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APRIL 2018

Research Report 427

Global and Regional Value Chains: How Important, How Different?

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This report has been prepared for the European Commission, DG GROW, under Specific Contract No SI2-723971 implementing the Framework Service Contract ENTR/300/PP/2013/FC-WIFO coordinated by the Austrian Institute of Economic Research (WIFO) (coordinator: Andreas Reinstaller).

The authors wish to thank Alexandra Bykova and Oliver Reiter for their statistical support.

Abstract

This study investigates in detail value chain trade of the EU and its Member States, compares it to that of other trading blocs and regions such as NAFTA and East Asia, and delves into implications of value chain trade on specialisation and competitiveness as well as on the declining income elasticity of trade. The analysis of value chain (VC) trade, understood as trade that involves internationally organised production processes, is based on the latest update of the World Input-Output Database (WIOD). It relies to a large extent on a forward production integration measure termed re-exported domestic value added (DVAre) which comprises exports of intermediates that cross international borders at least twice. Results confirm the conjecture that the expansion of international value chains has come to a halt in the post-crisis period (2011-2014). Still, the EU's VC trade was growing at the same pace as value added exports in general in the post-crisis years, implying that value chains were not dismantled. In contrast, worldwide VC trade was indeed less dynamic than value added exports, which could be seen as a sign that some value chains are on the retreat. Zooming closer into the EU, there was a marked reshuffling of market shares of Member States in EU-wide VC trade from large Member States such as France, Italy and the United Kingdom towards a group of Central European (CE) economies – Germany, Austria, the Czech Republic, Hungary, Poland and Slovakia – which together form the Central European Manufacturing Core. Looking at the question whether VC trade is rather regional in scope, VC trade is separated into regional value chain (RVC) trade – involving only regional production partners – and global value chain (GVC) trade – involving also extra-regional partner countries. For the EU as a whole this split is about half-half, with only a slight move towards GVC trade between 2000 and 2014. Strikingly, demand is strongly shaping the organisation of production: while RVCs are predominantly producing for the EU market, GVCs are predominantly procuring for third countries. As regards implications of value chain trade, these are harder to assess. Overall, implications for structural change and competitiveness are rather country and context specific. Changes in attitudes towards international value chains contributed to the significant decline in the income elasticity of trade.

Keywords: value chain trade, global value chains, regional value chains, Factory Europe, Factory North America, Factory Asia, revealed export preferences, regional introversion index, specialisation, competitiveness, income elasticity of trade

JEL classification: F14, F15

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The emergence and intensification of international value chains and the implied cross-border production sharing between countries has dramatically altered the international trading system. In view of the joint cross-border production processes numerous products would deserve the designation of origin 'Made in the World', as suggested by the WTO initiative of the same name – although in general there is the perception that international value chains are predominantly regional in scope. Since the Great Recession, however, there are concerns that the trend towards geographically-dispersed production has come to a halt with, among other factors, re-shoring initiatives and protectionist tendencies trying to 'bring manufacturing back' and increase domestic value added contributions to exports. One of the questions linked to this phenomenon relates to the extent to which international value chains have contributed to the decline in the income elasticity of trade which is well-documented for the post-crisis period. This leads also to the more general question of the actual impact of value chain integration and resulting value chain trade (also referred to as '21st century trade') on economic structures and performance and to what extent these effects differ from conventional trade.

This study investigates some of these issues with data stretching until 2014 with a focus on the EU and its Member States and occasional comparisons (where they deem insightful) with other trading blocs and regions such as NAFTA and East Asia. The analysis relies to a large extent on a measure of international value chain (VC) trade termed re-exported domestic value added which comprise exports of intermediates that cross international borders at least twice. This metric accounts for about 17% (2014) of total EU gross exports and is a forward looking production indicator, meaning that value added originating from one country is traced forward along the value chain, passing through other countries which are involved as production partners, until it reaches the country of final demand. Using this re-exported domestic value added as the indicator for international VC trade confirms the conjecture that the expansion of international value chains has come to a halt in the post-crisis period (2011-2014). This is not to say that international value chains have been dismantled; the EU's VC trade was still growing at the same pace as value added exports (VAX) in general in the post-crisis years (approximately 3.3%-3.4% when the entire economy is considered, about one percentage point less for manufacturing only). Comparing different types of export flows – gross exports, value added exports and VC trade – in this context reveals an interesting pattern for the EU. It is interesting because in the post-crisis period – and in contrast to the longer-term trend – the growth of the value added exports exceeded that of gross exports. At the same time, the VC trade component did grow at par with the value added growth. This constellation is compatible with a situation where EU Member States manage to capture large domestic value added in export transactions but *without* dismantling value chains. A more worrying trend is discernible at the global level: worldwide VC trade was indeed less dynamic than value added exports (except in the case of advanced manufacturing industries) which were in turn growing at a slower pace than gross exports. This could be seen as a sign that some value chains are on the retreat. While this would be a subject for further investigation, the data at hand are in line with the idea that the European Single Market, due to the guaranteed free movement of goods, services and investments and accompanying regulations such as the competition rules, acts as a reinsurance mechanism against potential protectionist tendencies. This is not to say that the EU-28 is immune to economic nationalism;

nevertheless, the idea that the Single Market provides an institutional anchor to safeguard also internationally-organised production is consistent with the patterns of the post-crisis export data. This finding is also confirmed when considering VC trade *intensities* of the EU, defined as the ratio of VC trade to value added exports. The VC intensity clearly levelled off after 2011 so that the VC trade to VAX ratio of about 26% may be considered as a peak in VC trade. Still, no signs of a massive decline in this VC intensity are discernible for the EU-28. A related finding is that the changes in attitudes towards international value chains contributed to the significant decline in the income elasticity of trade which is well documented in the literature. Confirming and supplementing existing findings with in-depth gravity estimations for gross exports, value added exports and VC trade flows (i.e. re-exported domestic value added), the decline in the elasticity of exports with regards to both own-country and foreign-country GDP is rather similar across the three types of export flows. If anything, the decline in this elasticity is typically lower for VC trade, which makes it unlikely that disruptions in international value chains had a significant impact on the lowered income elasticity of overall trade. In all likelihood there are some other structural factors at play which caused the income elasticity of trade to fall – a fact that entails the prospect that the current trade slowdown in the EU-28 will be a medium- to long-term phenomenon.

The trade slowdown, including the reduced dynamic in VC trade, is not a trend specific to the EU. While the EU-28 was clearly underperforming in terms of economic growth and much of Member States' trade in intra-EU trade, the EU was relatively successful in defending global export market shares given that with China and other emerging economies there appeared a number of important new players in the international trade arena. This is equally true for VC trade and becomes visible when comparing the 1 percentage point loss in the world market share in VC trade of the EU with the corresponding losses of the United States and Japan which amounted to 8 percentage points and 5 percentage points, respectively (2000-2014) when an extended manufacturing sector comprising also business services is considered. Zooming closer into the EU and at individual Member States reveals VC trade developments that are well-known from overall trade developments. In particular, there was a marked reshuffling of market shares of Member States in EU-wide VC trade from large Member States such as France, Italy and the United Kingdom towards a group of Central European (CE) economies – Germany, Austria, the Czech Republic, Hungary, Poland and Slovakia – which together form the Central European Manufacturing Core. By 2014 this CE Manufacturing Core accounted for 35% of the EU's entire VC trade, a more than 5 percentage points increase since 2000. Noticeably, all members of this group contributed to this positive trend which continued into the post-crisis years.

The complexity of VC trade implies that more than one partner countries are involved. In addition to the source country, which is the origin of the value added, an immediate production partner and the ultimate production partner, i.e. the last link in the production chain, can be identified plus the destination country where the value added is absorbed. By identifying the production partners that are involved in VC trade as value added from the source is shipped to other countries, processed and further re-exported, such VC trade can be separated in regional value chain (RVC) trade and global value chain (GVC) trade. The former includes all VC trade which involves only partners from within the region of the source country. The approach consists of defining the EU as the 'European region', so that European RVCs include VC trade where only EU Member States act as producers. In contrast, all GVC trade is VC trade involving also third countries as production partners. This way of defining the regional scope of value chains is arguably more precise than existing approaches in the literature, but also relatively restrictive, and challenges to some extent the stylised fact that cross-border production cooperation is predominantly regional in scope. According to this definition the split between RVC trade and GVC trade for the EU-28 is about half-half. The shift between RVC trade and GVC trade in the period 2000 to 2014 was modest, moving slightly towards more GVC trade so that European value chains indeed became more global but only slightly more so, with the share of GVC trade in total VC trade increasing from 49.4% to 51.1% when all industries in the economy are considered (numbers are similar for manufacturing).

One of the most striking results in the context of RVCs and GVCs is the extent to which demand is shaping the organisation of production. In models of offshoring, the extent of production relocation and hence cross-border production sharing is typically determined by the trade-off between the coordination costs of offshoring and the advantages resulting from the wage differential. The empirical data, however, suggest that the demand patterns are strongly influencing the decisions where to locate production. Qualitatively this result is not surprising but quantitatively it is. Splitting VC trade not only into RVCs and GVCs (determined by producers) but also by type of final demand, distinguishing between extra-EU and intra-EU demand (determined by the country of absorption), reveals that the EU's RVC trade serving intra-EU demand accounts for 33% of total EU VC trade compared to only 16% destined for extra-EU markets. For GVC trade exactly the opposite is true: More than 40% of total VC trade is GVC trade serving extra-EU demand while less than 10% of GVC trade involves value added destined for EU markets. In short, RVCs are predominantly producing for the EU market while GVCs are predominantly producing for third countries. Setting the focus on the RVC trade part, which can also be labelled 'Factory Europe', and looking at production linkages between Member States shows the expected picture: Germany emerges as the central hub which is the key production partner for basically all other Member States. Furthermore, the cross-tables of production linkages within Factory Europe reveal that the other large Member States, France, the United Kingdom and Italy, are key production partners of other EU Member States. The most prominent feature in this context is that for Germany, apart from the larger Member States, also the members of the CE Manufacturing Core are key production partners, which underlines once more the tight production integration within this country group.

The established patterns regarding production linkages are to a large extent driven by the economic size of Member States. One way to eliminate the influence of country size is to turn to revealed export preference which – applied to VC trade – indicates the intensity of joint production with a specific partner relative to how much the world average produces with that partner. The revealed export preferences RXP document a strong tendency of Member States to engage in joint production with other EU Member States, highlighting the role of geographic proximity. The exceptions here are Greece, which is actually less involved in RVC trade than the average country, and Ireland, which has also only a small positive RXP index. But distance is not the whole story as the example of Switzerland clearly shows. Located amidst EU Member States, its RXP index is strongly positive but still much lower than that of all its neighbouring countries such as Austria, Germany, France and Italy. This suggests that the Single Market, in addition to geographic proximity, facilitates cross-border production sharing, possibly due to lower non-tariff barriers within the Single Market.

Putting European RVC trade in perspective by comparing it with 'Factory North America' (comprising the United States, Canada and Mexico) and 'Factory Asia' (comprising Japan, Korea, China, Indonesia and Taiwan) shows that in absolute terms 'Factory Europe' is by far the largest of the three regional factories. In fact, with a size of EUR 463 billion it is about five times larger than Factory North America. For comparison, the EU's total VC trade is only about twice as large as that of NAFTA members. Again, this comparison is biased in the sense that the numbers strongly reflect the size of the respective trading bloc and also the number of members. To remedy this issue, the regional introversion index (RII), which is equal to the RXP index applied to trade within a region, is used. This metric establishes a clear ranking, which has Factory North America at the top with an RII of more than 0.70 when considering the entire economy, followed by Factory Europe with an index hovering around 0.6 over time and finally Factory Asia where the RII dropped significantly from about 0.5 to below 0.4 between 2000 and 2014. This constellation lends itself to the interpretation that, while being large and globally important, the EU is not a closed bloc by international standards.

While this close investigation of international value chain trade has established rather clear results regarding recent developments, the relative importance of RVC trade and GVC trade as well as the role of demand in this, the implications of VC trade for structural change and competitiveness are much harder to assess. The question here is to what extent VC trade is indeed qualitatively different from overall trade, which can be answered by looking at the economic impact of the VC trade *intensity*, i.e. the ratio of VC trade over VAX. In this context structural change is measured by changes in the value added share of manufacturing in total GDP, while labour productivity and world market shares in value added exports serve as measures of competitiveness. The key insight is that there seem to be little extra effects from VC trade *in addition* to the effects of overall trade. Clearly, VC trade is conducive to labour productivity growth in Member States, but so is value added trade (i.e. overall trade). Hence, there are no additional productivity gains to be expected from VC trade *relative* to trade in general. With regards to structural change, there is one interesting results which points to the fact that higher VC trade intensity is not fostering the manufacturing sector across Member States in general. However, there is a positive effect of VC trade intensity for the members of the CE Manufacturing Core which seems to stem from the GVC part of VC trade. Arguably, there is also a slight positive impact of VC trade suggested for the same country group on world market shares of VAX, but this effect is not robust. The main insight from these outcomes is probably that the expectations towards international value chains, both regional and global, should be scaled down given the wide-spread view that integration in international VCs necessarily facilitates structural upgrading and guarantees a stronger presence in global export markets. Certainly, this may be the case and the CE Manufacture Core demonstrates that there are examples where VC integration makes a difference, but it should not be seen as an automatism. Rather the implications of VC trade and the ‘additionality’ of VC trade in comparison to trade in particular general are country and context specific.

1. Introduction

This study focuses on value chain trade of EU Member States and the EU as a whole. One of the key elements to be addressed is the more recent, i.e. post-crisis, development in the international organisation of production. This sheds light on the question whether value chain trade (VC trade) has peaked (Veenendaal et al., 2015) in the aftermaths of the 'Great Trade Collapse' or even before. The analysis is based on the latest update of the World Input-Output Database (Timmer et al., 2016). The trends of the past 15 years are investigated at the global level but also separately for the EU and individual Member States (or groups thereof).

The analysis of value chain trade, understood as trade that involves internationally organised production processes, requires a proper definition and, given the plethora of measures for value chain trade proposed in the literature, also requires making a choice (Section 2). The analysis in this study relies strongly on a forward production integration measure which is referred to as re-exported domestic value added (*DVAre*) and used synonymous with the term value chain trade. General trends in value chain trade are depicted for the EU as a whole, its main competitors and for individual EU Member States (Section 3).

A specific challenge in the context of value chain trade is the definition of the regional scope of the value chain involved for which a plausible method is suggested to identify regional and global value chains (despite the awareness of the technical limitations in this respect). Essentially, international value chains are split into trade involving only regional production partners and which consequently constitute regional value chains (RVCs) on the one hand and global value chains (GVCs) on the other hand which involve also extra-regional partner countries. Hence, in contrast to the bulk of the literature the term GVC in the context of this study denotes only a subset of international value chains. RVCs and GVCs together constitute international value chains. The importance of distinguishing between RVCs and GVCs becomes evident against the background of observation such as the one in Baldwin and Lopez-Gonzalez (2013) who argue that GVC trade is a misnomer for '21st century trade' (Baldwin, 2011) given that the international organisation of production is predominantly regional in scope. Consequently, the developments of RVC trade compared to GVC trade of the EU over time are traced with a focus on the post-crisis period (Section 4). While the EU and its individual Member States, respectively, are centre stage in this analysis, some comparisons with other regions are made in this section as well, in particular with respect to RVC trade in other trading blocs such as NAFTA and the main trading nations in the South East Asian region, notably Japan, China and Korea.

Turning to the implications of value chain trade, a section (Section 5) of this study explores the relationship between countries' involvement in value chains and the implied value chain trade, on the one hand, and international competitiveness and structural change, on the other hand. Regarding competitiveness, two different concepts are considered: the first one, which in line with the firm-level literature associates competitiveness with productivity, whereas in the second concept competitiveness is interpreted as success in international markets, which allows making use of world market shares as an appropriate measure.[1] The analysis of structural change emphasises the impact of value chain trade on the value added share of manufacturing. The implicit assumption in this analysis is that manufacturing, due to its particular characteristics, is of central importance for the economy such that an increase in the manufacturing share is considered as 'positive structural change'. The econometric models used in both the competitiveness and the structural change analysis are applied to the entire sample of countries available in the World Input-Output Database (WIOD, 2016 release). Additionally, individual effects for the EU or sub-groups of Member States, notably the Central European (CE) Manufacturing Core, are identified.

The final section (Section 6) addresses the issue of the decline in the trade-to-GDP elasticity since the Great Recession (cf. Freund, 2009; Constantinescu et al., 2015). The updated WIOD comprises five post-crisis years (2010-2014) which allows tackling this question with both gross and value added based measures of trade in a gravity framework. This extends available analysis by analysing both reporter and partner specific elasticities as well as distinguishing between intra- and extra-EU trade flows as a proxy for differences between RVCs and GVCs.

1 The analysis does not make use of the admittedly broader and more comprehensive concepts of competitiveness such as the one suggested in Aiginger et al. (2013) where competitiveness is defined as the *'ability of a country (region, location) to deliver the beyond-GDP goals for its citizens today and tomorrow'*(p. 13). The reason is that such a broad holistic concept, which is closer to the notion of welfare than the common understanding of competitiveness, lacks precision and, above all, it is difficult to make it operational.

2. Defining value chain trade

2.1. RELATION TO THE EXISTING LITERATURE

Following the growing importance of international value chains and the geographically-dispersed organisation of production as a real world phenomenon, empirical measures and indicators for this type of trade have mushroomed. The first generation statistics for measuring offshoring (Feenstra, 2016) relied on the share of imported intermediate inputs in costs (Feenstra and Hanson, 1999). These were soon supplemented with second generation statistics which are derived from inter-country input-output (IO) tables; most of the recent research on international value chains and offshoring employs such inter-country IO-based measures. The reason is that the information contained in inter-country IO tables is more suitable for analysing international production linkages (Feenstra, 2016). Thanks to various research endeavours, several inter-country IO datasets have become available in recent years. This study builds on one of the most recent initiatives in this area, which is the comprehensive update of the WIOD, Release 2016 (Timmer et al., 2016). The WIOD update includes an enlarged country sample (covering also Croatia, Norway and Switzerland)[2] and a larger number of industries (from previously 35 to 56) based on the NACE Rev. 2 industry classification and according to the SNA2008/ESA2010 methodology. Importantly, the WIOD Release 2016 provides international input-output tables for the years 2000-2014, thus encompassing the crisis years and a sufficient number of post-crisis years.

There are numerous second generation statistics measuring trade flows that are part of cross-country production sharing. One of the first of these measures was the foreign value added in exports (*FVAiE*) (see Koopman et al., 2014). This indicator belongs to the so-called 'backward' production integration measures because it singles out foreign value added embodied in a country's export vector. By definition, the foreign value added that forms part of a country's exports must have previously been exported too. Hence, starting from a country's gross exports, the *FVAiE* measure allows tracing backwards the origin of the foreign value added contained therein. The backward production integration measure is interesting because it reflects the extent to which countries have managed to link into international production networks.

An issue surrounding measures of backward production integration, however, is that they can lead to misleading interpretations. Usually, a rising *FVAiE is* considered as being a positive development. However, a high *FVAiE* implies that the domestic value added content of exports is relatively lower. Since countries have an interest in capturing a large domestic value added share, especially in innovative, high-productivity industries, a lower *FVAiE* would actually be preferable. For this reason the interpretation of the development of *FVAiE* is ambiguous.[3]

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2 For the full list of countries see Appendix.

