economic (and political) background with the rest of new EU countries. The subsequent part of the paper thus concentrates on these 25 countries (14,875 observations).

I expect that DVA in exports will be, on average, smaller in NMS-10 than in EU-15 states since: (1) the majority of NMS-10 countries have relatively low own R&D intensity, and are heavily dependent on R&D embodied in imported inputs, and so mostly rely upon imported technology (Reinstaller & Unterlass, 2011); and since (2) NMS-10 have attracted relatively high amount of FDIs. These can be at the beginning, as Aminian, Fung & Iizaka (2007) claim, associated with higher volume of host country's imports from FDI source country, due to increased imports of intermediates and capital goods related with production offshoring. However, through time the effect of FDIs can change if foreign affiliates begin to source intermediates from local firms.

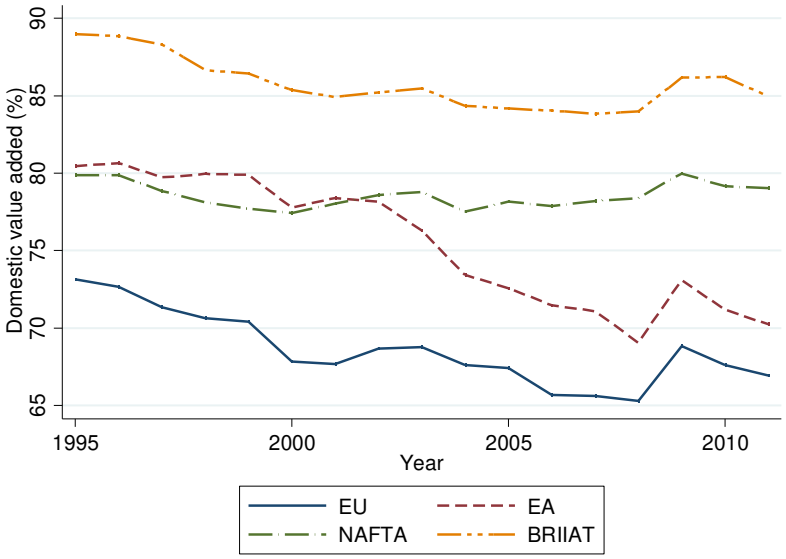
Additionally, offshoring to NMS-10 countries has gradually shifted from routine activities in the first years of transition (Gál, 2014) to high value-added and skill intensive activities (Marin, 2004, 2011; Lorentowicz, Marin, & Raubold, 2005; Sass & Fifekova, 2011), especially due to skilled labour and strategic location, so I expect that the differences in DVA diminish over time.

## 5 Results and discussion

The starting point of the analysis is the identification of EU countries position among other major groups of economies in terms of value-added in exports. As Figure 3 demonstrates, EU countries have the lowest DVA share in exports amongst the selected groups of countries, while East Asian countries saw the largest decline in the share[9].

[9] Although East Asian countries registered (on average) a declining trend in DVA, this was not the case in China, where DVA has been increasing from 2005.

*Figure 3: Domestic value added in exports by major group of world countries[10], 1995-2011*




*Source: WIOD tables, own calculations.*

Figure 3 clearly shows that DVA in exports has on average a declining path in all groups of countries with a rise in the year 2009, due to the beginning of the global financial crisis. The details of these features are further discussed in the following sections focusing on EU-15 and NMS-10 countries.

## 5.1 Exports in gross and value-added terms

Since the country's export success (by volume of exports) is not necessarily reflected in economic growth one of the key questions is how large is the difference between the volume of exports and the value-added implicit in those exports? The structure of exports in analysed countries is firstly presented with gross exports across the three main sectors – manufacturing, services, and natural resources. As seen in Table 2, in all EU countries the majority of exports (on average almost 75 per cent) represent exports in the manufacturing sector, while exports in services amount to, on average, more than 20 per cent. In EU-15 countries, the share of manufacturing in exports declined during the observed period (by 7.5 percentage points), while the share of exports of services has increased (by 7.6 percentage points). The opposite process can be noticed in the NMS-10 countries, where exports from manufacturing sector increased by 7.7 percentage points and exports in services decreased by 4.3 percentage points.

[10] BRIIAT stands for Brasil, Russia, India, Indonesia, Australia, and Turkey. The whole list of countries by group is provided in Appendix 3.

*Table 2: Gross and value added exports by main sectors for NMS-10 and EU-15, 1995-2010, in per cent of total exports*

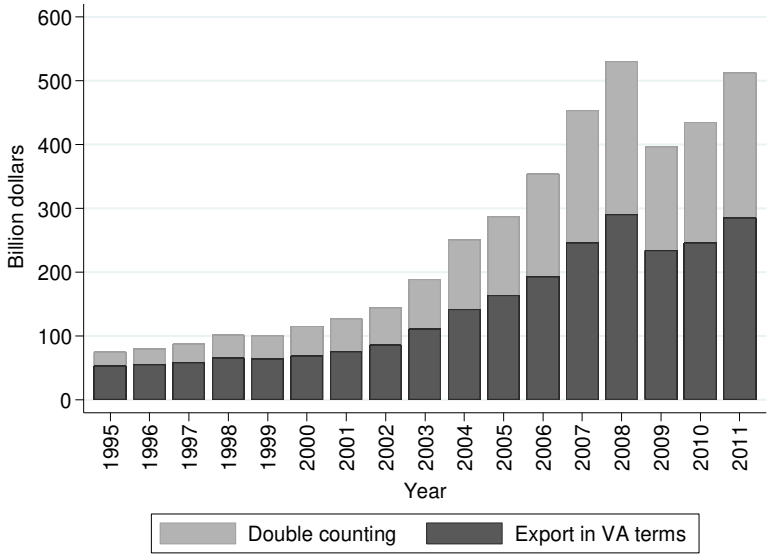
| | 1995 | 2000 | 2005 | 2010 | Average 1995-2011 | Average annual growth 1995-2011 |
|---|---|---|---|---|---|---|
| **EXPORTS IN GROSS TERMS** | | | | | | |
| | NMS-10 | | | | | |
| **Manufacturing** | 66.5 | 72.0 | 76.1 | 73.3 | 72.5 | 0.7 |
| **Natural resources** | 7.1 | 3.4 | 3.1 | 3.7 | 3.9 | -3.5 |
| **Services** | 26.5 | 24.6 | 20.8 | 23.0 | 23.5 | -1.0 |
| | EU-15 | | | | | |
| **Manufacturing** | 78.8 | 76.3 | 73.2 | 70.3 | 74.5 | -0.6 |
| **Natural resources** | 3.7 | 3.4 | 3.2 | 3.7 | 3.4 | 0.0 |
| **Services** | 17.5 | 20.2 | 23.6 | 26.0 | 22.1 | 2.3 |
| **EXPORTS IN VALUE ADDED TERMS** | | | | | | |
| | NMS-10 | | | | | |
| **Manufacturing** | 63.2 | 65.9 | 69.5 | 66.0 | 66.5 | 0.4 |
| **Natural resources** | 8.0 | 4.2 | 4.2 | 4.6 | 4.8 | -3.0 |
| **Services** | 28.9 | 29.9 | 26.4 | 29.4 | 28.7 | 0.0 |
| | EU-15 | | | | | |
| **Manufacturing** | 76.5 | 73.6 | 70.0 | 66.9 | 71.6 | -0.8 |
| **Natural resources** | 4.1 | 4.0 | 3.6 | 4.1 | 3.8 | 0.1 |
| **Services** | 19.4 | 22.4 | 26.3 | 29.0 | 24.5 | 2.4 |

*Source: WIOD tables, own calculations.*

More interesting results can be seen by comparing exports expressed in gross terms and exports in value-added terms. The latter is lower than gross exports for DVA incorporated in intermediates used by direct importer to produce goods, exported back to the source country ("reflected DVA") and for value-added from the foreign country incorporated in gross exports (foreign value-added). In this case the shares of services in total exports are higher and represent on average 28.7 per cent in NMS-10 and 24.5 per cent in EU-15. According to Drake-Brockman and Stephenson (2012, p.7), services add a significant value to manufacturing and agricultural output since they are "embodied" in products in the production process (e.g. energy, communications, transport insurance, software, accountancy, design, and other technical expertise). Other services, for example, like financing, training, maintenance, repair, and other after-sales service can be "embedded" at the point of product sale. Embodied services represent a large share of the value of goods for many products, but the full export value of embodied services is considered (for trade purposes) as manufactured exports without exports value attributed to services. Thus, the traditional statistical approach neglects the value of 'embodied' and 'embedded' services.

Exports in services and natural resources[11] in value-added terms are on average lower compared to exports in services and natural resources in gross terms (for about 20 per cent), while in manufacturing the difference is larger (on average 40 per cent in NMS-10 and for 30 per cent in EU-15). As mentioned, these differences result from double counting that consists of value-added from foreign country incorporated in gross exports (larger proportion) and so called 'reflected domestic value added.' As presented in Figure 4, the share of double counted exports in manufacturing sector in NMS-10 increased over time. From the beginning of the observed period (1995) to the end of the period in 2011, the gap between exports in value-added and gross terms increased from almost 30 to 44 per cent. Similarly, in the same period the share of double counting in EU-15 countries increased from 26 to 34 per cent.

*Figure 4: The structure of gross exports for manufacturing sector in NMS-10, 1995-2011, in billion dollars*




*Source: WIOD tables, own calculations.*

The figure reveals a decline in exports in the manufacturing sector due to the global economic crisis of 2008 that is reflected in exports data for 2009. Both EU-15 and NMS-10 registered a smaller decline in exports in value-added terms (20.2 per cent for EU-15 and 19.2 per cent for NMS-10) than in gross terms (23.7 per cent for EU-15 and 25.2 per cent for NMS-10). This signifies, like Bems, Johnson, & Yi (2011) explain, that the vertical specialization contributed to a large reduction in overall trade. The drop in demand, which occurred during the crisis, did not only affect trade flows of finished products, but had also a negative impact on related trade flows of intermediate products and components (Stehrer et al., 2011). Usually, when facing a sudden drop in demand companies delay acquisitions and reduce inventories. Consequently, the fall in demand extends along the supply chain and can lead to a stalemate for firms that are located upstream (Ahmad, 2013, p. 89). The role of GVCs during the collapse of international

[11] Countries that have significant shares of natural resources, oil or other goods in their exports have higher domestic value-added trade shares since such exports are in the first part of GVCs and do not require a lot of foreign input (UNCTAD, 2013a, p. 8).

trade in 2009 was studied by Altomonte et al. (2012), who found that trade in intermediates represents the main determinant of the significance of the decline in trade, which has bounced back since then.

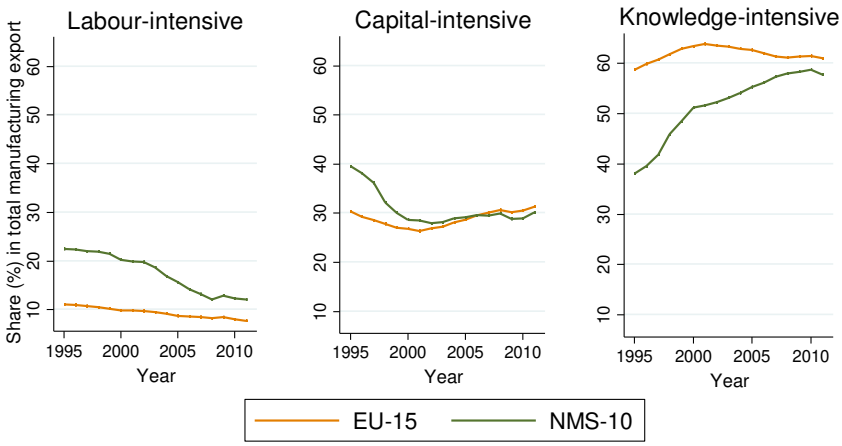
To this point it was shown that the gap between exports in value-added and gross terms has increased. Another question to be explored is whether the gap in domestic value-added in exports between NMS-10 and EU-15 countries persists or decreases over time both at the aggregate as well as at the sectoral level. The next section tries to provide a broader picture of the exports structure for labour, capital, and knowledge-intensive manufacturing and services sectors.

## 5.2 The structure of EU country's manufacturing and services sector exports

### *5.2.1 Manufacturing sector exports*

Since manufacturing exports account for three quarters of the total exports in EU, it is interesting to take a closer view at its structure. It can be seen from Figure 5 that knowledge-intensive[12] exports dominate in manufacturing exports, both in EU-15 (account on average for 62 per cent) and in NMS-10 countries (52 per cent).

*Figure 5: Share of exports in manufacturing subgroups for EU-15 and NMS-10, in the period 1995-2011, in percentage of total manufacturing exports*




*Source: WIOD tables, own calculations.*

During the observed period the share of knowledge-intensive exports for EU-15 increased by 2.3 percentage points, while for NMS-10 increased from 38 per cent to 58 per cent, and has thus almost matched the share in EU-15 countries (62 per cent in 2011). The reverse happened in capital intensive manufacturing exports, where through the years the share for NMS-10 declined (from 40 to 30 per cent), and the share for EU-15 increased (from 30 per cent to 31 per cent). Labour-intensive manufacturing exports

[12] Detailed information about sectors by group is provided in Appendix 1.

have the smallest share, which is in all examined years still higher for NMS-10 (average share is 17 per cent) than for EU-15 countries, although it declined through the years.

A sharp increase in knowledge-intensive exports can be explained by the fact that multinationals from hub countries, like Austria and Germany, are outsourcing the most skill and R&D-intensive activities to Eastern Europe, due to much lower costs of skilled labour in Eastern Europe (Marin, 2004). NMS-10 countries (and within them especially the so-called Visegrad or CE4 countries – Poland, Slovakia, Hungary, and the Czech Republic) attracted greenfield investments contributing to the expansion of productive capacity. FDIs were mostly directed towards the car industry, which is in line with the accelerated offshoring of the German automotive industry. This process has spurred the transfer of technology and enabled considerable benefits in terms of comparative advantage (Augustyniak et al, 2013). Rahman & Zhao (2013) computed the revealed comparative advantage index (using domestic value-added in exports). They found that all four mentioned countries improved their comparative advantage in knowledge-intensive sectors, even though none of these countries had a comparative advantage in 1995.

As stated by Labaye et al. (2013), the CEE countries now represent the headquarters of industrial clusters, crucial for further development of knowledge-intensive manufacturing, such as automotive and aerospace, since manufacturing clusters, research institutions, universities, suppliers, and others enabled a quick development of innovation. Nevertheless, Labaye et al. (2013) comment that the development of the automobile and electronics centres is still considerably behind the level of clusters in the United States, the EU-15, and BRIC countries. In order to expand the knowledge-intensive manufacturing in CEE countries, the investment in R&D and innovation is required with maintenance of high level of skills in the workforce.

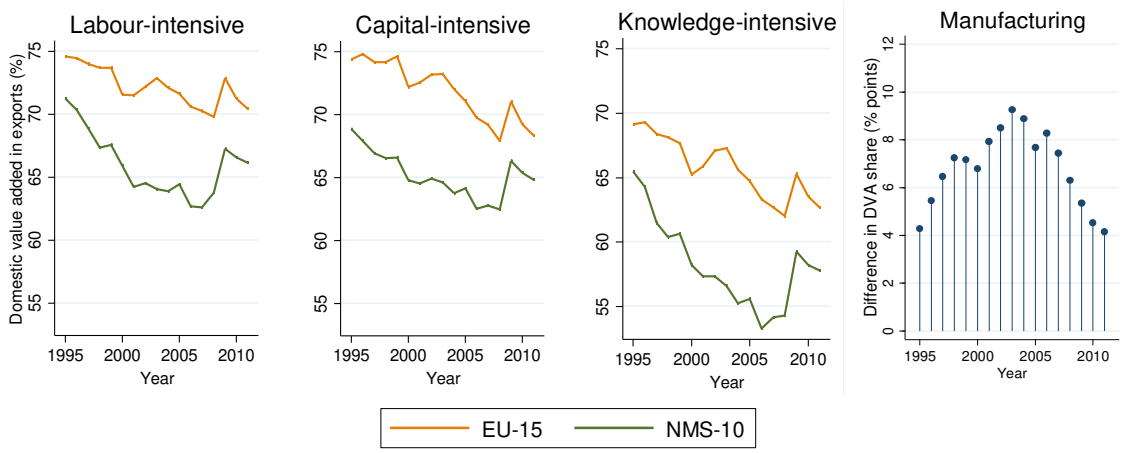
However, throughout our sample, DVA in exports by manufacturing subgroups in EU-15 was higher than in NMS-10, with the highest shares in labour-intensive activities. On average, it amounts 72 per cent in EU-15 and 65 per cent in NMS-10 (Figure 6)[13]. In all subgroups both NMS-10 and EU-15 record high growth in 2009 although NMS-10 countries registered a 6.8 per cent growth in 2009 contrary to the EU-15 countries with 4.7 per cent growth in the same year. In NMS-10 the largest growth (9.1 per cent in 2009) was recorded in knowledge-intensive manufacturing sector.