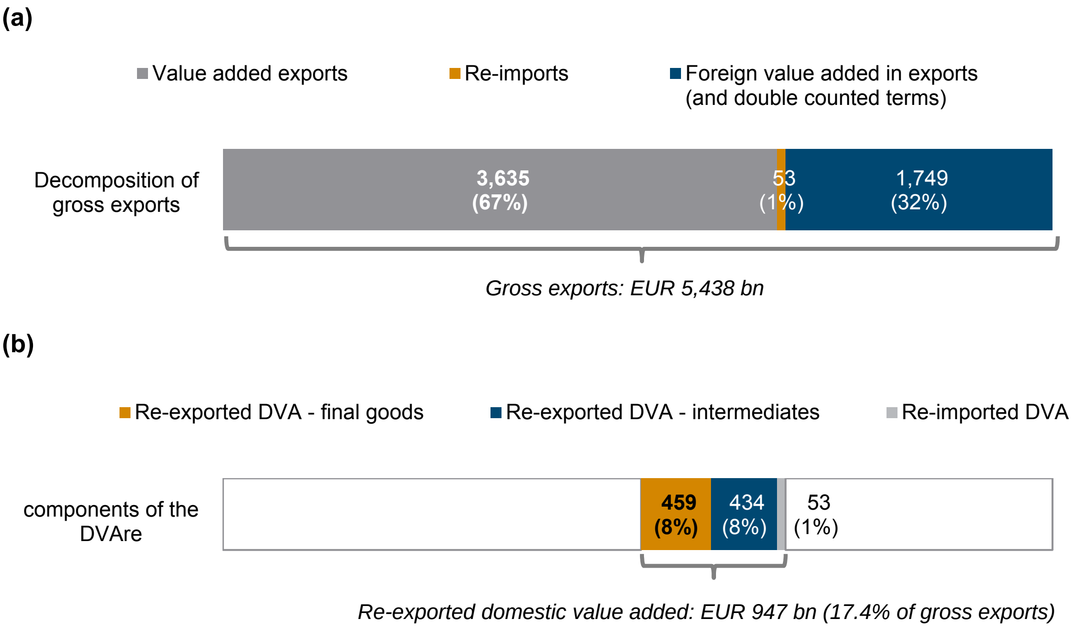
3 The ambiguity problem in interpreting the *FVAiE* (or any other backward measure) stems from the fact that it is unknown whether a growing *FVAiE* reflects (i) a situation where domestic content is replaced by foreign content (e.g. due to offshoring) or (ii) a situation where new additional exports are stimulated by activities of foreign firms, for example due to inward FDI, where the newly created export capacity also contains a high share of foreign value added.

Due to the ambiguity problem of backward production indicators, this study relies on a forward production integration measure: the re-exported domestic value added, or *DVAre* for short. Measures of forward production integration comprise exclusively domestic value added. This makes the interpretation easier as a high *DVAre* can generally be considered to be positive as it indicates that countries capture a growing share of value chain-related trade. The *DVAre* indicator comprises all value added of a country that is exported and crosses borders at least twice. Wang et al. (2016) also use this criterion to define 'deep international production sharing', which is synonymous with value chain trade (VC trade). The *DVAre* measure is similar to the vertical specialisation (VS1) measure initially suggested by Hummels et al. (2001) and defined mathematically by Koopman et al. (2012) but it avoids the double counting included in the VS1 measure (see Koopman et al., 2012; Wang et al., 2013).

2.2. RE-EXPORTED DOMESTIC VALUE ADDED AS A MEASURE OF INTERNATIONAL VALUE CHAIN TRADE: AN ILLUSTRATION

The *DVAre*, defined as the domestic value added embodied in a country's intermediate exports that cross borders at least twice, includes three components. These components are the value added of reporting country *r* embodied in its exports of intermediates to a partner country – the immediate production partner (*ipp)* – which are then (i) finally shipped to the destination country (*dest)* – either directly or via another production partner – the ultimate production partner (*upp*) – in the form of final goods; (ii) finally shipped to the destination country *(dest)* in the form of intermediates); or (iii) shipped back to the country of origin *r* in the form of either intermediates or final goods[4].

Figure 1 / Decomposition of EU-28 gross exports, 2014



Note: Values refer to economy-wide value added exports of EU Member States to all countries in the world. Including intra-EU trade. Converted into euro using Eurostat's EUR/USD exchange rate (yearly averages).
Source: WIOD Release 2016. wiiw calculations.

4 See Appendix for details.

The *DVAre* part of gross export flows is illustrated in Figure 1 using EU-28 exports in 2014 as an example. In this illustrative example, the EUR 5.4 trillion of gross exports can be decomposed into the well-known value added exports (VAX), which comprise the value added originating in EU Member States that is absorbed by other countries (Johnson and Noguera, 2012), exported value added that returns home, i.e. re-imports, and foreign value added that is embodied in domestic exports (panel a). The criterion of two border-crossings for defining VC trade implies that not the entire 3.6 trillion of VAX enter the *DVAre* indicator. Rather only two parts thereof, namely EUR 459 billion worth of re-exported domestic value added that is shipped to the destination country as final goods and the EUR 434 billion worth of re-exported domestic value added that is shipped to the destination country as intermediates, enter the definition of the *DVAre* (panel b). In addition, *DVAre* includes also the re-imports, that is value added that has been exported by the country of origin and is re-exported back to that country after some processing. All three components taken together make up the *DVAre* which in 2014 amounted to EUR 947 billion, accounting for about 17.4% of gross exports.

2.3. OTHER METHODOLOGICAL ASPECTS: NORMALISATION AND THE DEFINITION OF INDUSTRIES

While the *DVAre* measure as the main indicator for VC trade emerges from the decomposition of gross exports, it is preferable to use the VAX (or alternatively value added) for normalisations. The reason is that the *DVAre* is a value added-based measure. Hence, it is methodologically consistent to relate it to another value added-based indicator. The normalisations are needed especially in cross-country comparisons but are equally employed in the econometric work.

With regard to the industry split-up, there are several possibilities to disaggregate value chain trade due to the large number of dimensions emerging in complex trade transactions. The most basic distinction is between defining the industry (or sector) as the *industry of origin* of the value added that is exported or, alternatively, as the *industry of export*, i.e. the industry which records the gross export flow. In the latter case, since there are multiple export transactions involved in VC trade flows, the question arises which of these flows defines the export sector. However, throughout the entire study, all analyses of sector respectively industry level follow the sector of origin approach. More specifically, the industry aggregates that are considered, apart from the entire economy comprising all industries, are the manufacturing sector[5], advanced manufacturing industries and an extended manufacturing sector which includes manufacturing plus business services[6].

2.4. DEFINING EUROPEAN VALUE CHAINS

A second crucial dimension for the analysis of international VC trade is the definition of regional value chains (RVCs) as opposed to global value chains (GVCs). For the purpose of this analysis RVC trade refers to the situation where two or more EU Member States are jointly involved in producing for some other country or for themselves (i.e. the source country of value added and the production partner(s) are EU Member States)[7]. In contrast, GVC trade refers to inter-regional production sharing, i.e. the situation

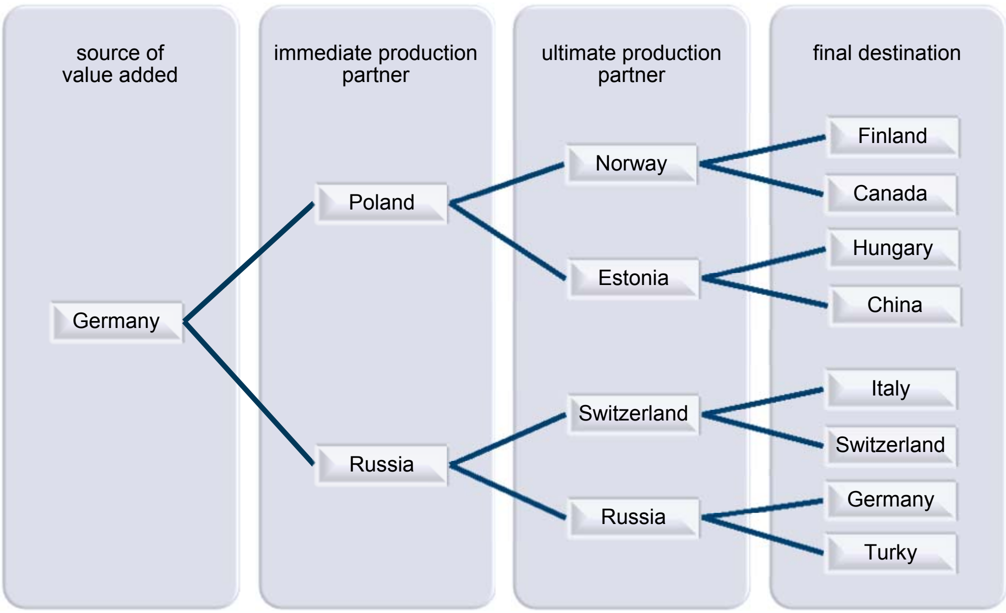
5 As defined in NACE Rev. 2 by NACE section C.

6 For the definition of these sectors see Appendix.

7 That is, the term ‘European’ refers here to the EU-28. A ‘European’ value chain is defined to comprise EU-28 countries only because it facilitates the comparison wither other trading blocs such as NAFTA.

where at least one EU Member State and at least one third country is involved in internationally organised production. This approach is illustrated in Figure 2 taking Germany's involvement in value chain trade as an example.

Figure 2 / Illustrative example: Germany's involvement in RVCs and GVCs



Source: wiiw's own representation.

In tracing the value added from some source country (or reporting country) to its final destination, the methodology allows the identification of four 'functions' that a country can take within an international value chain. It can be *(i)* the source of the value added that is traced (taking a forward perspective) - which in the example is always Germany; *(ii)* the immediate production partner; *(iii)* the country where the last production step takes place, i.e. the ultimate production partner; and *(iv)* the final destination country which is the country absorbing the value added. Obviously, a particular country can take several functions in a trade transaction. For example, in the case of a re-export of domestic value added in the form of intermediate goods, the destination country is also the ultimate production partner. In Figure 2 the sequence Germany – Russia – Switzerland – Switzerland would be such a transaction. For the definition of European value chains in the context of VC trade, it is necessary to identify which countries take which functions in the value chains. This approach allows tracing the value chains in more detail than, for example, in the approach by Baldwin and Lopez-Gonzalez (2013) who – while using input-output information – only focus on the bilateral relationships between source country and the neighbouring country in the supply chain. What this means is that in their approach, for example, value added originating from Germany that is re-exported by Poland (as in the upper part of Figure 2) would be part of the EU value chain. This is a legitimate approach but neglects the possibility that this German value added passes through additional production partners before arriving at the destination country. The sequence Germany – Poland – Norway – Finland could serve as an illustrative example for this. In this case, it is not fully adequate to consider the German value added that is re-exported by Poland as an element of a pure EU value chain. Instead, it is more accurate to define trade constellations as part of the European value chain trade[8] whenever the functions (i)-(iii), i.e. source country, immediate production partner and ultimate production partner, which all act as 'producers', are occupied by EU Member States. Among the illustrated production relations in Figure 2 only one satisfies this criterion which is the triplet Germany – Poland – Estonia. In this example, the joint production between Germany (as source country), Poland (as immediate production partner) and Estonia (as ultimate production partner) satisfies either Hungarian or Chinese final demand. In general, the *DVAre* indicator, in addition to allowing for a distinction between RVCs and GVCs, can also identify whether an international VC produces to satisfy intra-EU demand (with Hungary as the destination in this example) or for satisfying extra-EU demand (with China as the destination in this example). Note that in both cases, the last trade flow is an export of final goods out of Estonia involving by then German, Polish and Estonian value added.

The figure shows several other trade relations involving re-exported German value added which by the above criterion all constitute GVCs because they involve EU Member States as well as third countries as producers.

With regards to the distinction between re-exports in the form of intermediates on the one hand and re-exports in the form of final goods on the other hand, only the sequence Germany – Russia – Switzerland – Switzerland represents a re-export of intermediates. All other cases involve the re-export of a final good in the last export transaction which is discernible from the fact that the ultimate production partner is different from the destination country. With a view to the number of border crossings, in the sequence Germany – Russia – Switzerland – Switzerland as well as in the sequences Germany – Russia – Russia – Germany and Germany – Russia – Russia – Turkey there are two border crossings while in the other cases there are three border crossings. Two more comments on the illustrated trade flows may be warranted. Firstly, the second to last trade relation shows Germany as the destination. This is a German re-import of value added via Russia (involving two border crossings). The last trade flow, involving Germany and Russia as producers – the latter having the function of both immediate and ultimate production partner – is a common constellation which is characterised by two border crossings[9].

8 Remember that European value chains are those involving EU Member States only as production partners.

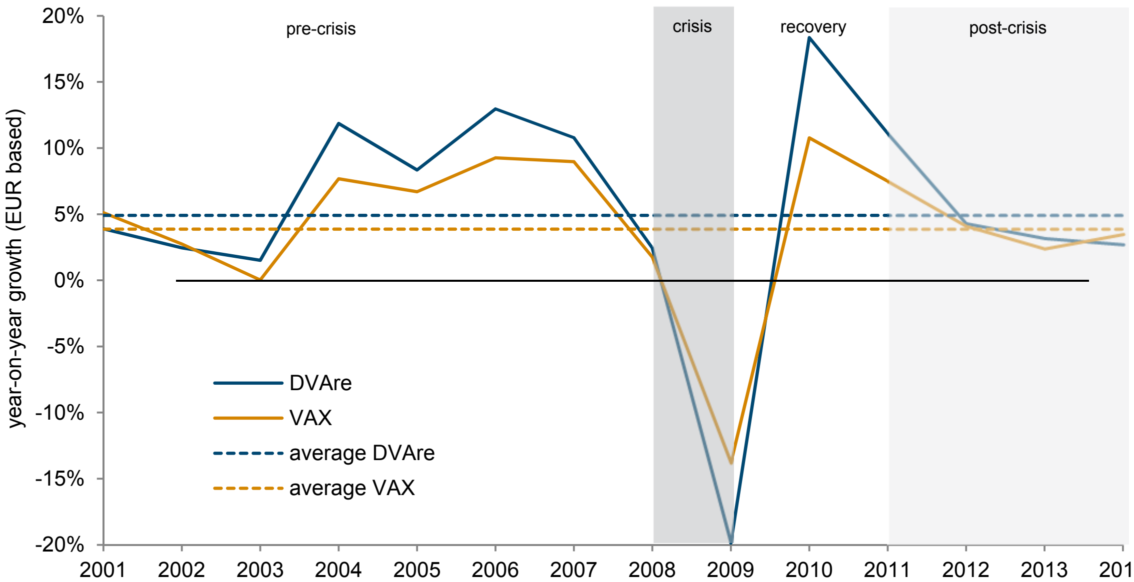
9 Strictly speaking there are *at least* two border crossings in the former cases and *at least* three border crossings in the latter cases. This is because the methodology for identifying the countries fulfilling the various functions in these trade relations makes use of the so-called global Leontief Inverse, which reflects both direct and indirect production linkages. Therefore, in all the examples shown in Figure 2, there may be other countries involved between the immediate and the ultimate production partner.

3. Global and European trends in value chain trade: the post-crisis era

3.1. RECENT TRENDS IN VALUE CHAIN TRADE: HAS VALUE CHAIN TRADE PEAKED?

Despite widespread fears of incipient protectionism and the dismantling of international value chains (e.g. Baldwin and Evenett, 2009; Evenett, 2013), which in some instances are accompanied by political attempts to trigger such a development by initiating *'reshoring'* initiatives[10], little is known about the post-crisis trends in value chain trade. Here evidence on exports and VC-related exports is presented for the EU-28. For the purpose of this analysis the 15-year time span under consideration is divided into 4 sub-periods: a pre-crisis period (2000-2008), the crisis years (2008-2009), the recovery phase (2009-2011) and the post-crisis period (2011-2014).

Figure 3 / VC trade and value added exports growth of the EU-28, total economy, 2000-2014



Note: Values refer to economy-wide exports of EU Member States to all countries in the world. Including intra-EU trade. Converted into euro using Eurostat's EUR/USD exchange rates (yearly averages).
Source: WIOD Release 2016. wiiw calculations.

Figure 3 tracks the development of VC trade growth rates – proxied by re-exported value added originating in the EU-28 (*DVAre*) introduced in the previous section – over the period 2000-2014. The figure refers to value added generated across all industries of the economy. As can be seen, the year-on-year growth rate of VC trade follows closely the movements of value added export (VAX) growth. An

[10] See, for example, the 'UK Reshore' initiative; https://www.gov.uk/government/news/new-government-support-to-encourage-manufacturing-production-back-to-the-uk

interesting aspect in this co-movement is that for almost all years, the growth rate of VC-related exports (*DVAre*) was slightly higher than that of the VAX. Likewise, during the great trade decline of 2009 the drop in VC trade[11] was more pronounced than that of the VAX. In recent years, however, the two lines have narrowed and in 2014, the growth rate of VAX was even slightly above that of VC trade. This convergence of growth rates for the different types of export flows occurred in the context of comparatively modest export growth that characterises the post-crises period (2011-2014) which amounted to 2.8% for VC trade and 3.3% for VAX in 2014 (all in nominal terms denoted in euro)[12]. These numbers are considerably lower than the corresponding longer-term (2000-2014) average growth rates which amounted to 4.9% and 3.9% respectively.

These trends are further analysed in Table 1, which shows the compound annualised growth rate for the four sub-periods, the pre-crisis years (2000-2008), the crisis (2008-2009), the recovery phase (2009-2011) and the post-crisis years (2011-2014), as well as the average rate over the entire time span (2000-2014).

In addition to the economy-wide flows of exported value added (panel a) – for VC trade (comprising both RVC trade and GVC trade), VAX and gross exports respectively – the table also shows the corresponding numbers for exported value added that is restricted to value added originating from the manufacturing sector (panel b), advanced manufacturing industries (panel c) and an expanded manufacturing sector which includes business services (panel d).

A first observation regarding Table 1 is that in the 'post-crisis' period[13], the current growth rate of exports (all types) is still below the corresponding longer-term average[14]. Focusing on panel (a), which shows the economy-wide developments, the longer-term growth rates of trade flows ranged from 3.9% for the VAX to 4.9% for the *DVAre*. Looking at the corresponding averages for the 'post-crisis' years suggests indeed that exports lost dynamism in the period after the Great Trade Collapse.

Most importantly, the table reveals an interesting pattern across the three types of exports: over the longer term, gross exports grew faster than value added exports which is evidence of a growing share of foreign value added in exports and therefore more complex trade transactions. In fact, this growing discrepancy between gross trade flows and trade flows on a value added basis (i.e. the VAX) is the main reason for the growing interest in analyses of trade on a value added basis. In the case of economy-wide exports, gross exports grew by 4.6% on average compared to 3.9% recorded for VAX. This confirms the proclaimed trend towards more complex trade transactions which is also in line with the fact that VC trade (*DVAre*) has been growing faster than VAX so that VC trade accounted for an increasing share of value added exports. This pattern is also found when considering the other aggregates (i.e. manufacturing, advanced manufacturing and manufacturing plus business services).

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11 Throughout the analysis the terms *DVAre* and VC trade are used interchangeably.

12 The choice of the currency – US dollar, which is the currency of the WIOD, or euro, which is the most relevant currency at least for the euro area members – has a big impact on the resulting growth rates of the trade flows. The described pattern of the DVAre relative to the VAX, however, remains unchanged.

13 The term 'post-crisis' should indicate that the Great Recession had more or less ended by 2011 though the eurozone crisis was still ongoing.

14 In terms of US dollar, the growth rates of exports in the post-crisis period appears to be even more depressed, amounting to only approximately one third of the long-term average. This difference is due to the almost 5% devaluation of the euro vis-à-vis the US dollar between 2011 and 2014.

Table 1 / Annualised compound growth rates of EU-28 exports by period, 2000-2014

(a) economy	***long-term***	**pre-crisis**	**crisis**	**recovery**	**post-crisis**
	2000-2014	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	*4.91%*	6.69%	-19.87%	14.68%	3.38%
VAX	*3.87%*	5.23%	-13.81%	9.13%	3.32%
gross exports	*4.58%*	6.12%	-16.34%	13.19%	2.77%

(b) manufacturing	***2000-2014***	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	*3.65%*	5.08%	-22.51%	15.50%	2.43%
VAX	*2.80%*	4.03%	-17.37%	10.24%	2.25%
gross exports	*3.76%*	5.76%	-20.82%	14.35%	1.16%

(c) advanced manufacturing	***2000-2014***	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	*3.60%*	4.85%	-21.16%	15.09%	2.46%
VAX	*3.04%*	4.33%	-18.13%	11.49%	2.09%
gross exports	*3.36%*	5.14%	-20.07%	12.82%	1.47%

(d) manufacturing and business services	***2000-2014***	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	*4.48%*	5.95%	-21.55%	15.03%	3.88%
VAX	*3.49%*	4.72%	-16.34%	9.90%	3.41%
gross exports	*4.22%*	5.97%	-19.21%	14.07%	2.19%

Note: Values refer to exports of EU Member States to all countries in the world. Including intra-EU trade. Converted into euro using Eurostat's EUR/USD exchange rates (yearly averages).
Source: WIOD Release 2016. wiiw calculations.

This pattern, however, has changed in the post-crisis period. During these years, the average growth rate of VAX exceeded that of gross exports which would signal that the domestic value added component in exports is gaining in importance. At the same time the growth of VC trade (3.4%) could keep pace with (or even slightly exceed) the VAX growth. The implication is that, while domestic value added content in exports may have risen slightly, this was not to the detriment of VC trade. Hence, the fact that the share of VAX in gross exports was increasing marginally between 2011 and 2014 does not per se imply that international value chains are threatened.[15] Of course, given that the overall dynamic of international trade seems to be comparatively low in the post-crisis period, it cannot be ruled out that the identified pattern across trade flows is influenced by demand factors. At the same time it is not obvious, why the three types of export flows in Table 1 should be affected differently by lower demand if the attitude of firms towards offshoring and international production sharing were to remain unchanged.

Importantly, the relative growth of the different types of trade flows for the global economy is not identical to the patterns observed for the EU-28. In particular, when considering VC trade of all reporters (EU Member States and third countries), it seems that VC trade is indeed on the retreat, growing at a slower pace than VAX (Table 2).[16] The latter also grow faster than gross exports. In this respect the global pattern and the pattern found for the EU-28 are identical.

[15] The difference between VAX in per cent of GDP and gross exports in per cent of GDP is used, for example, in the analysis by Veenendal et al. (2015).

[16] Except for the case of 'advanced manufacturing' industries where the two are growing at par.

Table 2 / Annualised compound growth rates of global exports by period, 2000-2014

(a) economy	***long-term***	**pre-crisis**	**crisis**	**recovery**	**post-crisis**
	2000-2014	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	5.73%	6.87%	-20.85%	22.88%	2.40%
VAX	4.80%	5.13%	-13.41%	16.60%	3.17%
gross exports	5.14%	5.69%	-16.12%	18.86%	3.01%
(b) manufacturing					
	2000-2014	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	4.13%	4.23%	-19.33%	20.62%	2.55%
VAX	3.73%	3.45%	-13.09%	15.44%	3.21%
gross exports	4.63%	4.84%	-17.10%	19.36%	3.00%
(c) advanced manufacturing					
	2000-2014	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	3.70%	3.11%	-16.99%	19.26%	3.29%
VAX	3.53%	3.03%	-13.21%	15.73%	3.28%
gross exports	3.95%	3.84%	-15.76%	17.53%	3.04%
(d) manufacturing and business services					
	2000-2014	**2000-2008**	**2008-2009**	**2009-2011**	**2011-2014**
VC trade	4.67%	4.92%	-18.27%	19.40%	3.47%
VAX	4.07%	3.92%	-12.44%	14.60%	3.76%
gross exports	4.84%	5.03%	-15.93%	18.63%	3.43%

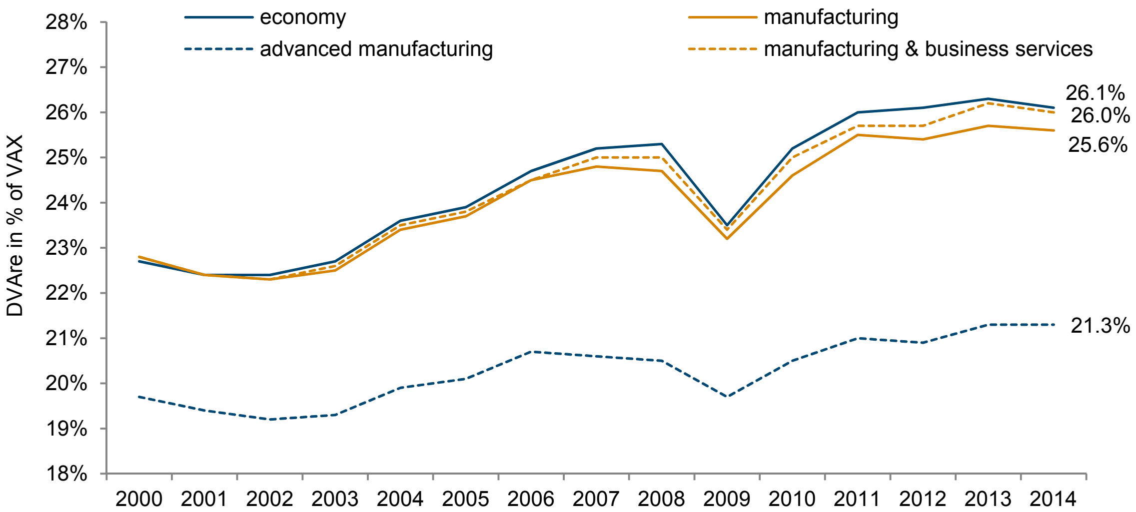
Note: Values refer to global exports to all countries in the world. Including intra-EU trade. Converted into euro using Eurostat's EUR/USD exchange rates (yearly averages).
Source: WIOD Release 2016. wiiw calculations.

Table 1 and Table 2 only provide first insights into trade developments in the post-crisis era for the three-year period from 2011 to 2014. Nevertheless, the pattern for the EU-28 – if it were to persist – could be read as a reassuring sign. This is because it could signal a situation where EU-28 economies capture a growing share of value added embodied in exports (VAX are growing faster than gross exports), without dismantling VC trade which keeps pace with the growth of VAX. In contrast, at the global level the move towards growing domestic value added in exports coincides with a relative decline of VC trade (VC trade growth is lagging behind that of VAX). This is worth mentioning because the EU was definitely not the most dynamic economic area in the post-crisis phase and could still combine growing domestic value added with continued growth of VC trade. This may be related to the benefits of the Single Market which can also act as a reinsurance mechanism against potential protectionist tendencies. This is not to say that the EU-28 is immune to economic nationalism; nevertheless, the idea that the Single Market provides an institutional anchor to safeguard also internationally-organised production is fully consistent with the patterns of the post-crisis trade data in Table 1.

Most of the assertions made are confirmed when switching from *levels* of VC trade and growth rates thereof to a relative measure. More precisely, the ratio between VC trade (*DVAre*) and value added exports shall serve as the intensity measure for an economy's involvement in VC trade. This is a statistic that indicates the extent to which domestic value added that is exported takes the form of VC trade.

The picture that emerges for this intensity measure in the case of the EU-28, still considering international VC trade (i.e. RVC trade and GVC trade combined) is one of a clear upward trend in the longer term that was interrupted in 2009 due to the Great Recession of 2008/2009 (Figure 4). After this crisis-related set-back, VC trade intensity recovered quickly, reaching the pre-crisis ratio already by 2011.

Figure 4 / Intensity of VC trade in the EU-28, 2000-2014



Note: Values refer to exports of EU Member States to all countries in the world. Including intra-EU trade. Converted into euro using Eurostat's EUR/USD exchange rates (yearly averages).
Source: WIOD Release 2016. wiiw calculations.

A potentially worrisome aspect of the development is the levelling off in the VC trade to VAX ratio in the post-crisis period which would signal a peak in VC trade. Constantinescu et al. (2015) argue that the expansion of global value chains lost momentum already during the 2000s. Using the re-exported domestic value added (*DVAre*) as a proxy for VC trade leads to a different conclusion (at least for the EU-28) because the share of *DVAre* in VAX for the EU-28 was clearly increasing during that period. The peak in VC trade discernible in Figure 4 could not yet be identified by Veenendaal et al. (2015), who use a similar VC trade indicator as in this analysis, to explore whether the expansion of international production sharing has stopped.[17] The reason is that their analysis is limited to 2011. It is well possible that the levelling off of VC trade since 2011 is a short-term phenomenon, but for the time being it seems that the long-term trend towards increasingly deeper international production sharing (Wang et al., 2016) has come to a halt.

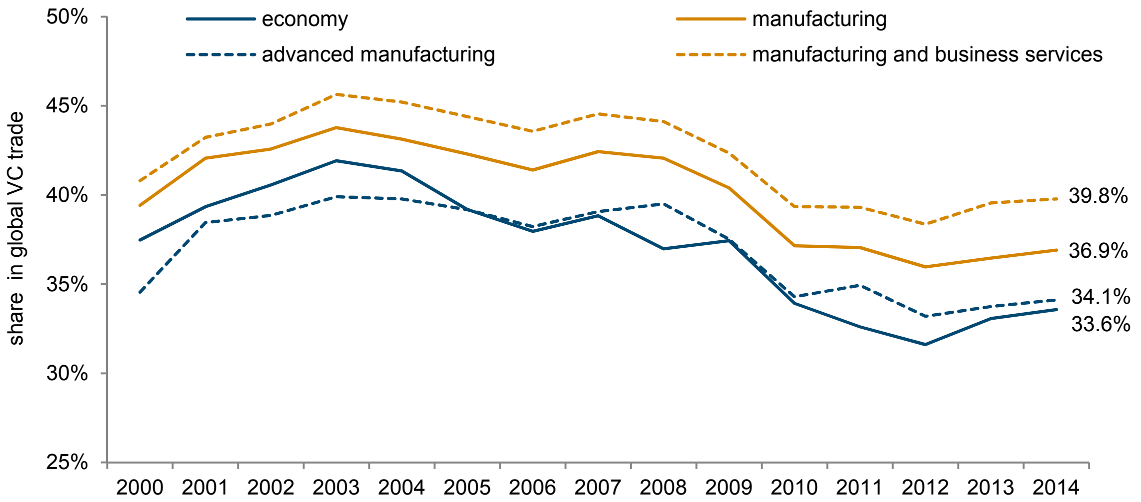
3.2. THE COMPETITIVE POSITION OF THE EU IN VC TRADE

The previous subsection has focused on the development of the EU-28's VC trade. In this subsection, these trends are compared to those in main competitor countries, including the United States, Japan, Korea, China, Brazil, Russia, India and Switzerland, by investigating the world market shares in exports.

[17] See Figure 9 in Veenendaal et al. (2015), p. 175.

As with international trade in general, the EU-28 is also a key player in VC trade. This is illustrated in Figure 5, which shows Member States' combined world market share in VC trade. In 2014 the EU's world market share[18] exceeded one third of global *DVAre* for value added originating from all industries in the economy; where these figures include intra-EU trade. If only value added originating from manufacturing and business services industries is considered, the share reaches even 40%. These figures are similar to the EU's world market share in gross exports, which stood at 35% in 2014.[19] Nonetheless, it should be noted that the world market share – both overall trade and VC trade – had been falling over the past 15 years – in the case of economy-wide VC trade – by roughly 4 percentage points.

Figure 5 / World market share in VC trade of the EU-28, 2000-2014



Note: Based on global re-exported domestic value added including intra-EU trade.
Source: WIOD Release 2016. wiiw calculations.

However, this decline in world market shares reflects primarily the stronger integration of China and other emerging economies into the world economy. This is discernible from Figure 6, which shows the world market shares of the EU along with other major trading economies in 2000 and 2014 as well as the changes in these shares. When considering the economy-wide value added (panel a), the 4 percentage points decline in world market shares of VC trade is relatively modest compared to the losses experienced by the United States, which amounted to 7 percentage points. Also Japan's drop in world market share of VC trade exceeds that of the EU-28 despite the fact that the initial share in the year 2000 was much lower. Gains in world market shares were recorded by the BRIC countries (Brazil, Russia, India and China), with the lion's share of that gain, 6.5 percentage points, being captured by China. Qualitatively, the same picture emerges when only value added originating from manufacturing and services industries are considered (panel b). One aspect worth mentioning is that in this case the

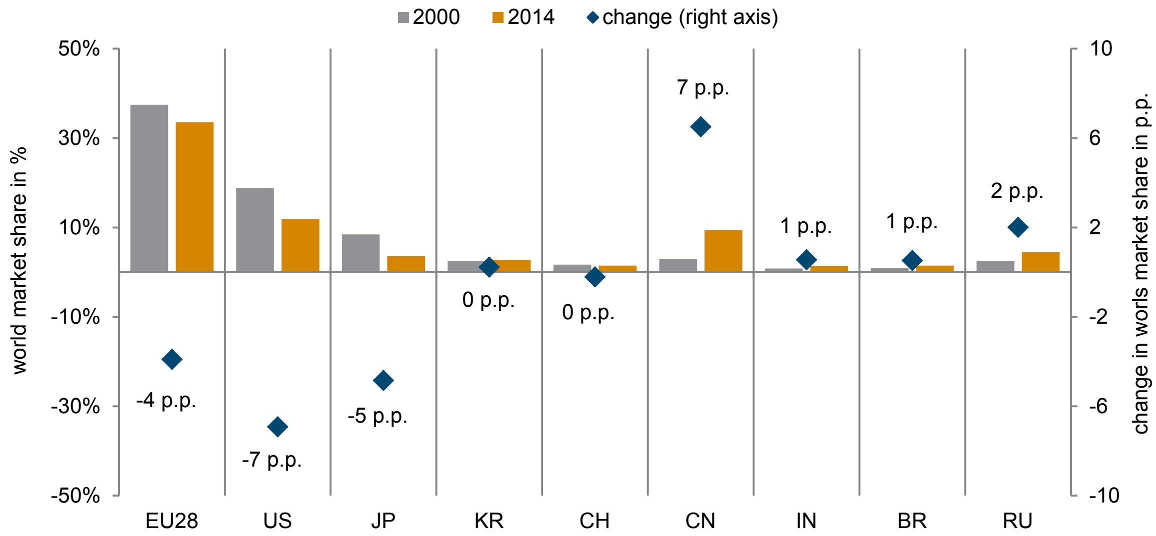
18 The EU's share here refers to value added re-exported by EU Member States, i.e. where Member States take the role of the reporter.

19 For value added originating from manufacturing industries the share amounted to 36.9%, which is close to the 38.5% reported by WTO (WTO, 2005, Table II.27) for the EU-28 world market share in manufacturing exports. The difference is partially due to the 'industry of origin' approach applied in this task which excludes services value added embodied in exports by manufacturing industries but includes manufacturing value added exported via services (and other) industries.

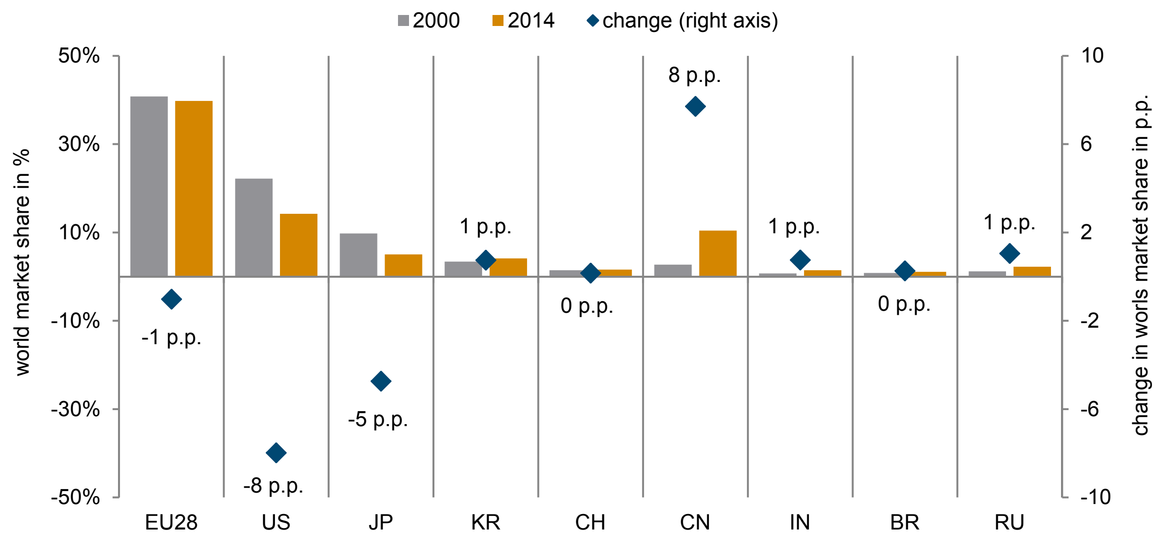
loss in the EU's world market share is more modest, while this is not true for the United States and Japan.

Figure 6 / World market share in VC trade, country comparisons, 2000-2014

(a) total economy



(b) manufacturing and business services



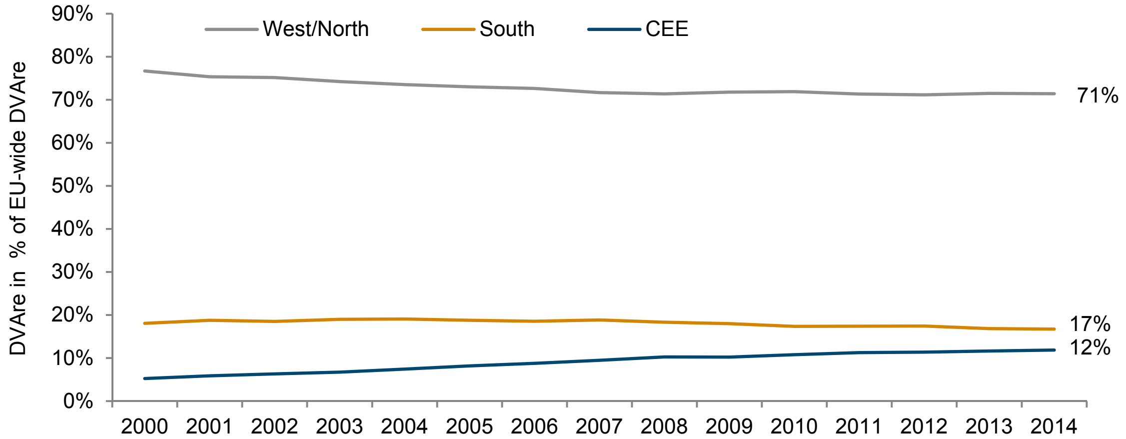
Note: Based on global re-exported domestic value added including intra-EU trade.
Source: WIOD Release 2016. wiiw calculations.