One possible explanation why DVA increased in 2009 is that the crisis could have caused firms to start re-shoring before offshored activities, which lead to higher DVA in exports. This effect was even more pronounced if re-shoring activities were present in sectors with relatively high foreign VA in exports (Stehrer & Stöllinger, 2013, p.40).

[13] Figure A1 (Appendix 4) additionally provides median values of the share of DVA in exports in manufacturing. The difference between median and mean values for NMS-10 is negligible, while for EU-15 median is on average for 2 percentage points higher (in every manufacturing subgroup).

Los, Timmer, & de Vries (2015, p. 78) explain that firms' long production chains became more vulnerable during the crisis. As they mention the decline in fragmentation can be driven by rising transportation costs (due to higher fuel prices) and increasing wages in China. However, Amador, Cappariello and Stehrer (2013) found that China remained an important input supplier for euro area countries, since its supplier role decreased only in 2009.

*Figure 6: Share of DVA in exports for EU-15 and NMS-10, in period 1995-2011, by manufacturing subgroups, in percentage of total exports and the difference in manufacturing DVA between EU-15 and NMS-10, in percentage points*




*Source: WIOD tables, own calculations.*

Although the differences between NMS-10 and EU-15 in terms of DVA share have persistently increased since 1995, they started diminishing over the observed period (Figure 6). Estimation of the presented model (7), by using DVA data for manufacturing, provides significant regression results which show that the trend for EU-15's share of DVA is almost linear and decreasing, but starts at higher values of DVA as compared to NMS-10 (Table 3). On the other hand, a positive value of the quadratic trend term for NMS-10 indicates the curvature is upwards sloping, which shows that a difference in share of DVA between both groups of countries systematically closes over time.

The decrease in the DVA gap can be explained by the fact that after 2004 the share of imported intermediates in total intermediates used in NMS-10 starts to decline (-1.2 per cent per year from 2004 to 2011), while at the same time in EU-15 this share is slightly increasing (0.5 per cent per year). Nonetheless, it is important to note that the average share of imported intermediates in NMS-10 is still higher than in EU-15. Regarding the exports of intermediates, Behar and Freund (2011) found (using sophistication measure developed by Hausman, Hwang and Rodrik, 2007) that new EU member countries intermediates exports to the EU-15 have become 15 per cent more sophisticated, while imported intermediates of new member countries from EU-15 have become only 7 per cent more sophisticated. Moreover, new member countries have become a more important source of intermediates for EU-15.

*Table 3: Convergence of DVA in the manufacturing sector*

Dependent variable: DVA in exports in manufacturing

| VARIABLES | POLS | FE (1) | FE (2) |
|---|---|---|---|
| NMS | -3.172*** | | |
| | (0.908) | | |
| t | -0.473*** | -0.445*** | -0.0551 |
| | (0.156) | (0.0599) | (0.0620) |
| $t^2$ | 0.0059 | 0.0040 | -0.0172*** |
| | (0.0085) | (0.00317) | (0.0034) |
| NMS*t | -1.209*** | -1.250*** | -1.249*** |
| | (0.234) | (0.135) | (0.135) |
| NMS*$t^2$ | 0.0690*** | 0.0714*** | 0.0714*** |
| | (0.0127) | (0.0068) | (0.0068) |
| Constant | 73.73*** | 72.44*** | 71.64*** |
| | (0.610) | (0.275) | (0.257) |
| Observations | 5,493 | 5,493 | 5,493 |
| R-squared | 0.129 | 0.310 | 0.364 |
| # of country-industry | | 325 | 325 |
| Country-industry FE | | YES | YES |
| Year FE | | NO | YES |

*Notes*: Regression estimates of the model (7) for the manufacturing sector; robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1; *NMS* = 1 if the observation belongs to NMS-10, *NMS* = 0 if the observation belongs to EU-15.

*Source: WIOD tables, own calculations.*

As claimed by Augustyniak at al. (2013) for the case of CE4, initial increase in FVA of these countries has eventually resulted in increased DVA based on improved technology capacity (provision of know-how to ensure quality) and increased demand for ancillary goods and services in home countries. However, the results differ between countries and between sectors within these sector groups. Although NMS-10 countries lead by exports in knowledge-intensive manufacturing, DVA in this sector is the lowest. Thus as argued by Labaye et al., (2013), generally Central and Eastern European economies should move up the value chain in knowledge-intensive manufacturing since the labour costs cannot represent the only source for comparative advantage due to increased competition from developing economies.

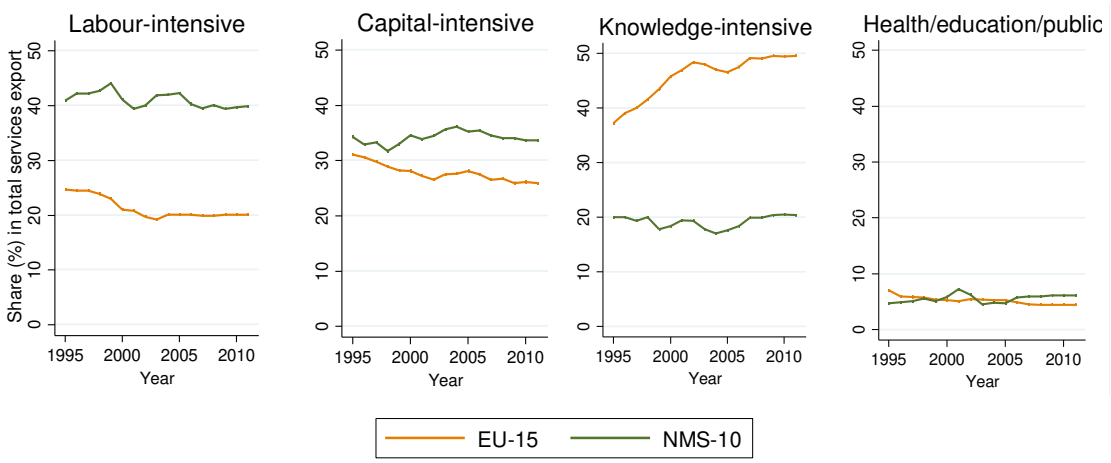
### *5.2.2 Services sector exports*

Services lead in many economies in terms of their share in the national GDP and as Low (2013, p. 73) argues, they represent an increasingly important component of international trade. They have a vital role in value chains though this aspect is often subject to misunderstanding and underestimation due to their intangible nature. They play an important part in international trade and investment flows by facilitating the development of value chains of goods which usually start and end with a series of service activities or with the creation of services value chains (Stephenson, 2012, p. 17), since in new business models, firms outsource not only the assembly of goods, but also many tasks typical for services.

Regarding the service sector, a difference between vertical and horizontal FDIs can be recognized. While market-seeking investors (horizontal investments) set up branches in the host country for the provision of services to the local market and are usually concentrated in developed countries with strong market potential, the resource-seeking investors (vertical investments) are driven by intention to reduce costs by using cheaper production factors. The latter are offered in developing and transition economies where the majority of this services are exported to (Sass & Fifekova, 2011).

In EU-15 countries the highest shares in services exports[14] can be observed in knowledge-intensive or business services (almost 50 per cent in 2011) of which share has increased by 12 percentage points through the observed years (Figure 7). These are followed by capital intensive (26 per cent in 2011) and labour-intensive services (20 per cent in 2011) for which the share has declined over time (for almost 5 percentage points). On the other side, NMS-10 countries have the largest share in services exports in labour-intensive services (40 per cent in 2011), followed by capital-intensive services (34 per cent in 2011). Positive annual growth rate is recorded in health, education and public services (2.4 percentage average annual growth) and in knowledge-intensive industries (0.2 percentage average annual growth).