Comparing the dynamics in world market shares in VC trade with that of gross trade shows that the losses in the industrialised countries and the gains in emerging economies are larger in the former than in the latter. This constellation points to the fact that the globalisation process in large emerging markets is partly driven by the FDI activities of multinational enterprises (MNEs). In the case of vertical FDI, these activities are creating additional trade flows which tend to be complex, leading to an expansion of VC trade flows in the target countries of FDI.

3.3. DEVELOPMENTS OF THE EU'S VC TRADE BY MEMBER STATES

One reason why the EU-28 as a whole suffered a comparatively modest loss in world market shares in VC trade – relative to the United States and Japan – is the performance of the Central and Eastern European (CEE) Member States (Figure 7). Between 2000 and 2014 these countries could more than double their share in EU-wide VC exports from about 5% to more 11.6%. This is worth noting, as the VC trade indicator comprises uniquely domestic values. In the context of international value chains the CEE Member States are typically perceived as offshore destinations with the resulting trade flows from the offshoring activities being dominated by value added originating from the investor countries.[20] The trend for the CEE Member States shows, however, that these countries were also successful in participating with their domestic value added in such transactions.

Figure 7 / Development of shares in EU-wide VC trade, total economy, 2000-2014



Note: Based on EU-wide re-exported domestic value added including intra-EU trade.
Source: WIOD Release 2016. wiiw calculations.

Figure 7 also reveals a stagnating share in EU-wide VC trade for the Southern cohesion countries. This picture is in contrast with the evidence for earlier periods for which a clear catching-up process of the Southern cohesion countries is detectable. At the latest by 2005, this catch-up process came to a halt. Since 2008 even a slight decline of this share is observable which is certainly linked to the severe economic difficulties that the members of the Southern EU periphery are facing. Given the rather flat development of the share of Southern EU Member States in EU-wide VC trade, increases in this share for the CEE Member States mainly constitute a reshuffling of market shares from the Western and Northern EU Member States, whose share declined by about 5 percentage points between 2000 and 2014.

20 This is still true, and the CEE Member States have particularly high ratios of foreign value added in exports (see, for example, Stehrer and Stöllinger, 2015).

The relative success of the EU-28 as an economic block in defending global market shares in VC trade masks a high degree of heterogeneity in performances across Member States. The country groupings in Figure 7 are too broad to reveal the existing differences. Therefore Table 3 shows the developments of the involvement in the EU-wide VC trade for more disaggregated country groups, including some regroupings of countries. First of all, the four Visegrád countries (Czech Republic, Hungary, Poland and Slovakia) are grouped together with Germany and Austria, which together build the Central European (CE) Manufacturing Core. This CE Manufacturing Core is attracting a growing share of the manufacturing activities undertaken in the EU (see Stehrer and Stöllinger, 2015; Stöllinger, 2016). These agglomeration tendencies left their marks in the share in VC trade of the core countries which rose by almost 5.4 percentage points from 2000 to reach 35% in 2014. This longer-term trend is positive for each member of the CE Manufacturing Core, with Poland contributing most strongly to the overall gain. Arguably, this Manufacturing Core is expanding eastwards to embrace also Romania and arguably Bulgaria. Both these countries could increase their share in EU wide VC trade considerably.

These developments are in stark contrast to the trends in Italy, France and the United Kingdom. All three countries are characterised by relatively strong de-industrialisation tendencies which is why they are grouped into the 'Western De-industrialiser' although there are of course other Member States where similar trends are observable (e.g. the Scandinavian countries). This structural trend is bound to affect the export performance negatively, which is also true for VC trade as shown in Table 3. Taken together, the three Western De-industrialisers lost almost 7.5 percentage points of their EU-wide share in VC exports. In 2014 their share amounted to 31.5%, which is some 3 percentage points lower than that of the CE Manufacturing Core. Back in 2000 the situation was very different, with the combined share in VC trade of the 'Western de-industrialisers' surpassing that of the CE Manufacturing Core countries by a comfortable margin.

By and large these trends seem to have continued after the crisis of 2008/2009 though the dynamics have eased to some extent. An exception is the Southern EU, where for some of the countries, in particular Greece and Spain, the decline in the share of EU-wide VC trade has rather accelerated.

The reason for this rather pronounced agglomeration tendencies are manifold and include spillover effects and economies of scale coupled with geographic proximity and skill complementarities between the members of the CE Manufacturing Core. This is not to say that these factors are not present in the case of other EU Member States, but given the evidence in Table 3, Italy, France and the United Kingdom could exploit these opportunities to a much lesser degree. These shifts in the competitive positions in VC exports which are to the advantage of the (enlarged) CE Manufacturing Core and to the detriment of Italy, France and the United Kingdom as well as the Southern EU periphery constitute one of the greatest challenges that the EU will have to tackle in one way or the other.

Theoretically, the divergence in the shares of EU-wide VC trade may have been caused by different outward strategies of firms in, say, Germany and France, with the latter favouring to serve foreign markets predominantly by FDI instead of using the trade channel. Given the strong positive relationship between VC trade and FDI, however, this is very unlikely to explain the developments in Table 3 (see also Box 1).

Table 3 / Development of shares in EU-wide VC trade, total economy, 2000-2014

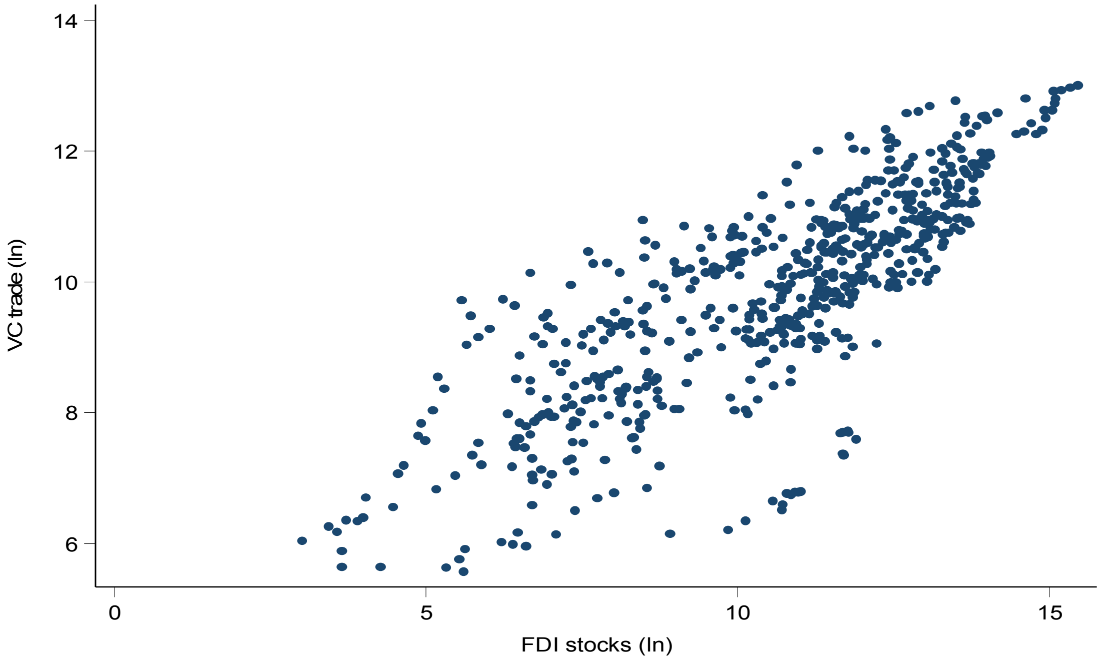
	2000	2005	2010	2011	2012	2013	2014	change 2011-2014	change 2000-2014
CE Manufacturing Core	**29.47%**	**32.15%**	**34.45%**	**34.55%**	**34.44%**	**34.28%**	**34.88%**	**0.33 p.p.**	**5.41 p.p.**
AT	*2.97%*	*3.09%*	*3.31%*	*3.28%*	*3.25%*	*3.19%*	*3.20%*	*-0.08 p.p.*	*0.23 p.p.*
DE	*22.54%*	*22.91%*	*23.28%*	*23.17%*	*22.96%*	*22.73%*	*23.18%*	*0.01 p.p.*	*0.64 p.p.*
CZ	*1.09%*	*1.74%*	*2.19%*	*2.26%*	*2.21%*	*2.19%*	*2.20%*	*-0.06 p.p.*	*1.11 p.p.*
HU	*0.71%*	*1.13%*	*1.20%*	*1.23%*	*1.25%*	*1.30%*	*1.29%*	*0.06 p.p.*	*0.58 p.p.*
PL	*1.87%*	*2.65%*	*3.59%*	*3.68%*	*3.80%*	*3.90%*	*4.04%*	*0.36 p.p.*	*2.17 p.p.*
SK	*0.29%*	*0.63%*	*0.89%*	*0.93%*	*0.98%*	*0.98%*	*0.97%*	*0.04 p.p.*	*0.68 p.p.*
Enlarged CEMC	**0.50%**	**0.82%**	**1.40%**	**1.57%**	**1.53%**	**1.67%**	**1.74%**	**0.17 p.p.**	**1.24 p.p.**
BG	*0.06%*	*0.17%*	*0.35%*	*0.43%*	*0.41%*	*0.42%*	*0.43%*	*0.00 p.p.*	*0.37 p.p.*
RO	*0.44%*	*0.65%*	*1.05%*	*1.14%*	*1.11%*	*1.25%*	*1.32%*	*0.18 p.p.*	*0.88 p.p.*
Western de-industrialisers	**38.98%**	**35.53%**	**32.18%**	**32.15%**	**32.34%**	**31.00%**	**31.50%**	**-0.65 p.p.**	**-7.48 p.p.**
FR	*12.81%*	*11.24%*	*11.26%*	*11.16%*	*10.97%*	*11.01%*	*10.72%*	*-0.44 p.p.*	*-2.09 p.p.*
GB	*16.39%*	*14.73%*	*12.67%*	*12.66%*	*12.82%*	*11.73%*	*12.63%*	*-0.03 p.p.*	*-3.76 p.p.*
IT	*9.78%*	*9.56%*	*8.26%*	*8.33%*	*8.55%*	*8.26%*	*8.15%*	*-0.18 p.p.*	*-1.63 p.p.*
Southern EU	**6.61%**	**7.35%**	**7.32%**	**7.27%**	**7.09%**	**6.84%**	**6.78%**	**-0.49 p.p.**	**0.17 p.p.**
CY	*0.09%*	*0.11%*	*0.19%*	*0.18%*	*0.20%*	*0.18%*	*0.17%*	*-0.01 p.p.*	*0.08 p.p.*
ES	*4.78%*	*5.07%*	*4.79%*	*4.82%*	*4.74%*	*4.51%*	*4.49%*	*-0.33 p.p.*	*-0.29 p.p.*
GR	*0.74%*	*0.95%*	*0.94%*	*0.86%*	*0.76%*	*0.74%*	*0.73%*	*-0.13 p.p.*	*-0.01 p.p.*
HR	*0.26%*	*0.33%*	*0.36%*	*0.36%*	*0.35%*	*0.34%*	*0.33%*	*-0.03 p.p.*	*0.07 p.p.*
MT	*0.06%*	*0.06%*	*0.07%*	*0.07%*	*0.08%*	*0.07%*	*0.07%*	*0.00 p.p.*	*0.01 p.p.*
PT	*0.69%*	*0.83%*	*0.96%*	*0.97%*	*0.97%*	*1.00%*	*0.99%*	*0.02 p.p.*	*0.30 p.p.*
EU Other	**24.44%**	**24.13%**	**24.65%**	**24.45%**	**24.61%**	**26.22%**	**25.09%**	**0.64 p.p.**	**0.65 p.p.**
BE	*5.16%*	*5.05%*	*4.97%*	*4.90%*	*4.90%*	*4.69%*	*4.54%*	*-0.36 p.p.*	*-0.62 p.p.*
LU	*0.64%*	*0.60%*	*0.80%*	*0.79%*	*0.75%*	*0.78%*	*0.81%*	*0.02 p.p.*	*0.17 p.p.*
NL	*8.06%*	*7.84%*	*7.91%*	*7.82%*	*8.01%*	*10.00%*	*9.36%*	*1.54 p.p.*	*1.30 p.p.*
DK	*2.02%*	*2.15%*	*2.01%*	*1.93%*	*1.96%*	*1.90%*	*1.82%*	*-0.11 p.p.*	*-0.20 p.p.*
FI	*1.92%*	*1.72%*	*1.60%*	*1.55%*	*1.54%*	*1.55%*	*1.46%*	*-0.09 p.p.*	*-0.46 p.p.*
SE	*4.16%*	*3.67%*	*4.09%*	*4.06%*	*4.01%*	*3.91%*	*3.68%*	*-0.38 p.p.*	*-0.48 p.p.*
EE	*0.08%*	*0.15%*	*0.20%*	*0.22%*	*0.23%*	*0.23%*	*0.23%*	*0.01 p.p.*	*0.15 p.p.*
LT	*0.12%*	*0.24%*	*0.33%*	*0.38%*	*0.42%*	*0.41%*	*0.40%*	*0.02 p.p.*	*0.28 p.p.*
LV	*0.09%*	*0.14%*	*0.20%*	*0.22%*	*0.23%*	*0.23%*	*0.22%*	*0.00 p.p.*	*0.13 p.p.*
IE	*1.95%*	*2.21%*	*2.13%*	*2.18%*	*2.15%*	*2.08%*	*2.11%*	*-0.07 p.p.*	*0.16 p.p.*
SI	*0.24%*	*0.36%*	*0.41%*	*0.42%*	*0.42%*	*0.42%*	*0.44%*	*0.02 p.p.*	*0.20 p.p.*

Note: Based on EU-wide re-exported domestic value added including intra-EU trade.
Source: WIOD Release 2016. wiiw calculations.

BOX 1 / INTEGRATION IN INTERNATIONAL VALUE CHAINS AND FDI

There is a long and established literature on the relationship between trade and FDI. One strand of the literature characterises exports and FDI as alternative modes of entries (Caves, 1985) and highlights the concentration-proximity trade-off in firms' choices of how to serve foreign markets (Brainard, 1997). The empirical results on whether trade and FDI are substitutes or complements is mixed, with a large number of (firm-level) papers arguing that actually both relationships can be found in the data.

Figure 8 / Relationship between FDI stocks and VC trade, global sample



Source: WIOD Release 2016, wiiw-calculations.

In the context of VC trade, the presumption is that there is a complementary relationship as also described in Baldwin's characterisation of 21st century trade as incorporating a trade-investment-services nexus (Baldwin, 2011). Indeed, papers investigating the determinants of GVC participation typically find that FDI is strongly correlated with countries' involvement in value chains (e.g. Stehrer and Stöllinger, 2015). This finding is fully in line with the growing importance of intra-firm trade which is also well documented. In a recent contribution, Buelens and Tirpák (2017) undertook an in-depth investigation of the relationship between FDI and VC trade using very similar measures for VC trade as in this report. They find that both inward and outward FDI plays a key role in shaping economies' participation in international production network. In order to illustrate the strong relationship, Figure 8 displays the correlation between the measure for VC trade, the *DVAre*, and FDI outward stocks for the global sample.

Table 4 shows the tight relationship between VC trade and FDI by way of a bivariate regression. Already the pooled model (specification B1) has a very high explanatory power and the coefficient of the FDI outward stock variable is highly statistically significant.

Demonstrating the tight relationship between VC trade and FDI reinforces the result shown in Table 3 on the diverging market shares especially between Germany and the three other large EU economies, France, the UK and Italy, which were grouped together as the 'Western de-industrialisers'. The result is reinforced in so far as the diverging paths in export market shares is explained by different choices of firms regarding the entry mode to foreign markets which would require a substitutional relationship between VC trade and FDI activities.

Table 4 / Labour productivity and trade, total economy, EU-28

Aggregate:	**Total economy**		
Sample:	**World (43 WIOD countries)**		
Dependent Variable:	**ln VC trade**		
	(B.1)	(B.2)	(B.3)
ln FDI outward stock	0.5070***	0.4925***	0.1805***
	(0.0135)	(0.0132)	(0.0574)
constant	4.4701***	4.3652***	7.2985***
	(0.1565)	(0.1850)	(0.5614)
time fixed effects	no	yes	yes
year fixed effects	no	no	yes
Observations	631	631	631
R-squared	0.6531	0.6643	0.9900
R-sq. dj.	0.653	0.656	0.989
F-test	1413	101.1	167.6

The positive relationship also remains when time fixed effects (specification B.2) and country fixed effects (specification B.3) are included. Hence, while the analyses in this subsection largely neglect FDI activities by multinationals firms, they are implicitly reflected in the VC trade indicator.

4. Regional value chains and global value chains: Is 'Factory Europe' going global?

4.1. A PORTRAIT OF FACTORY EUROPE

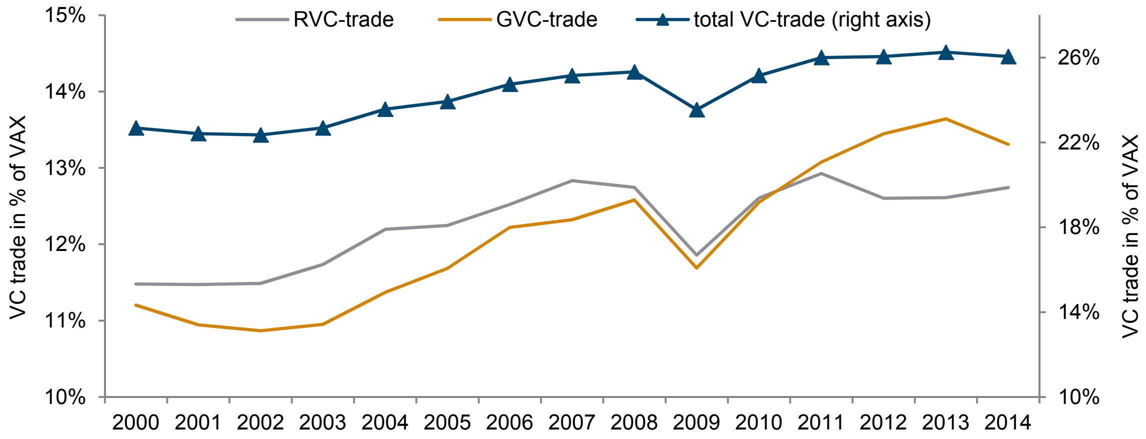
This section is dedicated to the analysis of the geographic dimension of internationally-organised production. The main distinction in this respect is between regional value chains (RVCs), which refer to cross-border production between countries of the same economic region, and global value chains (GVCs), which relate to joint production involving countries from different economic blocs. Following the concept introduced in Section 2, an RVC and the implied RVC trade flows are those where all 'producer' functions are occupied by countries from within the region. As a first step, the situation of the 'Factory Europe' is investigated which refers to the EU-internal production. Put differently, the EU-28 is defined as the region, making up the 'Factory Europe' for the purpose of this analysis.

According to Baldwin and Lopez-Gonzalez (2013) the use of the term 'global value chains' to denote internationally fragmented production in general is misleading because, according to their analysis, value chain trade is predominantly regional in scope. This result is derived using several indicators such as 'imports to produce', which is a backward production indication measure. The point stressed here is the fact that contributions in the literature that distinguish regional from global VC trade focus on bilateral relationships. The concept followed here traces the value chain from the reporting economy up until the final destinations and takes into account the 'regional affiliation' of all production partners involved.

Figure 9 starts with the split-up of the intensity of the EU's VC trade – shown in Figure 4 of the previous section – into the regional part (RVC trade associated with 'Factory Europe') and the global part (GVC trade).

Note that the scale, especially the left-hand scale, is rather small, so that the changes in the RVC intensity and the GVC intensity are actually rather modest. The RVC intensity, for example, rose by only 1.2 percentage points from 11.5% in 2000 to 12.7% in 2014. The increase of the GVC intensity component was somewhat stronger. Still, the intensities, and in particular their relative importance, seem to be moving slowly. Nevertheless, the trends of the two components are interesting. Focusing on the more recent years, one finds, for example, that RVCs and GVCs have been affected in a similar way and to a similar extent by the trade collapse of 2009. Also, the immediate recovery was quite synchronised. However, in 2012 a divergence occurred, with the intensity of GVC trade continuing to grow while that of RVC trade was declining slightly. Again, given the limited number of post-crisis years for which such data are available, this is only a snapshot. But if the trend were to continue, it would imply that VC trade involving value added originating in EU Member States becomes more global, even if the changes are not dramatic.

Figure 9 / RVC trade intensity and GVC trade intensity, EU-28, 2000-2014

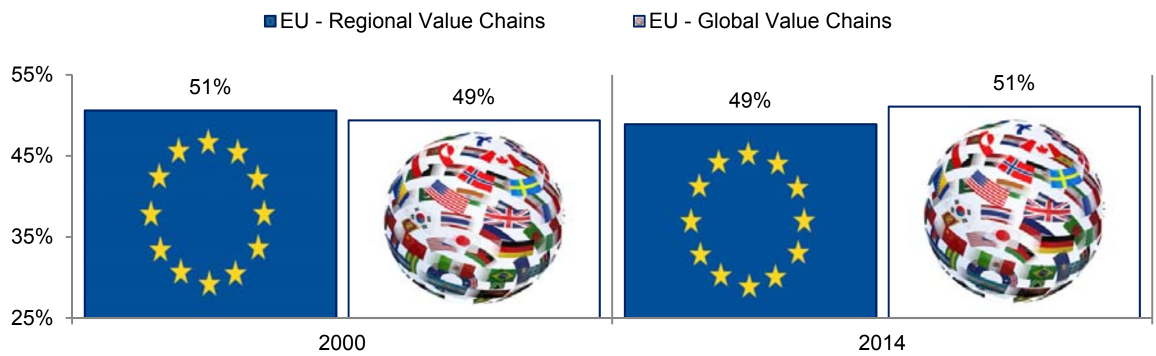


Note: RVC trade intensity = EU-28 DVAre involving EU producers only / total EU-28 VAX. GVC trade intensity = EU-28 DVAre involving EU and non-EU producers/ total EU-28 VAX. Hence RVC trade intensity + GVC trade intensity = VC trade intensity of the EU-28.
Source: WIOD Release 2016. wiiw calculations.

Figure 10 makes this more explicit by showing the relative shares of RVC trade and GVC trade involving EU-28 value added in 2000 and 2014. Again, the dynamics are limited but the trend seems to move towards GVC trade whose share increased from 49.4% to 51.1%.

In addition to this trend it also has to be emphasised that the commonly accepted fact that production fragmentation is predominantly regional needs to be qualified to some extent because almost half of VC trade by EU Member States also involves third countries as producers.

Figure 10 / Relative shares of RVC trade and GVC trade, EU-28, 2000 versus 2014



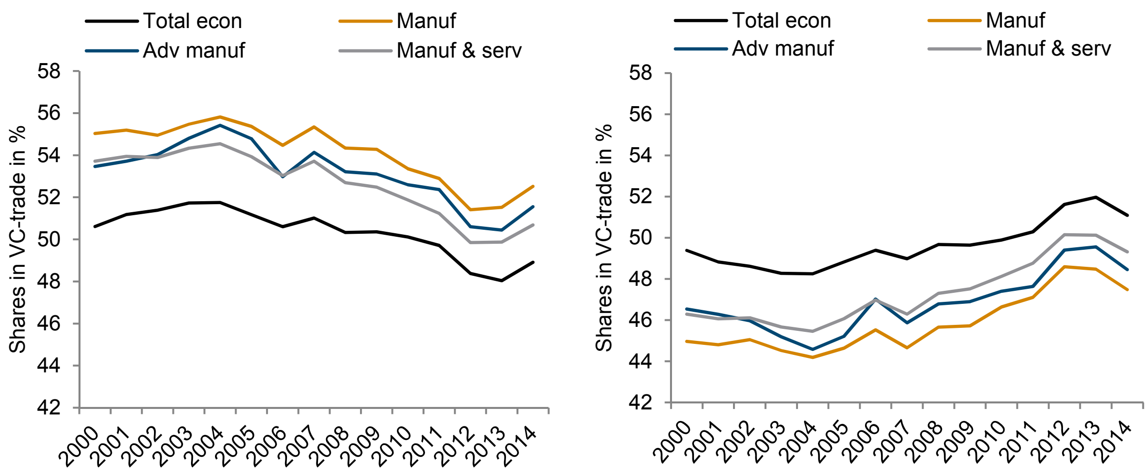
Note: RVC trade = EU-28 DVAre involving EU producers only. GVC trade = EU-28 DVAre involving EU and non-EU producers.
Source: WIOD Release 2016. wiiw calculations.

While Figure 10 shows that GVC trade has become slightly larger than RVC trade for the total economy when comparing the years 2000 and 2014, Figure 11 illustrates the developments of the two VC trade segments over time (2000-2014) for more detailed sectors, i.e. for manufacturing, advanced manufacturing and manufacturing including business services. The key insight is that the trends over time are very similar with only minor differences. In all cases, GVC trade slightly increased during the respective time period too, signalling that there is a tendency of 'Factory Europe' to embrace production cooperation that is global in scope. However, shifts were small in terms of percentage points, ranging from around 2 percentage points for the total economy and advanced manufacturing, to 2.5 percentage points in manufacturing and 3 percentage points in manufacturing and business services. Overall, in 2014, RVC trade still accounted for a slightly larger share than GVC trade in all the three sectors, in contrast to the total economy, where it fell to 48.9%. RVC trade still holds a share of 52.5% in manufacturing, 51.6% in advanced manufacturing and 50.7% in manufacturing and business services.

While these general shifts have occurred when comparing only the years 2000 and 2014, it is worth looking at the period in between. In fact, the share of regional value chain trade first rose between 2000 and 2004 and peaked in this latter year (see Figure 10, left-hand graph). Since then, however, the share fell decisively for eight years (except a small peak in 2007). RVC trade reached a trough in 2012/2013 but slightly recovered in 2014. Figure 10 on the right-hand side provides the mirror picture for global value chain trade shares. Looking at the total economy, global value chain trade in fact became slightly larger as a share in total value chain trade since 2011. For manufacturing and advanced manufacturing, regional value chain trade maintained a larger share than GVC trade throughout the period. For manufacturing and business services, the two shares approached each other and the GVC trade share slightly surpassed the RVC trade share in 2012 and 2013. This supports the observation of Baldwin and Lopez-Gonzalez (2013), who find that supply chain trade is more globalised for services than for goods.

Figure 11 / Evolution of RVC trade and GVC trade shares (total VC trade = 100), EU-28

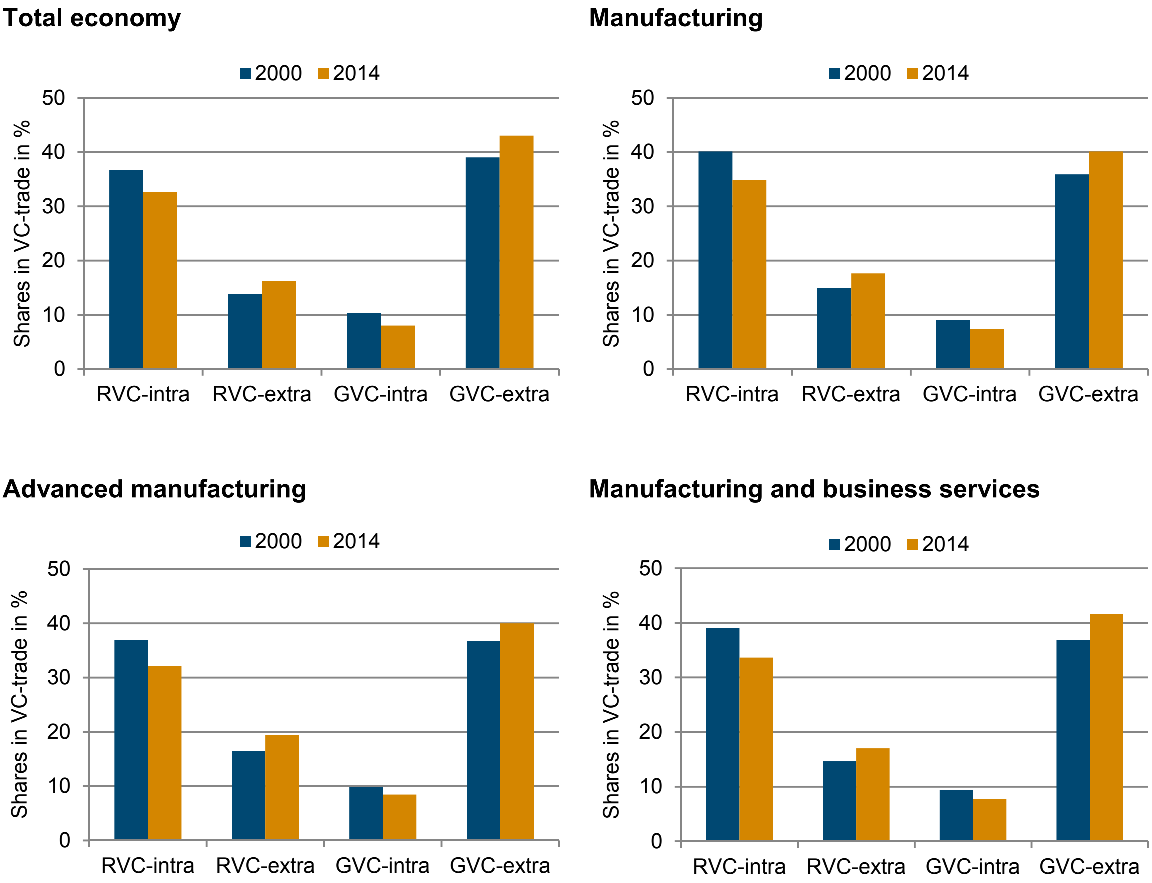
EU-28 Regional Value Chain Trade **EU-28 Global Value Chain Trade**



Note: RVC trade = EU-28 DVAre involving EU producers only. GVC trade = EU-28 DVAre involving EU and non-EU producers.
Source: WIOD Release 2016. wiiw calculations.

Having established the relative development of RVC and GVC trade, the data allow for a further disaggregation of VC trade according to final demand. Both EU RVCs and EU GVCs might either produce for intra-EU demand or for extra-EU demand. It may be expected that RVCs produce more for the Single Market and GVCs more for the global market. The extent to which the geographic scope of production sharing is determined by where the output is sold to, i.e. the dependence on demand, is surprising though. Overall, EU-28 regional value chains indeed mainly produce for servicing intra-EU demand, accounting for about 70% of RVC trade when the total economy is considered. Thus 'Factory Europe' is primarily manufacturing for the Single Market, while the share attributable to global market demand is about one third.[21] In advanced manufacturing, regional value chains are slightly more oriented towards extra-EU demand than the other sectors, shifting to about 40% produced for extra-EU demand and about 60% for intra-EU demand in 2014 but this does not change the main conclusion. Conversely, EU global value chains mainly produce for the global market, absorbing about 80% of GVC trade, while only 20% satisfy EU demand when the total economy is considered.

Figure 12 / RVC and GVC trade by final demand (intra vs extra), EU-28, 2000 and 2014



Note: RVC trade = EU-28 DVAre involving EU producers only. GVC trade = EU-28 DVAre involving EU and non-EU producers.
Source: WIOD Release 2016. wiiw calculations.

In Figure 12 visualises this 'demand dependence' of the organisation of VC trade by exhibiting the above mentioned four shares in per cent of total VC trade for the years 2000 and 2014. The general pattern is that the components serving extra-EU demand increased between 2000 and 2014, while those serving intra-EU demands decreased. The same picture emerges irrespective of whether the total economy or

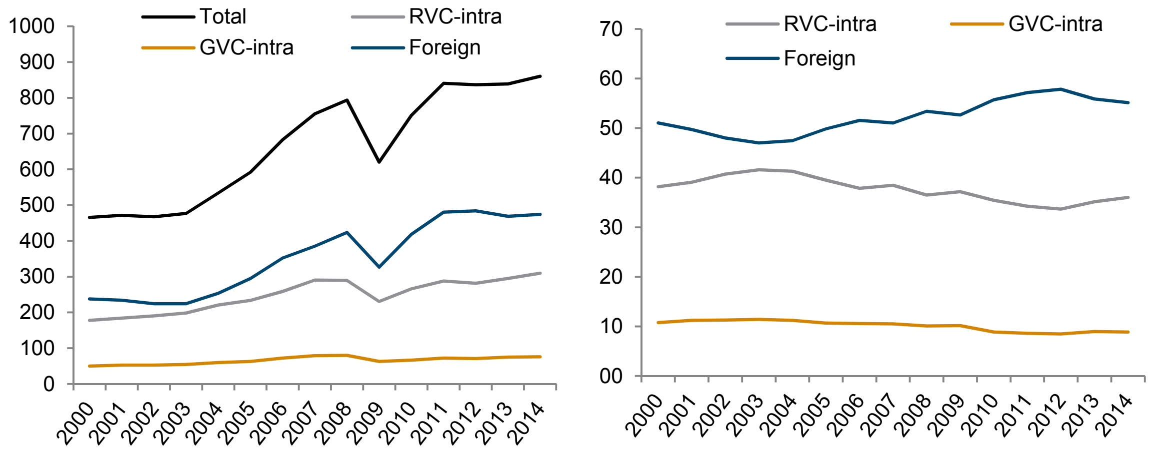
21 However, one has to note that for a part of VC trade, i.e. the re-exported intermediates part, by definition, the RVC cannot produce for the global market as the final production step takes place in the destination country.

any of the three manufacturing aggregates is considered. Thus, larger demand from global markets explains part of the growing share of GVC trade relative to RVC trade for the EU-28. In Figure 12 this can be seen by comparing the RVCs producing for intra-EU and extra-EU demand with each other and likewise for the GVCs.

Figure 13 further explores the composition of VCs in serving EU demand. Hence, in comparison to the above analysis, here the extra-EU demand is disregarded, focusing only on intra-EU demand but VC trade from non-EU Members is also taken into consideration. Therefore three types of VCs are distinguished which are EU RVC trade for intra-EU demand (i.e. 'Factory Europe'), EU-GVC trade for intra-EU demand and foreign VC trade serving EU demand. Note that the latter includes value added originating from third countries but producing for the EU market (potentially including EU production partners). These shares were approximately 38%, 11% and 51% respectively in 2000 and reached 36%, 9% and 55% respectively in 2014. Thus, Factory Europe has slightly lost shares for satisfying EU demand, while foreign VC trade has gained in shares and is now servicing 55% of EU demand. While this general trend reflects again the catching-up of emerging economies as documented in the previous section, it is also interesting to note that in the post-crisis period, the trend was reversed and the share of 'Factory Europe' in satisfying EU demand was slightly growing again.

Figure 13 / EU demand serviced by value chain trade by sources, 2000-2014

Total economy, in EUR bn | **Total economy, in % of total EU-demand**



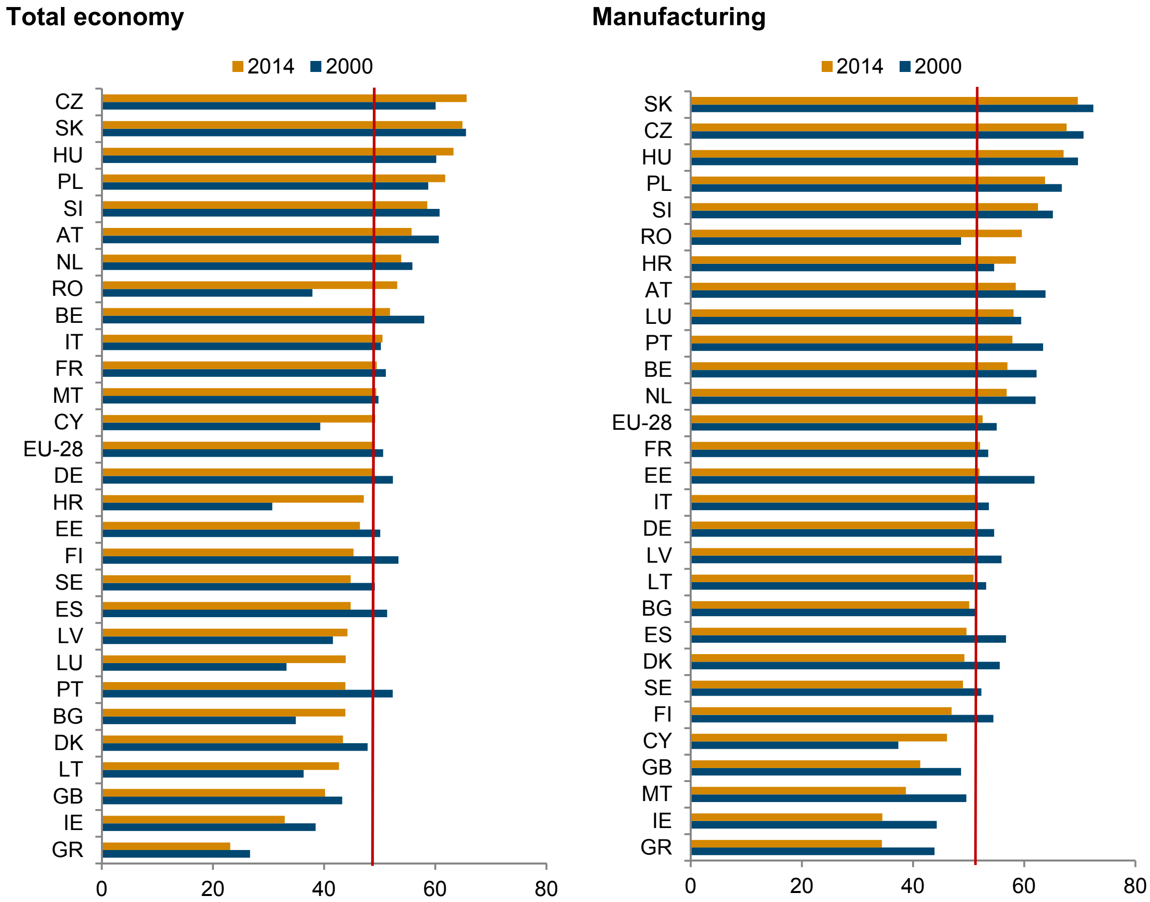
Source: WIOD Release 2016. wiiw calculations.

In a next step, value chain trade at the level of EU Member States is explored, focusing again on the split up into GVC and RVC trade.