*Figure 7: Share of exports in service subgroups for EU-15 and NMS-10, in the period 1995-2011, in percentage of total services exports*




*Source: WIOD tables, own calculations.*

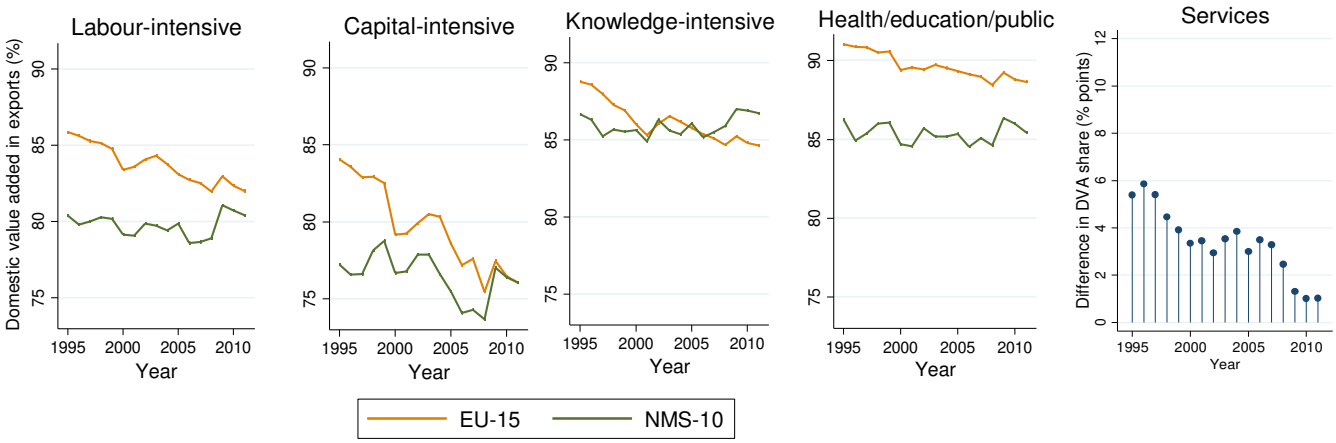
The highest DVA shares in exports in EU-15 (on average) were registered in services-related with health, education, and public services (89.6 per cent) and knowledge-intensive services (86.2 per cent) (Figure 8)[15]. Similarly, in NMS-10 the knowledge-intensive services (85.9 per cent) and health, education, and public services also recorded the highest share (85.4 per cent).

[14] Detailed information about sectors by group in Appendix 1.

[15] Figure A2 (Appendix 4) additionally provides median values of the share of DVA in exports in services. The difference between median and mean values for NMS-10 is negligible, while for EU-15 median is on average 2 percentage points higher. Individually, the difference for EU-15 is the highest in knowledge-intensive services (3 percentage points higher the median).

The largest average decline of DVA share in EU-15 was recorded in the capital-intensive sector (0.6 per cent per year), while for NMS-10, it was only 0.1 per cent per year). In recent years of the observed period, the share of DVA in NMS-10 approached the share of EU-15 (76 per cent for both groups in 2011). In the case of knowledge-intensive services the share for NMS-10 was since 2007 higher than in EU-15, which observed the decreasing path of DVA in the reference period. While in EU-15, the share of DVA in exports decreases in all services groups, and in NMS-10 DVA has a relatively stable path.

*Figure 8: Share of DVA in exports for EU-15 and NMS-10, in the period 1995-2011, by services subgroups, in percentage of total exports and the difference in services DVA between EU-15 and NMS-10, in percentage points*




*Source: WIOD tables, own calculations.*

Labaye et al. (2013) argue that CEE countries have created highly competitive outsourcing and offshoring capacities in knowledge-intensive services exports and are positioned to move into new activities with high value-added. As Labaye et al. (2013) add, the competitive advantage of outsourcing and offshoring companies from CEE is usually based on skills, not on scale, and so offers higher value-added services compared to their competitors from other countries.

Similarly, as in the manufacturing sector the estimation of the presented model (7) provided significant regression results for the services sector (Table 4), which confirm that differences between NMS-10 and EU-15 in terms of DVA in exports have lowered over the observed period. During these years, DVA in exports in NMS-10 countries was approximately 0.3 percentage points higher each year compared to EU-15, which again shows that the difference between both groups of countries is systematically lower. One possible explanation of the decrease in the DVA gap can be found in the fact that the share of imported intermediates in total intermediates used in EU-15 increases (by 1.3 per cent per year), while in NMS-10 remains relatively stable (with slight 0.2 per cent increase per year). After 2009 the share of imported intermediates in total intermediates used is higher in EU-15 countries.

*Table 4: Convergence of DVA in the services sector*

| Dependent variable: DVA in exports in services | | | |
|---|---|---|---|
| VARIABLES | POLS | FE (1) | FE (2) |
| NMS | -5.618*** | | |
| | (0.750) | | |
| t | -0.464*** | -0.449*** | -0.228*** |
| | (0.128) | (0.0448) | (0.0453) |
| $t^2$ | 0.008 | 0.0080*** | -0.0040* |
| | (0.0072) | (0.0023) | (0.0024) |
| NMS*t | 0.224 | 0.180* | 0.180* |
| | (0.194) | (0.0948) | (0.0949) |
| NMS*$t^2$ | 0.0019 | 0.0043 | 0.0043 |
| | (0.0105) | (0.0045) | (0.0046) |
| Constant | 87.23*** | 85.00*** | 84.71*** |
| | (0.471) | (0.221) | (0.215) |
| Observations | 7,554 | 7,554 | 7,554 |
| R-squared | 0.042 | 0.144 | 0.171 |
| # of country-industry | | 450 | 450 |
| Country-industry FE | | YES | YES |
| Year FE | | NO | YES |

*Notes*: Regression estimates of the model (7) for the services sector; robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1; *NMS* = 1 if the observation belongs to NMS-10, *NMS* = 0 if the observation belongs to EU-15.

*Source: WIOD tables, own calculations.*

As explained by Sass and Fifekova (2011), who focused on business services offshoring, initially FDIs in CEE comprised less complicated activities, but eventually activities with higher value-added and skill intensity were also offshored to this region. Gereffi and Fernandez-Stark (2010) reported that some Eastern European countries represent emerging locations for offshore services, which have expanded the most among all industries in many of these countries. Offshore services can be associated with certain positive externalities (e.g. knowledge transfer, employment, access to new markets).

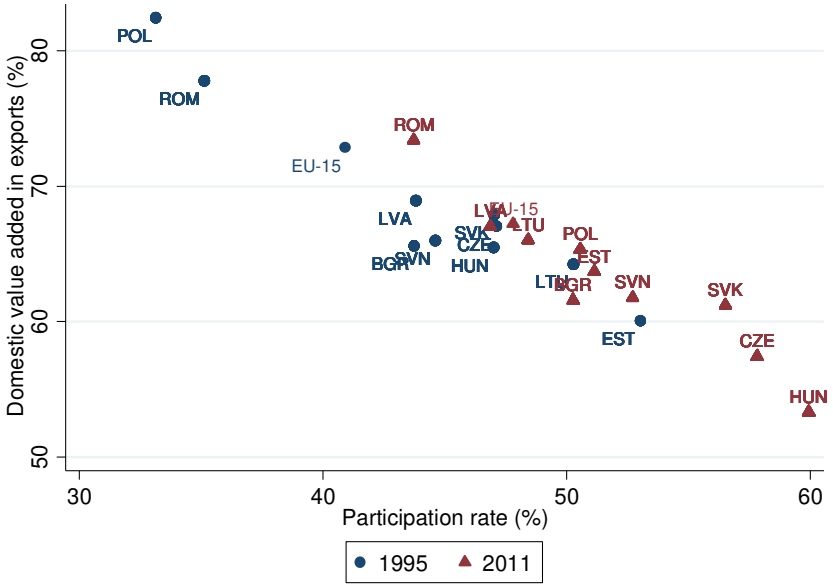
So far, it has been shown that DVA in exports has a declining path in almost all sectors. The participation in GVCs often indicates an entry into a more fragmented value chain, characterized by a greater use of inputs with foreign contents. When countries increase participation in GVCs, the share of DVA in exports is first reduced, although likely to increase the absolute value of the contribution of exports to GDP (UNCTAD, 2013b). The extent of EU countries integration in GVCs is presented hereinafter.