Regional value chain trade is most pronounced in the CE Manufacturing Core countries, including the Czech Republic, Slovakia, Hungary, Poland and Austria but also Slovenia (see Figure 14 for total economy and manufacturing, and the Appendix for the other aggregates). In the total economy, the RVC trade share reached with about 66% of total VC trade in 2014 its highest level in the Czech Republic. As for the other sectors, the highest RVC trade share was reached by Slovakia. In these sectors, also Romania and Croatia are found at the top of the list. As such, mainly smaller countries and especially the new Member States are recording higher shares of RVC trade in total VC trade, benefiting from their inclusion in the German-led CE manufacturing supply chains (IMF, 2013). Germany is close to the EU-28 average (weighted and unweighted). Between 2000 and 2014, RVC trade shares in the total economy mostly increased for these countries. However, for the other three sectoral aggregates RVC shares declined for nearly all countries, suggesting an increase in GVC trade shares then. Only for Romania and Croatia did RVC shares rise strongly.

Global value chain trade, conversely, is most pronounced in the case of Greece, Ireland and Great Britain, which typically have stronger trade links with countries outside the EU. Stehrer et al. (2016), for example, have shown that some countries are more outward-oriented (i.e. have larger shares in extra-EU trade) than others. For goods trade these countries typically include the United Kingdom, Greece, Cyprus and Malta, for services trade Cyprus, Finland, Ireland, Sweden and the United Kingdom. As such, also these countries are among those with the largest GVC trade shares and resemble this pattern.

Figure 14 / RVC trade share in % of total VC trade by Member States

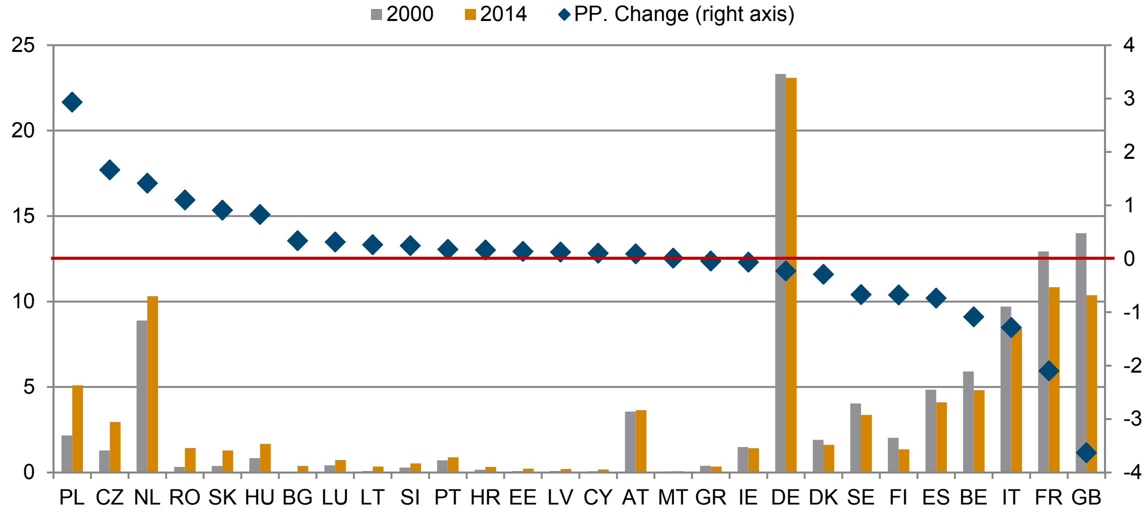


Source: WIOD Release 2016. wiiw calculations.

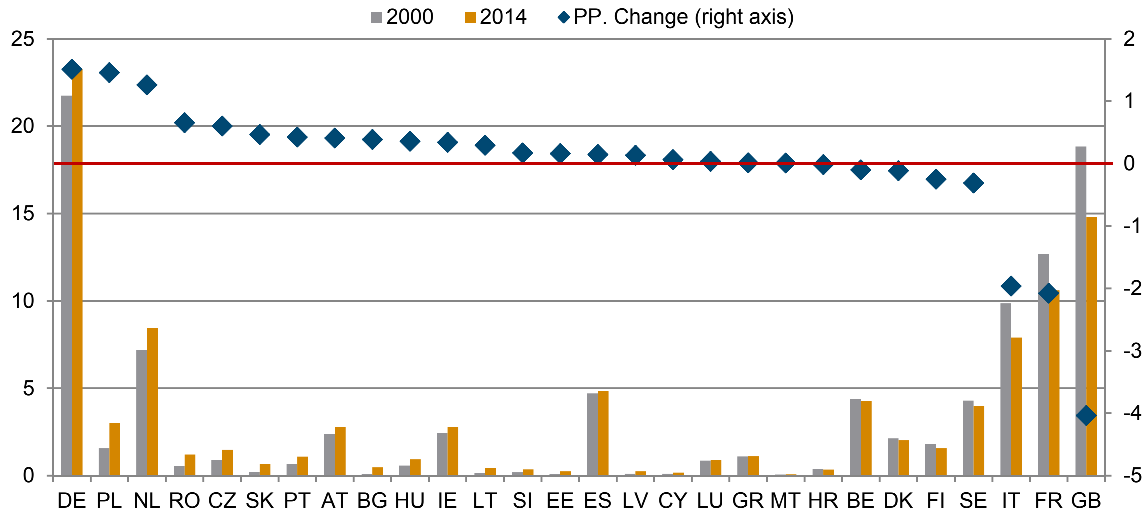
The involvement of Member States in the EU VC trade largely depends on their size. As has been shown already (Section 3.2.), the largest part of VC trade is conducted by the largest members, Germany, the United Kingdom, France and Italy, but also the Netherlands. Smaller players are Belgium, Spain and Poland. Typically again, this reflects their weight in goods and services trade (see Stehrer at al., 2016). Looking now at RVC and GVC trade separately shows again these countries as the main players in regional and global value chain trade. In terms of regional value chain trade, Germany accounts for 23% of total EU RVC trade, France for 11%, the United Kingdom and the Netherlands for 10% each and Italy for 8%. In terms of global value chain trade, Germany again accounts for 23% of total EU GVC trade, the United Kingdom for 15%, France for 11% and the Netherlands and Italy for 8% each.

Figure 15 / Regional and global value chain trade, total economy

(a) Regional value chain trade (EU-28 = 100), shares and p.p. change



(b) Global value chain trade (EU-28 = 100), shares and p.p. change



Source: WIOD Release 2016. wiiw calculations.

Figure 15 depicts EU Member States' shares in regional value chain trade (upper graph) and global value chain trade (lower graph), with countries being ranked according to their change in shares between 2000 and 2014.

Overall, the Central and Eastern European (CEE) Member States are the main gainers both in terms of RVC trade and in GVC trade for the total economy. The Netherlands registered the third largest increase; Austria and Portugal also gained shares. Conversely, countries where shares declined the most were the United Kingdom, France and Italy. Germany shows a differentiated picture: In terms of RVC, Germany's share declined slightly, whereas in GVC trade Germany gained the most. However, Germany's main role becomes evident also in RVCs when looking at sub-aggregates, i.e. manufacturing and advanced manufacturing (see Tables in the Appendix).

Here, in fact, Germany was the country gaining most RVC shares; in manufacturing including business services it was in third place. This is due to the development of the German-Central European supply chain in manufacturing, 'producing goods for exports to the rest of the world' (see IMF, 2013), which evolved during the 2000s. Bilateral trade links between Germany and the Czech Republic, Hungary, Poland and Slovakia expanded rapidly. The CE Manufacturing Core also encompasses Austria (see Stehrer and Stöllinger, 2015; Stöllinger, 2016), and also expands to the East (Romania and Bulgaria), explaining the growing shares for these countries as well.

Table 5 / RVC trade: Bilateral matrix (source country-immediate production partner), total economy, 2014, in % of RVC trade

	Immediate production partner																											
Source	AT	BE	BG	CY	CZ	DE	DK	ES	EE	FI	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SK	SI	SE	Total
AT	0.0	2.4	0.4	0.1	5.8	47.5	0.7	1.9	0.1	0.6	4.3	1.9	0.2	1.4	7.3	0.7	8.4	0.1	0.6	0.1	0.4	2.7	3.5	0.3	1.2	3.2	2.5	1.8	100.0
BE	1.9	0.0	0.2	0.1	2.1	25.1	1.8	2.9	0.1	0.8	15.1	5.3	0.3	0.1	1.4	2.1	5.6	0.3	6.0	0.1	0.2	21.4	2.3	0.6	0.3	0.6	0.2	3.0	100.0
BG	5.9	14.9	0.0	0.3	3.8	17.6	1.3	3.7	0.2	1.6	5.4	2.6	2.9	0.4	4.0	1.4	11.8	0.2	0.6	0.1	0.4	5.2	2.7	0.9	6.2	2.3	2.2	1.4	100.0
CY	1.3	3.6	0.5	0.0	1.7	3.8	12.5	0.2	2.6	0.1	0.7	2.2	2.5	0.1	3.0	1.0	3.2	0.2	2.3	0.3	47.5	3.9	3.2	0.1	0.9	0.5	0.2	1.8	100.0
CZ	7.0	5.5	0.3	0.1	0.0	38.9	1.1	2.6	0.2	0.6	4.2	2.2	0.1	0.3	6.2	0.6	3.6	0.2	0.4	0.1	0.1	2.9	7.1	0.3	0.8	12.2	0.7	1.6	100.0
DE	9.7	6.6	0.3	0.1	8.3	0.0	3.4	5.1	0.3	1.6	11.9	5.7	0.2	0.2	6.6	1.6	8.9	0.2	1.9	0.1	0.1	10.6	7.5	1.0	1.1	3.2	0.7	3.2	100.0
DK	1.3	4.0	0.2	0.0	1.7	24.2	0.0	2.3	0.4	6.7	5.5	7.5	0.2	0.2	6.4	1.9	2.9	0.6	1.1	0.4	0.3	7.0	5.0	0.3	0.3	0.6	0.2	18.7	100.0
ES	1.5	6.3	2.7	0.1	2.1	19.5	1.6	0.0	0.1	0.7	22.0	5.3	0.4	0.1	1.4	1.3	10.8	0.1	0.8	0.1	0.1	6.1	2.7	10.7	0.7	0.8	0.6	1.4	100.0
EE	1.5	3.6	0.3	1.0	0.8	8.9	5.6	2.5	0.0	18.9	1.9	2.6	0.2	0.1	0.9	0.9	1.5	4.8	1.6	9.5	0.7	4.2	3.0	0.3	0.1	0.5	0.2	23.7	100.0
FI	1.8	6.3	0.1	0.1	1.3	23.3	3.6	2.7	4.4	0.0	4.1	4.3	0.2	0.1	1.3	5.7	4.1	0.8	0.5	1.0	0.1	11.8	5.2	0.3	0.3	0.5	0.2	15.9	100.0
FR	1.7	13.1	0.2	0.0	2.3	23.9	1.4	12.2	0.1	0.6	0.0	7.9	0.2	0.1	1.9	2.7	10.0	0.1	3.3	0.0	0.2	9.8	2.7	1.2	0.7	1.6	0.3	1.9	100.0
GB	1.1	8.0	0.1	0.2	1.4	16.8	2.6	2.7	0.1	0.9	10.8	0.0	0.2	0.1	1.1	14.7	4.8	0.1	17.4	0.1	1.5	8.8	1.8	0.5	0.4	0.3	0.2	3.3	100.0
GR	2.3	7.4	8.6	3.4	1.5	17.5	1.8	3.9	0.1	0.7	5.3	8.3	0.0	0.6	1.0	0.8	17.7	0.2	1.4	0.0	0.3	5.0	3.0	0.7	4.6	0.6	1.0	2.2	100.0
HR	13.0	7.5	0.6	0.1	2.4	16.4	1.4	0.9	0.1	0.3	2.5	2.1	0.9	0.0	8.2	0.9	16.1	0.0	1.0	0.0	0.4	2.6	1.7	0.2	0.8	1.9	15.6	2.4	100.0
HU	9.2	3.1	0.5	0.0	6.6	35.1	0.9	3.2	0.4	0.5	3.7	2.8	0.1	0.9	0.0	1.7	6.4	0.2	1.1	0.1	0.0	4.9	4.8	0.3	3.9	6.7	1.2	1.7	100.0
IE	1.2	11.6	0.2	0.0	1.5	13.3	2.4	4.2	0.1	1.3	6.6	16.8	0.2	0.1	1.5	0.0	6.7	0.1	13.2	0.1	0.7	12.6	2.1	0.5	0.4	0.3	0.1	2.5	100.0
IT	4.5	4.0	0.6	0.1	3.2	27.7	1.6	8.2	0.2	0.8	18.2	5.1	0.5	0.7	3.1	2.0	0.0	0.2	2.1	0.1	0.5	3.7	4.9	1.2	2.1	1.7	1.5	1.5	100.0
LT	2.7	5.4	0.1	0.1	2.3	16.9	10.3	1.6	5.4	2.1	5.2	3.0	0.1	0.0	2.0	1.0	3.1	0.0	0.3	10.0	0.0	8.4	10.4	0.4	0.3	0.8	1.3	7.0	100.0
LU	3.1	13.8	0.3	0.8	1.5	20.7	1.6	1.2	0.2	0.6	7.5	2.7	0.4	0.1	1.7	9.5	5.1	0.1	0.0	0.1	9.2	14.9	1.2	0.6	0.3	0.5	0.3	2.2	100.0
LV	2.2	3.9	0.1	1.7	1.4	11.6	9.0	3.2	15.5	3.4	3.4	4.8	0.2	0.0	0.8	2.1	1.9	10.1	0.5	0.0	0.4	5.0	5.6	0.2	0.1	0.5	1.0	11.2	100.0
MT	6.5	5.7	1.5	1.7	2.2	3.9	9.0	0.3	0.6	0.3	5.1	9.7	1.2	0.8	1.9	2.0	10.2	0.5	8.1	0.2	0.0	10.0	2.6	0.1	5.9	0.5	0.4	9.1	100.0
NL	1.1	18.7	0.1	0.0	1.5	39.4	1.5	2.0	0.2	0.9	8.3	5.0	0.1	0.1	1.2	7.2	6.3	0.1	0.7	0.1	0.9	0.0	1.6	0.4	0.2	0.4	0.2	1.7	100.0
PL	3.0	4.4	0.3	0.1	11.9	36.2	2.6	2.9	1.0	1.1	5.1	3.4	0.1	0.2	4.8	1.3	4.4	1.2	0.6	0.5	0.2	4.8	0.0	0.2	1.2	4.5	0.5	3.4	100.0
PT	1.2	8.1	0.3	0.0	1.6	16.0	1.0	31.4	0.1	0.9	14.6	5.1	0.3	0.0	1.5	1.4	5.5	0.1	0.6	0.0	0.1	5.6	1.4	0.0	0.6	0.7	0.1	1.8	100.0
RO	7.2	6.6	2.5	0.2	3.2	28.9	1.0	3.2	0.4	0.3	7.2	1.8	0.6	0.3	9.2	0.9	11.0	0.1	3.5	0.0	0.1	4.3	2.8	0.3	0.0	2.0	0.8	1.5	100.0
SK	9.3	3.3	0.2	0.0	20.3	27.5	0.7	1.7	0.1	0.3	3.2	2.7	0.1	0.3	10.1	1.3	4.8	0.3	0.8	0.1	0.1	2.1	7.4	0.2	1.2	0.0	1.0	0.9	100.0
SI	16.7	4.0	0.4	0.1	4.0	27.7	1.1	1.3	0.1	0.3	4.1	1.4	0.1	6.0	6.7	0.6	14.0	0.1	0.8	0.1	0.0	1.9	3.0	0.2	0.9	3.2	0.0	1.2	100.0
SE	2.4	8.9	0.1	0.1	1.9	19.9	15.6	2.4	1.7	8.7	6.2	4.7	0.2	0.1	1.3	3.0	3.7	0.6	1.1	0.4	1.2	9.8	4.3	0.5	0.3	0.6	0.2	0.0	100.0

Note: Green cells: 5-15%, red cells: >15%.
Source: WIOD Release 2016. wiiw calculations.

When describing Factory Europe (defined as RVC trade between Member States), this should also include a picture of relations among Member States. As mentioned above, Germany has a main role, as bilateral links developed especially with the CE Manufacturing Core countries. Baldwin and Lopez-

Gonzalez (2013) refer also to a hub-and-spoke pattern of EU trade, with Germany being the 'hub'. This means that trade relations between the hub and the spokes are strong but trade relations between the spokes are sparse (based on bilateral trade flows).

Looking in more detail at where value added exports are going within Factory Europe, four positions in the value chain can be distinguished: (i) the source country, (ii) the immediate production partner, (iii) the ultimate production partner, and (iv) the final destination country. 'Bilateral matrices' will show what functions countries take in the value chain. Table 5 depicts the forward linkages row-wise between source country and immediate production partner (leaving aside the second production partner). For example, about 47% of Austria's value added exports involve Germany as the immediate production partner, 8% involve Italy, 7% Hungary and 6% the Czech Republic as an immediate production partner. Indeed, the dominant role of Germany as an immediate production partner becomes evident, not only for the CEE countries but also for most of the EU Member States (except Cyprus and Malta). In the case of Austria (47%), the Netherlands (39%), the other CE Manufacturing Core countries (including the Czech Republic, Poland, Hungary, Romania, Slovakia), but also Slovenia, Italy and Belgium (25-39%), value added exports involve Germany as the most important immediate production partner. For the EU Member States, it is still 10-25%.