## 5.3 Integration in GVCs and domestic content in export

The extent to which countries are involved in GVCs is measured by the participation index at the country-sector level which indicates the presence of the selected sector and country in GVCs. The participation index is calculated as a share of foreign inputs (backward participation) and domestically produced inputs used in third countries' exports (forward participation) in gross export (see equation (15) in Appendix 2).

From the Figure 9 it can be observed that in the manufacturing sector all countries changed their positions to the right side (they increased their participation in GVC) in the period from 1995 to 2011, except Estonia and Lithuania, which decreased their participation in GVC. But at the same time, all countries shifted downwards (their DVA decreased) which suggests they moved downstream in the value chains. In almost all sectors Hungary had the highest participation rate (60 per cent), followed by Czech Republic and Slovakia (both approximately 57 per cent) and Slovenia (53 per cent), while the smallest participation rate was recorded in Romania (44 per cent).

*Figure 9: Degree of the participation in GVCs and DVA in exports for the manufacturing sector in NMS-10 and EU-15 in 1995 and 2011*




*Note:* Participation rate identifies the extent to which countries are involved in GVCs and is defined as a share of: (1) foreign inputs in gross exports, plus (2) domestically produced inputs used in third countries' exports (forward participation) in gross exports.

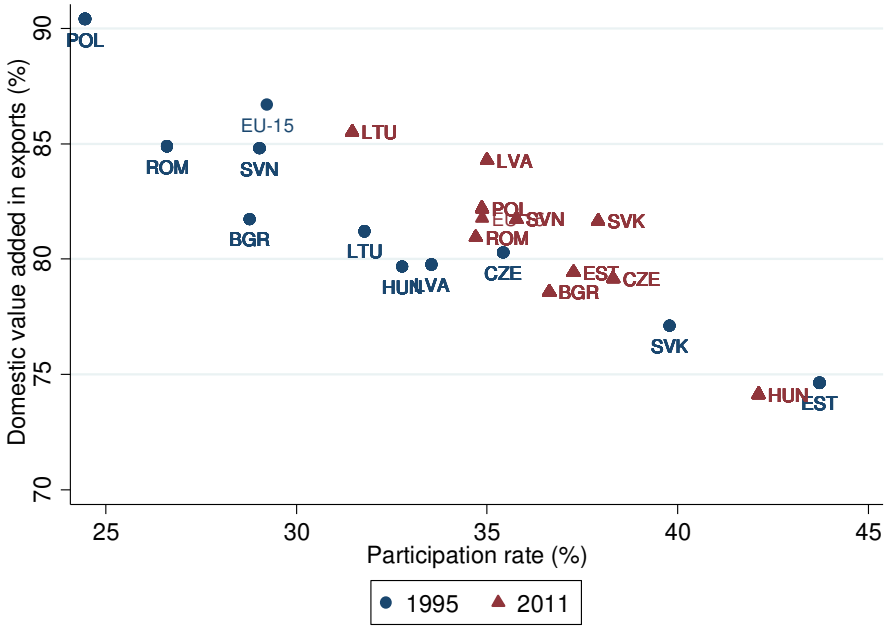
*Source: WIOD tables, own calculations.*

In the services sector, a rise in participation share from 1995 to 2011 can be observed in almost all countries (Figure 10), although there are some exceptions where countries lowered their participation rate from 1995 to 2011 (Estonia and Lithuania). The highest participation rate was in 2011 in Hungary (50 per cent), followed by Czech Republic and Slovakia (both 38 per cent).

The participation rate in services is still lower than participation in manufacturing GVCs (for NMS-10 represents 36 per cent in 2011, while in manufacturing it is on average 52 per cent), although in EU-15 average growth in share of participation in GVCs in the services sector is even higher (1.2 per cent) than growth of participation in GVCs for the manufacturing sector (1.0 per cent). The growing involvement of services in GVCs was as explained by Stephenson & Drake-Brockman (2014) enabled by application of information technology which allowed a segregation of business functions

in which intangible knowledge can be commoditised, and so similarly as for products, the production and trade became geographically separated.

*Figure 10: Degree of the participation in GVCs and DVA in exports for the services sector in NMS-10 and EU-15 in 1995 and 2011*




*Note:* The participation rate identifies the extent to which countries are involved in GVCs and is defined as a share of: (1) foreign inputs in gross exports, plus (2) domestically produced inputs used in third countries' exports (forward participation) in gross exports.

*Source: WIOD tables, own calculations.*

The estimation results of the model (8) indicate a negative relationship between participation in GVCs and DVA in exports in both sectors (Table 5). For the services sector this negative relationship increases slightly over time, while for the manufacturing sector this relationship is imprecisely estimated. However, results for NMS-10 countries show that negative relationship between participation in GVCs and DVA in exports is decreasing slightly over time in both the manufacturing and services sectors.

This is in line with results provided by UNCTAD (2013b, p. 170), showing that even countries with higher foreign value-added in exports can be in a better position in the long run if their GVC's participation rate is higher, since companies can expand into activities with higher value-added and upgrade their positions within GVCs. Companies create greater DVA from trade for the home country due to formation of domestic productive capacity which enables better outcome. Rahman and Zhao (2013, p. 11) found positively and statistically significant relationship between foreign value-added export growth lagged up to five years and DVA export growth (measured as a share of GDP).

*Table 5: Dynamics of DVA in exports with respect to GVCs participation*

Dependent variable: DVA in exports

| VARIABLES | POLS | FE | POLS | FE |
|---|---|---|---|---|
| | Manufacturing | | Services | |
| Part | -0.615*** | -0.743*** | -0.674*** | -0.271*** |
| | (0.0090) | (0.0383) | (0.0118) | (0.0442) |
| Part*t | -0.0018*** | -0.0009 | -0.001 | -0.0056*** |
| | (0.0005) | (0.0005) | (0.0007) | (0.0007) |
| Part*NMS | -0.0712*** | -0.189*** | -0.100*** | -0.253*** |
| | (0.0079) | (0.0472) | (0.0094) | (0.0642) |
| Part*NMS*t | 0.0017** | 0.0026*** | 0.0063*** | 0.0087*** |
| | (0.0007) | (0.0007) | (0.0009) | (0.001) |
| Constant | 98.20*** | 106.1*** | 107.1*** | 96.40*** |
| | (0.275) | (1.061) | (0.278) | (1.047) |
| Observations | 5,493 | 5,493 | 7,554 | 7,554 |
| R-squared | 0.703 | 0.824 | 0.662 | 0.466 |
| # of country*industry | | 325 | | 450 |
| Country-industry FE | | YES | | YES |

*Notes*: Regression estimates of the model (8); robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1; *NMS* = 1 if the observation belongs to NMS-10, *NMS* = 0 if the observation belongs to EU-15.

*Source: WIOD tables, own calculations.*

This evidence opens the question of factors influencing the country's participation in GVCs. Van der Marel (2015) shows (on the basis of OECD data for 50 countries) that size of the domestic market (measured by population) and barriers to investment negatively correlate with the extent to which countries participate in GVCs. On the other hand, countries with more skilled workers, higher index performance on logistics and higher R&D spending relative to GDP are connected to higher participation in GVCs. Using data for manufacturing sector in 26 EU countries (less Germany), assuming that Germany is the pillar of the CEE value chain, Stehrer & Stöllinger (2015) provided empirical evidence showing that inward FDI and relative GDP (to Germany) are positively correlated with GVC rates. Conversely, population, relative wage (to Germany), distance, and export sophistication are negatively correlated to the participation in GVCs.

## 5.4 Gains from participation in GVCs

Since domestic value-added is composed from (1) part outside of the GVCs and (2) part related with the GVCs, higher DVA does not necessarily imply higher gains from GVCs. The structure of country's participation in GVCs is composed of two parts, foreign value-added (backward linkages), and value-added created by goods and services to be used as intermediates in third countries' exports (forward linkages). These provide positive results for domestic economy from integration in GVCs, as they indicate increasing DVA in exports. As stated by Banga (2014), the ratio between forward and backward linkages can present an estimate of the range of gains from participation in GVCs. The higher this ratio, the higher are gains for the domestic economy. If the ratio is higher than one, this implies that a country by its participation in GVCs creates and exports more

domestic than foreign value-added. Table 6 shows that the ratios are higher than one only in the services sector, and that EU-15 countries have higher ratios than NMS-10.

*Table 6: Estimation of the gains from participation in GVCs by EU countries and the difference between 1995 and 2011*

| | EU-15 | | | | | | NMS-10 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Manufacturing** | | | **Services** | | | | **Manufacturing** | | | **Services** | | |
| | **1995** | **2011** | **Diff.** | **1995** | **2011** | **Diff.** | | **1995** | **2011** | **Diff.** | **1995** | **2011** | **Diff.** |
| AUT | 0.5 | 0.5 | -0.1 | 1.5 | 1.1 | -0.5 | BGR | 0.3 | 0.3 | 0.0 | 1.1 | 0.8 | -0.3 |
| BEL | 0.3 | 0.3 | 0.0 | 1.4 | 1.0 | -0.4 | CZE | 0.4 | 0.4 | -0.1 | 0.8 | 0.9 | 0.1 |
| DEU | 1.0 | 0.6 | -0.4 | 3.1 | 1.8 | -1.2 | EST | 0.3 | 0.4 | 0.1 | 0.9 | 1.0 | 0.1 |
| DNK | 0.5 | 0.4 | 0.0 | 1.7 | 0.9 | -0.8 | HUN | 0.4 | 0.3 | -0.1 | 0.7 | 0.8 | 0.1 |
| ESP | 0.8 | 0.6 | -0.1 | 2.8 | 2.1 | -0.7 | LTU | 0.4 | 0.4 | 0.0 | 0.8 | 1.5 | 0.7 |
| FIN | 0.7 | 0.6 | -0.1 | 1.1 | 1.1 | 0.0 | LVA | 0.4 | 0.4 | 0.0 | 1.0 | 1.6 | 0.6 |
| FRA | 0.8 | 0.6 | -0.2 | 1.8 | 2.0 | 0.2 | POL | 0.9 | 0.5 | -0.4 | 1.9 | 1.1 | -0.7 |
| GBR | 0.7 | 0.7 | 0.0 | 2.1 | 1.9 | -0.2 | ROM | 0.6 | 0.7 | 0.0 | 1.1 | 1.3 | 0.2 |
| GRC | 0.5 | 0.6 | 0.0 | 2.3 | 1.9 | -0.4 | SVK | 0.5 | 0.5 | 0.1 | 1.0 | 1.2 | 0.2 |
| IRL | 0.3 | 0.2 | -0.1 | 0.8 | 0.5 | -0.3 | SVN | 0.3 | 0.4 | 0.1 | 1.2 | 1.2 | 0.0 |
| ITA | 0.6 | 0.6 | -0.1 | 2.5 | 2.3 | -0.2 | *Mean* | 0.5 | 0.4 | 0.0 | 1.1 | 1.1 | 0.1 |
| LUX | 0.3 | 0.3 | 0.0 | 1.2 | 0.9 | -0.2 | | | | | | | |
| NLD | 0.4 | 0.4 | 0.0 | 1.0 | 0.9 | -0.1 | | | | | | | |
| PRT | 0.4 | 0.5 | 0.1 | 1.9 | 2.0 | 0.1 | | | | | | | |
| SWE | 0.6 | 0.5 | -0.1 | 1.6 | 1.3 | -0.2 | | | | | | | |
| *Mean* | 0.6 | 0.5 | -0.1 | 1.8 | 1.4 | -0.3 | | | | | | | |

*Note:* Gain from participation in GVC's present ratio between goods and services for intermediate use in the exports of third countries (forward linkages) and foreign value-added (backward linkages).

*Source: WIOD tables, own calculations.*

However, the evolution of the ratios over time shows that majority of EU-15 member states experience a decreasing trend in gains from GVC participation, while the opposite is recorded in almost all NMS-10. The latter see their ratios increasing especially in the services sector (positive changes are recorded also in manufacturing, but in a smaller extent), where again Latvia and Lithuania stand out. However, in both groups of countries exports contain more domestic than foreign value-added in the services sector, while the opposite is observed in manufacturing. These presented results imply that gains from participation in GVCs are not assured (OECD, WTO, & World Bank Group, 2014) since firms have to expand into higher value-added activities in GVCs.

Nevertheless, a country's participation in GVCs can stimulate growth and employment by creating demand for supplementary products and services in host countries (Aiyar et al., 2013). Participation in GVCs represents an opportunity for emergence of wider range of supporting activities (e.g. transport, logistics, finance, communication, and other business and professional services) (UNCTAD, OECD, & WTO, 2013). Additionally, Kim and Li (2014) find that inward FDI is positively related to the level of newly registered firms. Countries can thus benefit from participation in GVCs as the increase in FVA cannot be simply regarded as the replacement of their domestic production, but as their supplement.

# 6 Conclusion

This paper describes the development of the concept of value-added in exports upon which a thorough analysis of domestic content in exports is based. The focus of analysis is the comparison of DVA in exports between NMS-10 and EU-15 countries, on the sectoral level with the use of WIOD database and methodology developed by Koopman et al. (2010). The results show that from the beginning of the observed period (1995) to the end of the period in 2011, the gap between exports in value-added and gross terms has increased by almost 15 percentage points in NMS-10, while for only little less than 5 percentage points in EU-15, suggesting that FVA represents a larger share of exports of NMS-10 countries.

DVA in exports is thus higher in EU-15, while the decline in DVA share is primarily perceived in the manufacturing sector compared to some services sectors where DVA for NMS-10 remains stable through the observed period from 1995 to 2011 (knowledge-intensive and labour-intensive services). DVA in exports recorded a noticeable rise in 2009 compared to 2008, especially in the manufacturing sector in NMS-10 countries (almost 7 per cent growth compared to 4 per cent in EU-15), which indicates that the collapse of international trade due to the crisis had a larger impact on increase in DVA in exports (or increase in vulnerability of production) where value chains were more internationally fragmented (OECD, 2013b).

Furthermore, the participation of countries in GVCs is investigated. For NMS-10 countries the degree of participation in GVCs is, on average (both in services and in manufacturing sector) slightly higher compared to EU-15 average. Regression results for NMS-10 countries show that negative relationship between participation in GVCs and DVA in exports decreases slightly over time in both the manufacturing and services sectors. This is in line with research (UNCTAD, 2013b, p. 170; Rahman and Zhao, 2013, p. 11), suggesting that even countries with higher FVA in exports can be in a better position if their GVCs participation rate is higher, since in the long run, countries can upgrade their positions within GVCs and increase their DVA in exports even if they initially increase FVA in exports.

It should be noted that even though all current EU member countries are generally referred to as developed, NMS-10 countries had a different historical background which influenced their trade and economic development. The analysis exposes the differences between NMS-10 and EU-15 regarding the structure of the value-added in their exports. Despite the fact that NMS-10 countries became important suppliers of intermediate parts and components, semi-finished and finished goods, it is shown that NMS-10 still have a higher proportion of imports embodied in their exports than EU-15, even though for some sectors convergence is observed.

Gains from participation in GVCs, thus higher value added (related with the GVCs) created in a country, is not assured (OECD, WTO, & World Bank Group, 2014). Observed data show that NMS-10 countries slowly increase their gains from participation in GVCs, especially in services sector but however gains still remain lower than in EU-15 member states. Policy implication from this case refers to the promotion of business environment that not only attracts FDIs or increases country's participation in GVCs but also acquires more high value added activities. In terms of country's competitiveness and export performance measures it is important to take into account the difference between trade statistics in gross terms (traditional) and in value added terms.

However, certain limitations of the analysis based on the concept of value added have to be mentioned. The construction of Input-output tables requires extensive global databases which are often incomplete and thus the use of some simplified assumptions is required which may underestimate the effects of international participation on domestic economy (Powers, 2012). Especially the trade data in services do not meet the quality level of trade data for merchandize goods therefore WIOD database offers the best currently available approximation of global trade flows for services (Dietzenbacher et al., p. 86).

Nevertheless, the paper offers an insight into the structure of EU countries' exports from the perspective of value added, suggesting the existence of differences between old and new EU countries from CEE, which require a further investigation.