Table 6 / RVC trade: Bilateral matrix (source country-ultimate production partner), total economy, 2014, in % of RVC trade

	Ultimate production partner 2																											
Source	AT	BE	BG	CY	CZ	DE	DK	ES	EE	FI	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SK	SI	SE	Total
AT	1.4	2.9	0.4	0.1	4.3	37.9	1.5	3.7	0.1	0.9	8.4	5.4	0.4	1.0	4.9	0.9	9.1	0.2	0.5	0.1	0.3	2.9	4.1	0.6	1.5	2.9	1.5	2.2	100.0
BE	2.5	1.7	0.3	0.1	2.2	24.9	2.4	4.7	0.2	1.1	15.4	8.7	0.5	0.2	1.5	2.4	8.0	0.2	3.3	0.1	0.2	10.1	3.3	0.9	0.8	0.9	0.3	3.0	100.0
BG	4.4	7.8	0.3	0.2	3.1	22.1	1.8	5.2	0.2	1.2	9.8	5.7	2.3	0.5	3.1	1.5	11.2	0.2	0.6	0.2	0.3	5.0	3.3	1.2	3.7	1.8	1.2	2.1	100.0
CY	3.2	3.6	0.5	0.3	2.1	8.5	10.4	1.3	1.4	0.9	4.5	12.3	2.2	0.3	2.1	1.3	5.8	0.3	2.0	0.3	22.4	3.5	3.0	0.2	2.1	0.8	0.3	4.3	100.0
CZ	5.2	4.4	0.4	0.1	0.9	35.6	1.7	4.1	0.2	0.9	7.8	5.3	0.3	0.4	4.3	0.8	6.1	0.2	0.4	0.1	0.1	3.0	5.7	0.6	1.2	7.5	0.6	2.1	100.0
DE	6.3	5.6	0.4	0.1	5.8	8.5	3.3	6.2	0.3	1.6	13.3	8.4	0.4	0.4	4.9	1.8	9.6	0.3	1.1	0.2	0.1	6.3	5.9	1.1	1.3	3.0	0.6	3.3	100.0
DK	2.3	4.2	0.3	0.1	2.0	24.3	1.2	3.7	0.5	4.3	8.8	9.5	0.4	0.3	3.4	2.2	5.5	0.5	0.9	0.4	0.2	5.4	4.9	0.6	1.1	1.0	0.3	12.0	100.0
ES	2.0	5.3	1.3	0.1	2.1	22.2	2.0	2.9	0.1	1.0	19.4	8.3	0.6	0.2	1.5	1.5	10.5	0.2	0.7	0.1	0.1	4.1	3.1	6.2	1.1	1.1	0.4	1.9	100.0
EE	1.8	3.8	0.3	0.4	1.3	15.1	6.8	3.3	0.6	11.1	6.2	6.9	0.5	0.1	1.1	1.3	4.3	3.4	1.1	4.1	0.7	4.3	3.8	0.6	0.5	0.7	0.2	15.9	100.0
FI	2.3	5.2	0.2	0.1	1.8	22.0	4.3	4.0	2.3	1.3	8.9	8.0	0.5	0.2	1.5	4.6	6.4	0.7	0.5	0.7	0.1	6.9	4.8	0.7	0.7	0.8	0.2	10.0	100.0
FR	2.2	8.8	0.3	0.1	2.3	24.4	2.0	10.6	0.1	0.9	5.4	9.5	0.4	0.2	1.8	2.7	10.0	0.1	1.9	0.1	0.2	6.1	3.2	1.5	1.0	1.5	0.3	2.3	100.0
GB	1.9	6.1	0.2	0.2	1.6	19.3	2.8	4.1	0.2	1.2	12.0	5.3	0.6	0.2	1.2	11.5	7.2	0.2	10.0	0.1	1.3	5.2	2.5	0.8	0.7	0.6	0.2	3.0	100.0
GR	2.8	5.6	3.8	1.5	1.9	20.9	2.5	4.9	0.2	1.0	9.8	9.4	0.8	0.5	1.4	1.2	13.8	0.2	0.9	0.1	0.6	4.4	3.3	1.0	3.2	1.0	0.7	2.5	100.0
HR	8.4	5.1	0.6	0.1	2.5	22.0	1.9	2.8	0.1	0.8	7.5	5.1	1.0	0.6	5.0	1.1	14.5	0.1	0.8	0.1	0.3	2.8	3.0	0.5	1.5	1.9	7.4	2.4	100.0
HU	6.3	3.4	0.5	0.1	4.8	34.0	1.5	4.4	0.3	0.8	7.2	5.5	0.3	0.8	0.5	1.6	8.0	0.2	0.8	0.1	0.1	3.9	4.3	0.6	2.5	4.6	0.8	2.1	100.0
IE	1.8	7.9	0.2	0.1	1.7	17.3	2.8	4.9	0.1	1.3	10.4	15.8	0.5	0.2	1.4	0.7	8.5	0.1	7.7	0.1	0.5	7.9	2.7	0.9	0.7	0.6	0.2	2.8	100.0
IT	3.8	4.0	0.5	0.1	2.8	26.8	2.0	8.2	0.2	1.1	16.7	7.5	0.6	0.6	2.5	1.9	3.0	0.2	1.4	0.1	0.4	3.4	4.3	1.3	1.7	1.7	0.9	2.1	100.0
LT	2.7	4.6	0.3	0.1	2.2	20.1	9.3	3.3	2.9	2.7	8.2	6.5	0.3	0.2	1.7	1.3	5.5	0.4	0.4	4.8	0.1	5.7	7.3	0.6	0.7	1.0	0.7	6.3	100.0
LU	3.2	8.7	0.3	0.4	1.9	21.7	2.0	3.1	0.3	1.0	10.4	9.0	0.6	0.2	1.6	7.1	7.3	0.1	0.2	0.2	4.2	8.6	2.3	0.8	0.9	0.8	0.3	2.8	100.0
LV	2.3	3.8	0.3	0.6	1.6	16.3	8.7	3.6	6.3	4.2	7.2	8.0	0.6	0.2	1.1	2.1	4.6	6.5	0.5	0.9	0.5	4.5	5.0	0.6	0.6	0.8	0.6	8.1	100.0
MT	4.5	5.1	1.0	0.9	2.0	13.3	8.0	2.2	0.4	1.1	8.6	10.5	1.4	0.6	1.8	2.5	10.1	0.4	5.1	0.2	0.1	5.9	2.8	0.5	3.2	0.7	0.4	6.7	100.0
NL	3.2	10.0	0.2	0.1	2.3	27.8	2.5	4.0	0.3	1.1	12.1	8.5	0.5	0.2	1.5	5.5	7.9	0.2	0.8	0.1	0.5	1.9	3.7	0.8	0.8	0.9	0.3	2.5	100.0
PL	3.2	4.2	0.3	0.1	7.1	32.9	2.9	4.4	0.7	1.3	8.4	6.3	0.3	0.3	3.6	1.4	6.4	0.8	0.5	0.4	0.2	3.9	1.6	0.6	1.2	3.4	0.5	3.3	100.0
PT	1.7	5.6	0.4	0.1	1.7	18.7	1.6	22.8	0.1	0.9	15.9	7.8	0.5	0.1	1.4	1.5	7.3	0.1	0.6	0.1	0.1	3.7	2.3	1.0	0.9	0.9	0.2	2.1	100.0
RO	5.0	5.1	1.3	0.1	2.9	29.0	1.6	4.6	0.3	0.8	10.0	5.2	0.8	0.4	5.7	1.2	10.6	0.1	2.0	0.1	0.2	3.9	3.2	0.7	0.8	2.0	0.6	2.0	100.0
SK	6.5	3.5	0.3	0.0	11.0	31.3	1.3	3.4	0.1	0.7	6.9	5.4	0.3	0.4	6.2	1.4	6.8	0.3	0.6	0.1	0.1	2.5	5.9	0.5	1.5	0.6	0.7	1.7	100.0
SI	9.1	3.4	0.4	0.1	3.4	29.0	1.6	3.2	0.1	0.7	8.1	4.7	0.4	3.6	4.7	0.8	12.8	0.2	0.6	0.1	0.1	2.5	3.6	0.5	1.3	2.7	0.3	1.8	100.0
SE	2.4	7.7	0.2	0.1	1.9	20.4	12.2	3.8	1.1	5.5	9.0	7.9	0.4	0.2	1.4	2.8	5.5	0.5	0.9	0.4	0.7	6.5	4.1	0.7	0.7	0.9	0.2	1.8	100.0

Note: Green cells: 5-15%, red cells: >15%.
Source: WIOD Release 2016. wiiw calculations.

Table 6 depicts linkages between the source country, any EU Member State as the immediate production partner and the individual ultimate production partner. For example, close to 40% of Austria's value added exports involve Germany as the ultimate production partner, 9% in the case of Italy, 8% in France and 5% in Great Britain. Again, Germany is the main ultimate production partner, but now also France, Great Britain and Italy are main ultimate production partners. Table 5 and Table 6 confirm the importance of Germany as a main immediate and ultimate production partner in Factory Europe, but also highlight the importance of France, the United Kingdom and Italy as ultimate production partners. This is also attributable to the fact that these countries are also more important as destinations, i.e. are closer to final demand.

An important issue when investigating the geographic orientation in VC trade of EU Member States (as well as other countries) is that the outcome is strongly influenced by country size. The most prominent example in this respect is Germany. As has been shown, Germany is, also due to its economic size, the main production partner for other EU Member States. Since Germany cannot engage in regional production sharing with itself, it ends up having a comparatively lower amount of RVC trade. In order to take this aspect into account, the above analysis is complemented with an investigation of the revealed export preferences (RXP) index applied to VC trade. The RXP index is an indicator for the geographic focus of country *i*'s trade flows towards a country or region, relative to that of all other countries' trade intensity with the same region (see Cingolani et al., 2016). In this context the RXP index is calculated for the EU as the partner region, though applied to VC trade this means that the partner region is a pair of immediate and ultimate production partner. This way a proper measure for the relative focus on joint production with EU Member States is obtained for any reporting economy.

Methodologically the RXP index is based on a homogeneous bilateral trade intensity index (*HI*) defined as

$$HI_{i,r} = \frac{DVAre_{i,r}/DVAre_{i,world}}{DVAre_{world^{ex\,i},r}/DVAre_{world^{ex\,i},world}}$$

where *i* denotes the reporting country and *r* refers to the sum of intra-regional trading partners. As always $DVAre$ denotes VC trade flows and the index $world^{ex\,i}$ denotes all countries except for the reporting economy. Hence, for example, $DVAre_{world^{ex\,i},r}$, refers to VC trade with value added originating from all countries in the world except for country *i*, and including EU Member States as immediate and ultimate production partners[22].

The RXP index for VC trade, applied to regions, is then defined as

$$RTP_{i,r} = \frac{HI_{i,r} - \left[\left(1 - \frac{DVAre_{i,r}}{DVAre_{i,world}}\right)/\left(1 - DVAre_{world^{ex\,i},r}/DVAre_{world^{ex\,i},world}\right)\right]}{HI_{i,r} + \left[\left(1 - \frac{DVAre_{i,r}}{DVAre_{i,world}}\right)/\left(1 - DVAre_{world^{ex\,i},r}/DVAre_{world^{ex\,i},world}\right)\right]}$$

22 The particularity of VC trade implies that the 'EU region' does not include only 28 'countries' but 756 (27*28) country-pairs for EU countries and 784 (28*28) country-pairs for non-EU countries.

The term in squared brackets is the 'extra-regional' trade intensity index *(HE)*, i.e. the complement of the *HI*. Hence, the RXP index can be written more conveniently as[23]

$$RXP_{i,r} = \frac{HI_{i,r} - HE_{i,r}}{HI_{i,r} + HE_{i,r}}$$

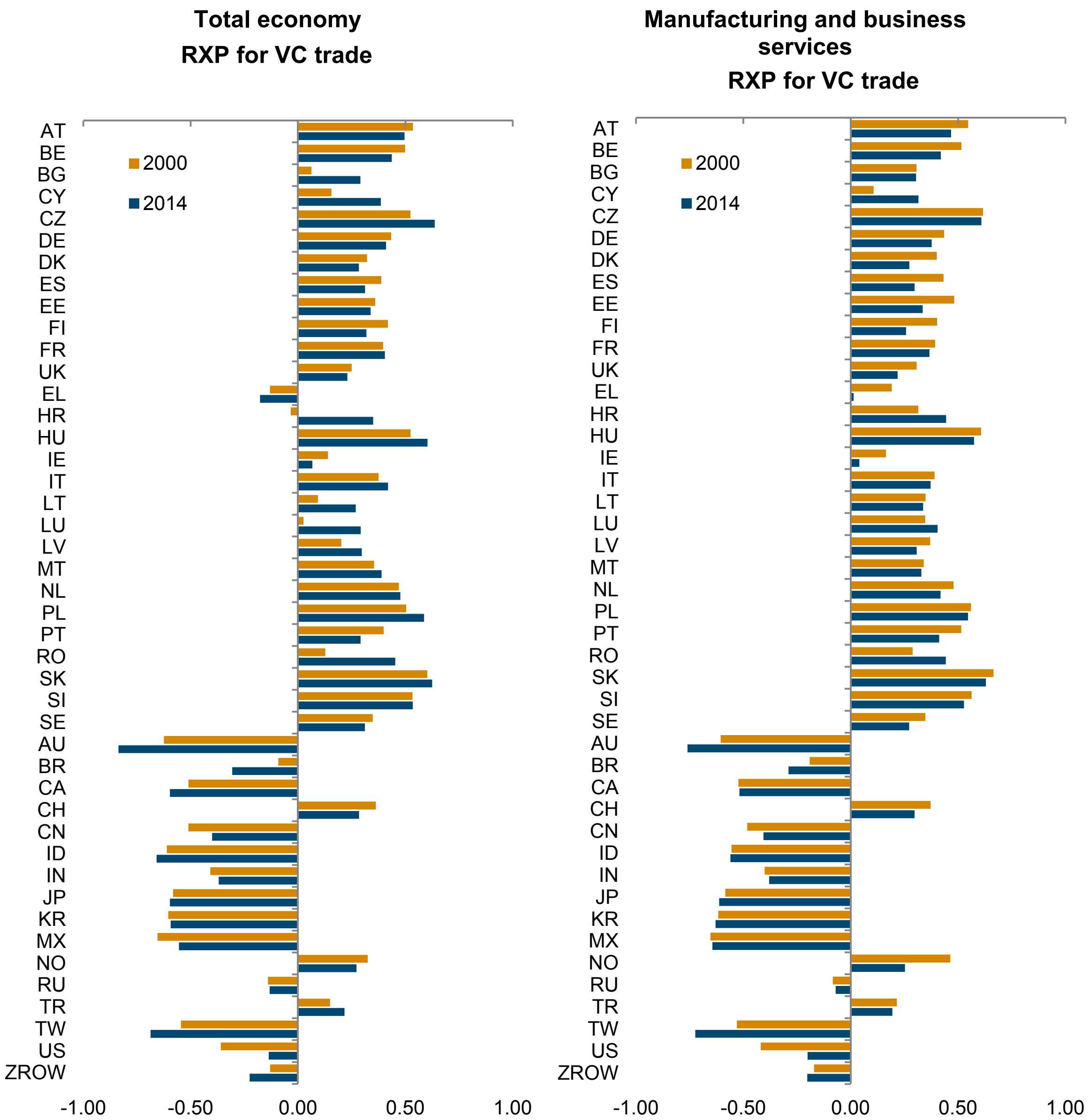
The RXP index is symmetrically around the value 0 which indicates 'geographic neutrality' and ranges from -1, indicating no joint production with pairs of EU Member States, to +1, indicating only joint production with pairs of EU Member States (Cingolani et al., 2016). Note again that as before any combination that involves an EU partner and a non-EU partner is treated as extra-regional production sharing and is hence attributed to the 'extra-regional' trade intensity index. Intuitively, this RXP index for the EU as production partner measures in relative terms how intensive is production sharing among EU members compared to production shares between the world average and EU Member States (Cingolani et al., 2016).

A first obvious pattern that is revealed by Figure 16 is that, in general, the RXP index is positive for EU Member States and negative for third countries. This is as expected because the RXP index emphasises the role of geography in shaping trade and – in this particular application – its role for joint production. The only exceptions from this general pattern are the two EFTA countries in the sample, Norway and Switzerland, as well as Turkey. The explanation for this is that these countries, while geographically close to the EU, do not form part of 'Factory Europe' – neither on the reporter side nor on the production partner side – because 'Factory Europe' is defined to comprise the EU only. This holds true for both value added originating from all industries in the economy (left panel) and value added originating from manufacturing and business services (right panel).

The case of Switzerland is particularly interesting due to its geographic location amidst EU Member States. This geographic location means that a comparison with countries such as Germany and Austria are useful in order to get an indicative idea about the role of the Single Market for the organisation of production sharing with the EU. More precisely, if it were only geography that is relevant for international production sharing, with no role for the Single Market, Switzerland should have a similar RXP index for VC trade as Germany and Austria. However, in 2014, the RXP index of Austria was more than 20 index points higher than that of Switzerland. One possible explanation for this difference might be that it is due to different size structures of firms because Switzerland is home to much more multinational companies that are truly global players than Austria. This would be an explanation because, as Cingolani et al. (2016) point out, the RXP index need not necessarily reflect regional integration but could reflect structural problems and difficulties of countries to integrate into global markets. If that were the case, however, one should expect that Germany has a much lower RXP index for VC trade than Switzerland. This is, however, not the case. On the contrary, Germany's RXP index is 13 index points higher than that of Switzerland. This is an indication that the Single Market may further facilitate the formation of regional production networks. The interpretation receives further support from the fact that also the remaining neighbouring countries of Switzerland – France and Italy – have markedly higher RXP indices.

23 The reason for including the HE into the formula is to avoid the dynamic ambiguity problem (the possibility that both the HE and the HI may be increasing over time).

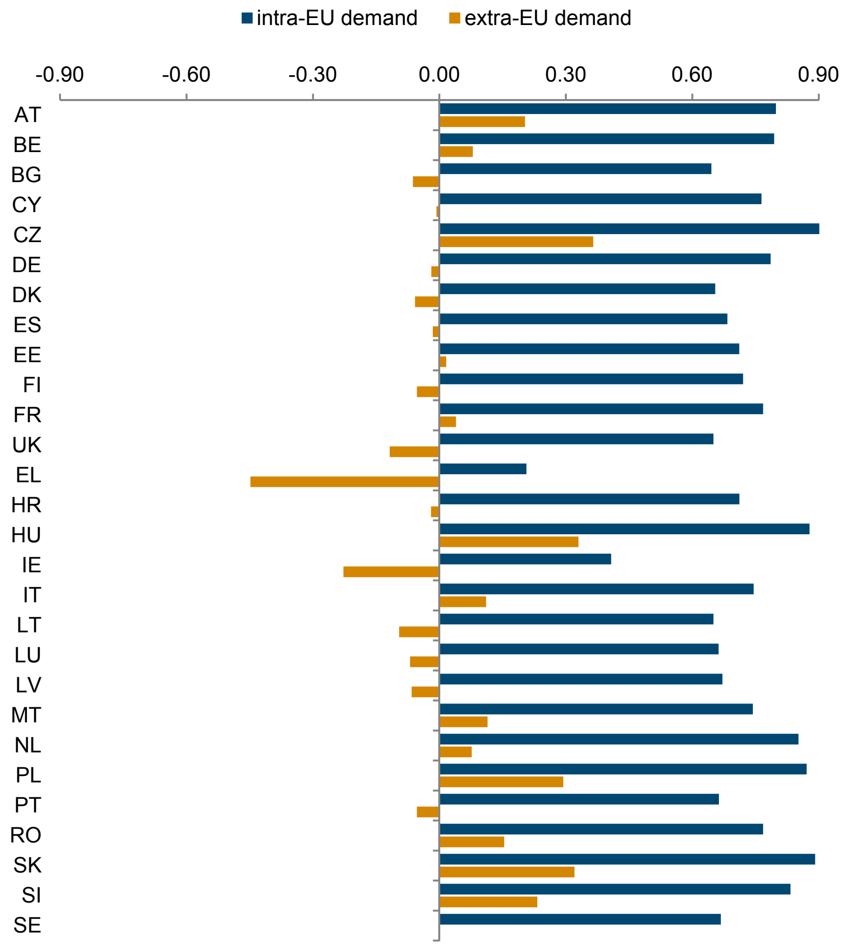
Figure 16 / Revealed export preferences for VC trade with 'Factory Europe', 2000 and 2014



Note: RXP calculation based on pairs of immediate production partner – ultimate production partner. VC trade with the EU includes all flows where both the immediate production partner and the ultimate production partner are EU Member States. Naturally, for non-EU countries, the RXP index for VC trade with the EU does not constitute RVC trade but GVC trade.
Source: WIOD Release 2016. wiiw calculations.

One of the main findings from the split of VC trade into RVC trade and GVC trade is that the members of the CE Manufacturing Core, apart from Germany, are among those with the highest shares of RVC trade in total VC trade. Though this finding is influenced by country size, it is again fully confirmed by the RXP index for the EU. Figure 16 shows that the members of the CE Manufacturing Core are those with the highest RXP indices, reaching more than 0.6 in 2014 in the case of the Czech Republic, Slovakia and Hungary. With 0.59 and 0.50, respectively, also Poland and Austria have very high RXP indices. With regards to Germany, it is worth mentioning that with an index value of 41 the country is still markedly below that of the aforementioned countries but the difference is less striking than for the share of RVC trade in total RVC trade. This is mainly because the RXP index controls for the fact that Germany cannot have any RVC trade with itself, which tends to lower its RVC share compared to other countries.