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## APPENDIX 1: Sectors included in the database

*Table A1: Sectors included in the database*

| Sector group | Sector code | Sector number | Sector description |
|---|---|---|---|
| Categories Primary and Natural resources | AtB | 1 | Agriculture, Hunting, Forestry and Fishing |
| | C | 2 | Mining and Quarrying |
| Labour-intensive manufacturing | 17t18 | 4 | Textiles and Textile Products |
| | 19 | 5 | Leather, Leather and Footwear |
| | 20 | 6 | Wood and Products of Wood and Cork |
| | 36t37 | 16 | Manufacturing, Nec; Recycling |
| Capital-intensive manufacturing | 15t16 | 3 | Food, Beverages and Tobacco |
| | 21t22 | 7 | Pulp, Paper, Paper , Printing and Publishing |
| | 23 | 8 | Coke, Refined Petroleum and Nuclear Fuel* |
| | 25 | 10 | Rubber and Plastics |
| | 26 | 11 | Other Non-Metallic Mineral |
| | 27t28 | 12 | Basic Metals and Fabricated Metal |
| Knowledge-intensive manufacturing | 24 | 9 | Chemicals and Chemical Products |
| | 29 | 13 | Machinery, Nec |
| | 30t33 | 14 | Electrical and Optical Equipment |
| | 34t35 | 15 | Transport Equipment |
| Labour-intensive services | F | 18 | Construction |
| | 50 | 19 | Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel |
| | 51 | 20 | Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles |
| | 52 | 21 | Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods |
| | H | 22 | Hotels and Restaurants |
| | 63 | 26 | Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies |
| | P | 35 | Private Households with Employed Persons* |
| Capital-intensive services | E | 17 | Electricity, Gas and Water Supply |
| | 60 | 23 | Inland Transport |
| | 61 | 24 | Water Transport |
| | 62 | 25 | Air Transport |
| | 64 | 27 | Post and Telecommunications |
| | 70 | 29 | Real Estate Activities |
| Knowledge-intensive services (Business services) | J | 28 | Financial Intermediation |
| | 71t74 | 30 | Renting of M&Eq and Other Business Activities |
| Health/education/public service | L | 31 | Public Admin and Defence; Compulsory Social Security |
| | M | 32 | Education |
| | N | 33 | Health and Social Work |
| | O | 34 | Other Community, Social and Personal Services |

* Excluded sectors from the analysis

Source: Rahman, J., & Zhao, T. (2013). *Export Performance in Europe: What Do We Know from Supply Links?*. IMF Working Paper No. 13/62.

**APPENDIX 2: Methodology of Measuring Value-added in exports**

The previously mentioned framework requires the use of inter-country input-output tables, which contain information on the source and destination country of all transaction flows by industry, separately for the use of intermediates and the use of final products (Koopman et al., 2014, p. 485). The model assumes an $m$-country world, where each country produces goods in $n$ tradable sectors, and so the $m$-country production and trade system can be presented in block matrix structure as (Koopman et al., 2010; Rahman & Zhao, 2013):

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

This structure shows that all gross output produced by country $g$ is used as an intermediate or final good by home country or by foreign countries ($h$). $X_g$ *thus* represents the $n$ *x 1* gross output vector of country $m$ and each block matrix $A_{gh}$ represents $n$ *x* $n$ I-O matrix of coefficients that stand for intermediate use in country $h$ of goods produced in country $g$. $Y_{gh}$ denotes the $n$ *x 1* final demand vector, which represents a country's $h$ demand for the final goods produced in country $g$. To simplify, this can be (for all countries and sectors) also presented as $\hat{X}=\hat{A}\hat{X}+\hat{Y}$, where $\hat{X}$ and $\hat{Y}$ are $mn$ *x 1* vectors and $\hat{A}$ is an $mn$ *x* $mn$ matrix.

By reorganizing the equation, the gross output vector $\hat{X}$ can be expressed as

$$\begin{bmatrix} X_1 \\ \vdots \\ X_m \end{bmatrix} = \begin{bmatrix} I-A_{11} & \dots & A_{1m} \\ \vdots & \ddots & \vdots \\ A_{m1} & \dots & I-A_{mm} \end{bmatrix}^{-1} \begin{bmatrix} Y_{11}+\dots+Y_{1m} \\ \vdots \\ Y_{m1}+\dots+Y_{mm} \end{bmatrix} = \begin{bmatrix} B_{11} & \dots & B_{1m} \\ \vdots & \ddots & \vdots \\ B_{m1} & \dots & B_{mm} \end{bmatrix} \begin{bmatrix} Y_{11}+\dots+Y_{1m} \\ \vdots \\ Y_{m1}+\dots+Y_{mm} \end{bmatrix}, \quad (2)$$

where $B_{gh}$ represents an $n$ *x* $n$ Leontief inverse matrix, which defines the amount of gross output in producing country $g$, needed to increase the final demand in country $h$ for one-unit.

If the results should be expressed by sector, instead of a final demand vector (which represents the sums of final demand amounts along the row), then the final demand matrix has to be used. The entire matrix $\hat{X}$ now represents an $mn$ *x* $n$ gross output matrix:

$$\begin{bmatrix} X_{11} & \dots & X_{1m} \\ \vdots & \ddots & \vdots \\ X_{m1} & \dots & X_{mm} \end{bmatrix} = \begin{bmatrix} I-A_{11} & \dots & A_{1m} \\ \vdots & \ddots & \vdots \\ A_{m1} & \dots & I-A_{mm} \end{bmatrix}^{-1} \begin{bmatrix} Y_{11} & \dots & Y_{1m} \\ \vdots & \ddots & \vdots \\ Y_{m1} & \dots & Y_{mm} \end{bmatrix} \quad (3)$$

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)

$$\mathrm{E}_{g*\_} = \sum\nolimits_{h \neq g} E_{gh} = \sum\nolimits_{h \neq g} (Y_{gh} + A_{gh}X_h). \tag{4}$$

For each country, the result represents an *n x 1* vector, so for the purpose of consistency the diagonal matrix $\mathrm{E}_{g*}(n\ x\ n)$ is defined from each vector $\mathrm{E}_{g*}$ All diagonal matrices are combined together to form $\hat{E}$, an *mn x mn* diagonal matrix:

$$\hat{E} = \begin{bmatrix} diag(E_{1*\_}) & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & diag(E_{m*\_}) \end{bmatrix} = \begin{bmatrix} E_{1*} & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & E_{m*} \end{bmatrix} \tag{5}$$

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

$$V_g = u(I - \sum\nolimits_h A_{gh}) \tag{6}$$

Each element of $V_g$ signifies the ratio of direct domestic value-added in total output for country *g*. For consistency, $\hat{V}$ is defined, an *m x mn* matrix of direct value-added for all countries:

$$\hat{V} = \begin{bmatrix} V_1 & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & V_m \end{bmatrix} \tag{7}$$

The direct domestic value-added matrix $\hat{V}$ multiplied with Leotief inverse matrix $\hat{B}$ forms a matrix VA, which is a basic measure of value-added shares by source. Each column in the diagonal block matrices represents the domestic value-added share of domestically produced products for each sector. Each column in off-diagonal block matrices represents another country's value-added in the same sector. Since all value-added is either domestic or foreign, the sum of each column represents unity (*u*).

The multiplication of value-added share VA matrix and export matrix $\hat{E}$ results in a sectoral measure of value-added by the source country or $\hat{V}\hat{B}\hat{E}$:

$$\hat{V}\hat{B}\hat{E} = \begin{bmatrix} V_1B_{11}E_{1*} & V_1B_{12}E_{2*} & \cdots & V_1B_{1m}E_{m*} \\ V_2B_{21}E_{1*} & V_2B_{22}E_{2*} & \cdots & V_2B_{2m}E_{m*} \\ \vdots & \vdots & \ddots & \vdots \\ V_mB_{m1}E_{1*} & V_mB_{m2}E_{2*} & \cdots & V_mB_{mm}E_{m*} \end{bmatrix} \tag{8}$$

Diagonal block row vectors (1 x n) of matrix $\hat{V}\hat{B}\hat{E}$ indicate domestic value-added *(DVA)* in exports for each country (by sectors), and can be expressed as:

$$DVA_g = V_g B_{gg} E_{g*} \tag{9}$$

The off-diagonal row vectors, summed along a column, indicate foreign value-added *(FVA)* in exports for each country (by sectors) and can be expressed as:

$$FVA_g = \sum\nolimits_{h \neq g} V_h B_{hg} E_{g*} \tag{10}$$

As already mentioned, the sum of foreign and domestic value-added share in exports forms a unity which implies that sum of domestic and foreign value-added in exports represents the official value of gross export:

$$\mathrm{E}_{g*} = DVA_g + FVA_g \tag{11}$$

The gross export $\mathrm{E}_{gh}$ can be broken down into final demand (A) and intermediates. Intermediates can than be further divided into (B) goods that are consumed by direct importer, (C) goods that are processed and exported to third countries and (D) goods that are processed and exported back to the source country:

$$\mathrm{E}_{gh} = Y_{gh} + A_{gh}X_g = Y_{gh}(A) + A_{gh}X_{hh}(B) + \sum\nolimits_{h \neq g} A_{gh}X_{ht}\,(C) + A_{gh}X_{hg}(D) \tag{12}$$

Connecting the equation (9) and (12), summing over all trading partners and inserting in the equation (11) gives an equation that presents the breakdown of the country's gross export into five categories:

$$\begin{gathered} E_{g*} = DVA_g + FVA_g = \\ V_g B_{gg} \textstyle\sum_{h \neq g} Y_{gh}\,(A) + V_g B_{gg} \sum_{h \neq g} A_{gh}X_{hh}(B) + V_g B_{gg} \sum_{h \neq g} \sum_{t \neq g,h} A_{gh}X_{ht}\ (C) \\ + B_{gg} \textstyle\sum_{h \neq g} A_{gh}X_{hg}\ (D) + FVA_g\ (\mathrm{E}) \end{gathered} \tag{13}$$

(A) Domestic value-added in exports of final goods/services consumed by the direct importer

(B) Domestic value-added in exports in intermediates used by the direct importer to produce products needed in the domestic country

(C) "Indirect value-added exports" - domestic value-added incorporated in intermediates used by direct importer to produced goods for third countries

(D) "Reflected domestic value-added" - domestic value-added incorporated in intermediates used by the direct importer to produce goods exported back to the source country

(E) Foreign value-added – value-added from a foreign country incorporated in gross exports

As it can be seen from the equation (13), the sum of (A), (B), (C), and (D) is equal to the domestic content in each country's gross export. The components (A) and (B) represent the exports of a country outside of the supply chain, while components (C), (D), and (E) regard 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 a part of export that is double counted in the official trade statistics, and the sum of (A), (B), and (C) divided by gross exports equals to Johnson and Noguera's (2012) VAX ratio.

As further mentioned in Koopman et al. (2010), the sum of (C) and (D) equals to Hummels, Ishii and Yi's (2001) measure of vertical specialization which represents the domestic value-added in inputs exported indirectly to third countries. The before mentioned indirectly exported value-added was mathematically defined by Koopman et al. (2010) as:

$$IVA_g = \sum\nolimits_{h \neq t} V_g B_{gh} E_{ht} \tag{14}$$

On the basis of the decomposition described above (country-sector level) Koopman et al. (2010, str. 21) defined the GVC participation index as:

$$\mathrm{GVC}_{\mathrm{participation}} = \frac{IVA_g}{E} + \frac{FVA_g}{E} \tag{15}$$

which summarizes the importance of the GVC for the selected sector.

## APPENDIX 3: Countries included in WIOD database

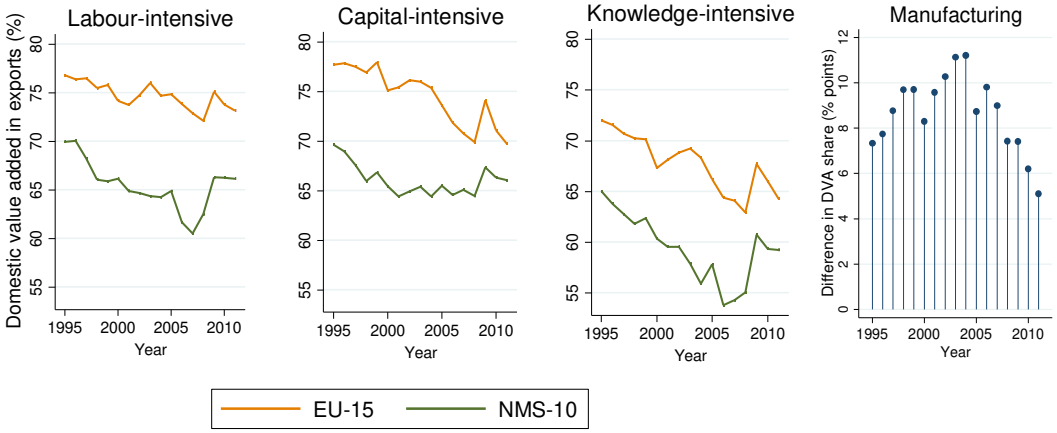
*Table A2: The list of countries included in WIOD database*

| EU-15 | | NMS-10 | Other EU | NAFTA | BRIIAT | East Asia |
|---|---|---|---|---|---|---|
| Austria(AUT) | Luxembourg | Bulgaria | Cyprus | Canada | Brazil | Japan |
| Belgium | Netherlands | Czech Rep. | Malta | Mexico | Russia | Korea |
| Finland | Portugal | Estonia | | USA | India | Taiwan |
| France | Spain | Hungary | | | Indonesia | China |
| Germany | Denmark | Latvia | | | Australia | |
| Greece | Sweden | Lithuania | | | Turkey | |
| Ireland | UK | Poland | | | | |
| Italy | | Romania | | | | |
| | | Slovakia | | | | |
| | | Slovenia | | | | |

*Source: E. Dietzenbacher, B. Los, R. Stehrer, M. Timmer, & G. de Vries, The Construction of World Input–Output Tables in the Wiod Project, 2013, p. 95.*

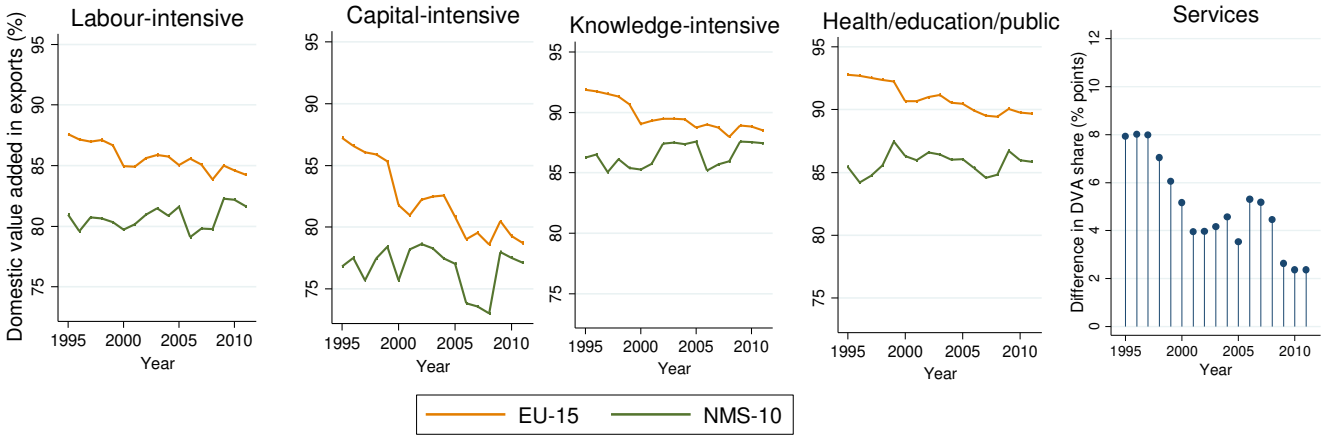
## APPENDIX 4: Share of DVA in exports (median values)

Figure A1*: Share of DVA in exports for EU-15 and NMS-10 (median values) by manufacturing subgroups in period 1995-2011, in percentage of total exports and the difference in median values of manufacturing DVA between EU-15 and NMS-10, in percentage points*




*Source: WIOD, own calculations*

Figure A2*: Share of DVA in exports for EU-15 and NMS-10 (median values) by services subgroups in period 1995-2011, in percentage of total exports and the difference in median values of services DVA between EU-15 and NMS-10, in percentage points*




*Source: WIOD, own calculations.*