Figure 17 / RXP of VC trade within 'Factory Europe' by type of final demand, total economy, 2014

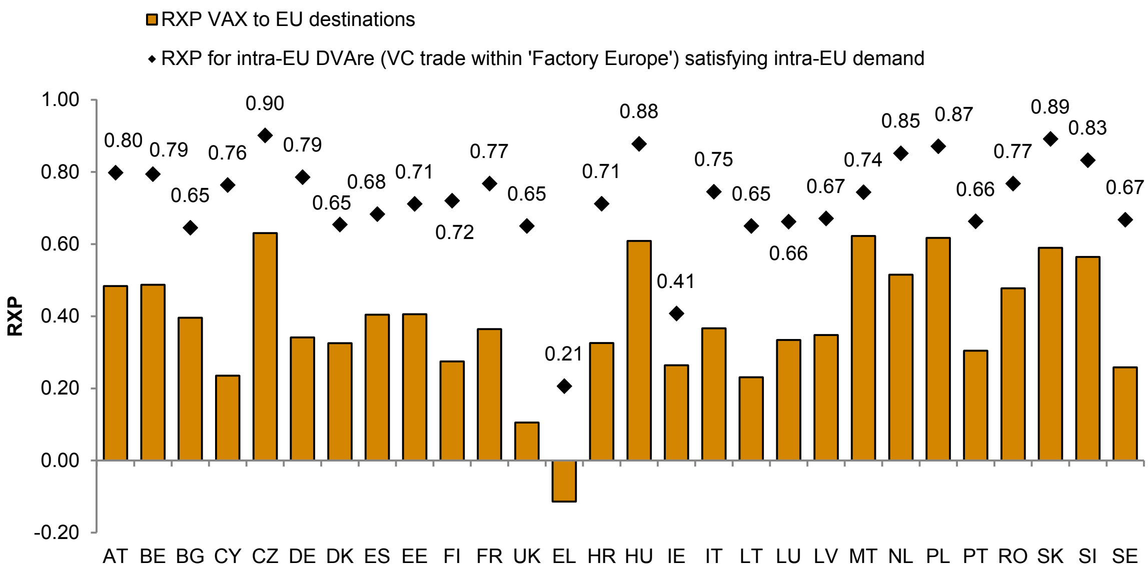


Note: RXP calculation based on pairs of immediate production partner – ultimate production partner. VC trade with the EU includes all flows where both the immediate production partner and the ultimate production partner are EU Member States.
Source: WIOD Release 2016. wiiw calculations.

It was equally shown that the demand patterns, distinguishing only between final demand coming from intra-EU or extra-EU partners, matters for the organisation of international production sharing. This is made explicit in Figure 17, which depicts the RXP index defined as above but with separate calculations for value added that is produced to serve intra-EU demand, on the one hand, and extra-EU demand, on the other. The result is striking. All EU Member States tend to have significantly more joint production with other Member States than the world average when the value added is finally absorbed within the EU. In fact, the RXP index for some Member States is really astonishingly high, reaching e.g. 0.9 for the Czech Republic in 2014. The picture changes when considering extra-EU demand. In this case there are quite a few Member States that have negative RXP indices, which means that the intensity to produce with EU partner countries is lower than that of the global average. For Greece, which has already been shown to be less involved in regional production sharing, and Ireland, which is a favourite location choice for multinational enterprises, this is less of a surprise but it is unexpected for other countries such as Denmark or Finland.[24]

Focusing on RVC trade for satisfying EU demand, it is possible to show to what extent the RXP index of RVC trade (involving only EU Member States as production partners) exceeds the RXP index of VAX that are destined for the EU market. This is shown in Figure 18. While it is true that the countries with the highest RXP indices for RVC trade in the subset of value added that serves EU final demand also have high RXP indices for VAX trade satisfying EU demand, the degree of focusing on trade and production integration, respectively, with EU partners varies significantly. For the extreme cases, such as the Czech Republic and Slovakia, this difference is between 37 and 30 index points. The discrepancies between the two RXP indices are often equally large and for some countries even larger although the level of the RXP indices is comparatively lower. This is also true for Greece, which records a negative RXP index (-0.11) for the VAX destined for the EU-28 but a positive RXP index (+0.21) for the RVC trade producing value added for EU partners, resulting in a 0.32 index points difference.

Figure 18 / RXP of VC trade within 'Factory Europe' and RXP of VAX for serving intra-EU demand, total economy, 2014



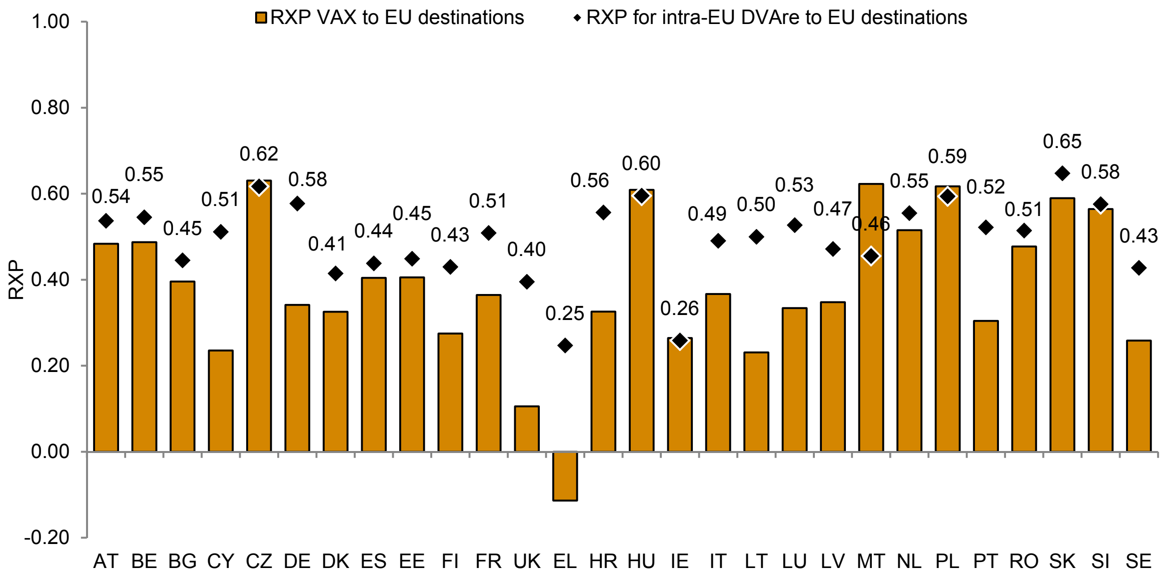
Note: RXP calculation for intra-EU DVAre based on pairs of immediate production partner – ultimate production partner. Reference trade flows are DVAre absorbed in the EU. RXP calculation for the RXP of VAX is based on destinations. VC trade with the EU includes all flows where both the immediate production partner and the ultimate production partner are EU Member States.
Source: WIOD Release 2016. wiiw calculations.

Hence, an alternative type of comparison is to use total DVAre flows as the reference (instead of differentiating between intra-EU and extra-EU markets) and calculate the RXP index based on triplets (instead of pairs) where any partner j is a triplet of the immediate production partner, the ultimate

[24] To some extent, these patterns are influenced by certain sub-categories of the DVAre. For example, exported valued added that is re-imported in the case of EU Member States by definition serves intra-EU demand. Likewise, there can be no re-export of intermediate goods that are absorbed by extra-EU demand because in this category of DVAre trade the ultimate production partner coincides with the country of absorption.

production partner and the destination. This can be calculated for each EU Member State for the partner-triplet where the immediate production partner and the ultimate production partner and the destination are EU Member States. The result for this way of calculating the RXP index is shown in Figure 19. This comparison suggests somewhat less pronounced differences between VAX- and *DVAre*-based RXP indices of EU Member States. The reason is that the reference trade in this variant of the RXP calculation is trade with the world (instead of intra-EU trade). Nevertheless, Figure 19 indicates that for the overwhelming majority of Member States, the RXP indices of *DVAre* produced by Factory Europe for Europe exceed the VAX-based RXP indices for trade orientation towards the EU-28 by a comfortable margin. There are exceptions, however. These exceptions are either countries that are in the EU's periphery, such as Malta and Ireland, or countries whose overall trade orientation (i.e. the RXP index of VAX) is already very high. This is true for the Czech Republic, Hungary and Poland. For this second set of countries, it may be argued that the very high trade orientation towards EU partners is presumably not entirely voluntary but is also the result of difficulties with engaging successfully in trade with extra-EU partners.

Figure 19 / RXP of VC trade within 'Factory Europe' producing for EU markets and RXP of VAX for serving intra-EU demand, total economy, 2014



Note: RXP calculation for intra-EU DVAre based on triplets of immediate production partner – ultimate production partner – destination. Reference trade flows are DVAre absorbed in the world. RXP calculation for the RXP of VAX is based on destinations. VC trade with the EU includes all flows where both the immediate production partner and the ultimate production partner are EU Member States.
Source: WIOD Release 2016. wiiw calculations.

An interesting comparison is also that between Germany and France. With regards to the overall trade orientation towards the EU (RXP index of VAX) the two countries have similar RXP indices, with the index of France being even slightly higher (0.36 for France against 0.34 for Germany in 2014). In contrast, the RXP index for RVC trade producing for satisfying intra-EU demand is considerably higher (by 7 index points) in Germany than in France. This would support the claim that Germany has a special role as the main hub for organising production within value chains (Baldwin and Lopez-Gonzalez, 2013; IMF, 2013). In fact, Germany's RXP index for RVC trade serving EU markets is almost as high of that of the top ranking Member States such as Slovakia, the Czech Republic and Hungary. This means that when serving EU markets, also Germany makes use of the advantages of geographic proximity (which should imply lower co-ordination costs of offshoring) and of the amenities of the Single Market (lower co-ordination costs of offshoring but also lower trade barriers, especially lower non-tariff barriers) and is collaborating intensively with other Member States within 'Factory Europe'.

To summarise, this section split up European value chain trade (VC trade) into regional (RVC trade, involving only partners from within the European Union) and global value chain trade (GVC trade, involving partners from outside). While RVC trade satisfies predominantly demand from the Single Market, GVCs are more strongly oriented towards third markets. Both types of VC trade increased between 2000 and 2014, but global value chain trade slightly faster, mostly due to faster rising international demand. Thus GVC trade has gained a larger share in VC trade throughout the economy and its aggregates, reaching finally 51% of VC trade in 2014 for the total economy.

How important is 'Factory Europe' (i.e. EU RVCs) in satisfying EU demand compared to GVCs and 'foreign' value chains? Factory Europe is serving 36%, EU GVC trade 9% and foreign value chains about 55% of EU demand (2014). Thus, Factory Europe has slightly lost shares between 2000 and 2014 (2 percentrage points), while foreign VC trade gained in shares (4 percentage points).

Within Factory Europe (defined as EU RVC trade only), the Central and Eastern European Member States expanded their shares in EU regional value chains, while the United Kingdom, France and Italy lost within the EU. Germany has a special role within Factory Europe. Between 2000 and 2014, it showed the largest increase in EU regional value chain shares within manufacturing, advanced manufacturing as well as in manufacturing and business services (note: not in the total economy), due to the evolvement of the 'German-CE Manufacturing Core'. In addition, Germany serves as the most important destination of value added exports from Member States as the immediate or ultimate production partner. The United Kingdom, France and Italy also serve as main ultimate production partners.

4.2. REGIONAL VALUE CHAINS: COMPARING EU, NAFTA AND THE ASIA-5

So far, it has been shown that – due to 'gravity factors' (i.e. the role of distance) – EU Member States are typically more than proportionately involved in VC trade with EU partners than it is the case for third countries. Another question is how strong this regional focus of production-cooperation is within 'Factory Europe' compared to other regional trading blocs, notably NAFTA. A similar comparison can be made with important economies in Asia (Japan, Korea, China, Taiwan and Indonesia) which will be referred to as Asia-5[25].

Table 7 thus first looks at the absolute size of VC trade in these three regional trading blocs, splitting it up into three components. These components are RVC trade, a 'mixed VC' component and a 'pure GVC' trade component. RVC trade is defined as above, meaning VC trade among countries from within

[25] The fact that not all major South Eastern and Eastern Asian countries are covered by the WIOD will bias downwards the intra-regional VC trade of Asia-5 (because some intra-regional partners are included in the Rest of the World); however, the inclusion in the WIOD of the three largest economies makes it worthwhile to look also at Asia-5. One may argue the same for Factory Europe for another reason, which is that Factory Europe was defined to comprise the EU-28 only, hence excluding EFTA and some other partners in the region.

the same region. Hence, in this context RVC trade involving EU Member States is denoted as 'Factory Europe', 'Factory North America' refers to RVC trade by NAFTA members and 'Factory Asia-5' is RVC trade where the region is made up of Japan, Korea, China, Taiwan and Indonesia. The 'mixed VC' trade and the 'pure GVC' trade together equal the GVC trade component. Mixed VC trade refers to joint production where the reporting economy is producing jointly with at least one partner from the region and at least one partner from another region. In contrast, 'pure GVC' trade is a constellation where the reporting economy engages in production sharing only with partners from outside its own region.

In this comparison, 'Factory Europe' emerges by far as the largest of the three regional factories with EUR 463 billion in RVC trade, followed by 'Factory Asia' with EUR 101 billion and 'Factory North America' with EUR 93 billion. Hence, Factory Europe is about five times as large as Factory North America. The result may be expected qualitatively, but in terms of magnitude it is surprising given that the ratio between overall VC trade of the two trading blocs is about 2 to 1 (EUR 947 billion for the EU, EUR 416 billion for NAFTA).

The importance of Factory Europe (i.e. RVC trade of EU Members States) is also revealed by the fact that the share of RVC trade accounted for 49% of the EU's total VC trade compared to 22% for NAFTA and 19% for the Asia-5. The differences are less pronounced in what is termed 'mixed' value chain in Table 7, which represents VC trade that involves one production partner from within the region and one production partner from another region. Mixed VC trade accounts for a quarter of total VC trade for the EU-28 and the Asia-5 and 15% for NAFTA. This implies that 'purely' global VC trade is much less important for Factory Europe than for Factory North America and Factory Asia-5.

Obviously, these comparisons are influenced by the fact that EU Member States have much more regional production partners to engage in production sharing with.

Table 7 / VC trade of main regional factories, total economy, 2014, in EUR billion

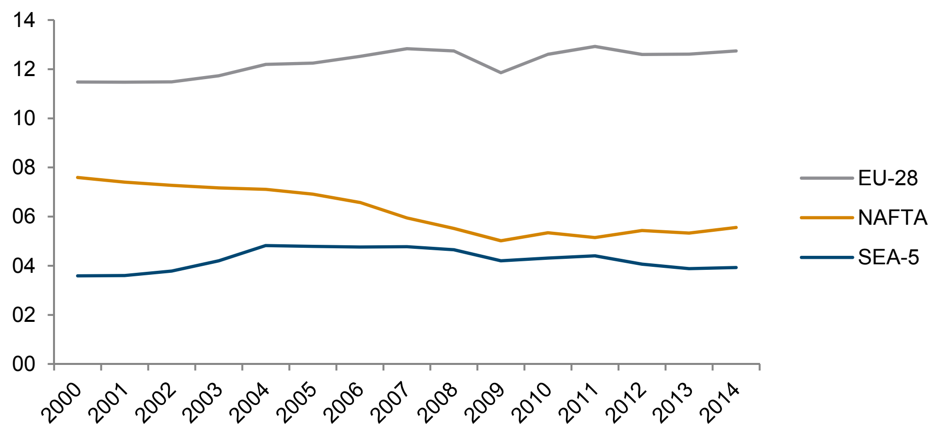
	RVC	mixed VC	'pure' GVC	VC trade
EU	463	238	246	947
	49%	25%	26%	
NAFTA	93	61	262	416
	22%	15%	63%	
Asia-5	101	133	294	528
	19%	25%	56%	
Sum by type	657	432	802	1,891
	35%	23%	42%	

Note: RVC = DVAre from respective factory involving production partners from the same factory only. Mixed VC = DVAre from respective factory with one production partner from the same factory and one extra-regional production partner. 'Pure' GVC = DVAre from respective factory involving extra-regional production partners only.
Source: WIOD Release 2016. wiiw calculations.

Switching from an absolute to a relative comparison of the magnitude of intra-regional intensity of VC trade, for which the ratio between RVC trade and overall value added exports (VAX) is used, the importance of Factory Europe is fully confirmed. As shown in Figure 20, according to this metric too, Factory Europe shows the highest VC trade intensity (12.7%), followed by Factory North America (5.6%) and Factory Asia-5 (3.9%). While the relative size of Factory Europe grew over time, that of Factory

North America declined steadily. Factory Asia-5's relative intensity first grew (up until 2004) but then also declined slightly.

Figure 20 / Comparison of RVC trade intensity across trading blocs, total economy



Source: WIOD Release 2016. wiiw calculations.

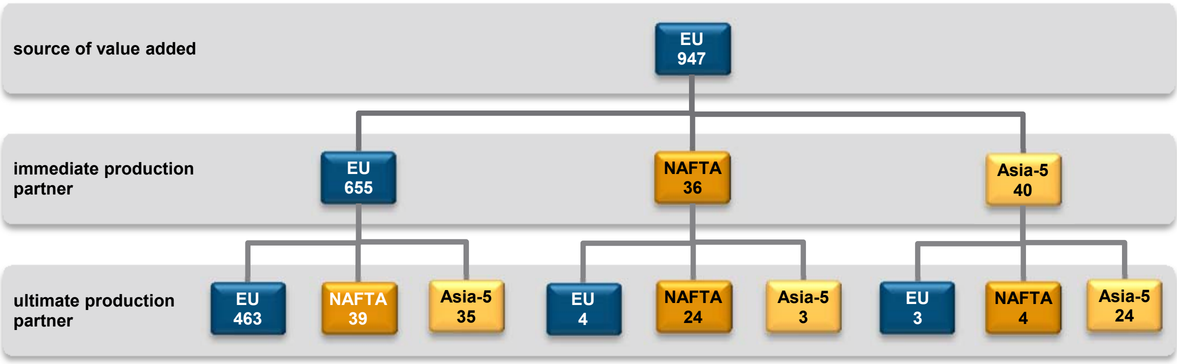
The patterns of international production cooperation can be further explored by looking at the existing production linkages between the three major trading blocs, in addition to production cooperation within the regional factories[26]. Figure 21 shows these production linkages between the blocs, in absolute terms, for the total economy in 2014. Each of the three panels depicts one of the trading blocs as the reporter and shows the interconnectedness with the two other trading blocs, taking into account the immediate production partner and the ultimate production partner. The strong 'within-factory' production sharing presented in Table 7 is also discernible in Figure 21. It is represented by the high numbers (shown in bold) for the linkages of the blocs EU, NAFTA and the Asia-5 with themselves, which are of course the regional factories described in detail above. In the EU and the Asia-5 the 'within-factory link' is the strongest, while NAFTA in this respect is exceptional because the production links with EU partners (both as immediate and ultimate partner) are of equal importance (EUR 93 billion) as 'Factory North America'.

It is also noticeable that once an immediate production partner from a region is chosen, e.g. the EU as source region (panel a) producing with a country from Asia-5 as the immediate production partner, also the second production partner is likely to be from the Asia-5 region. This pattern is expected as the DVAre indicator on which this analysis is based traces forward value chains and not networks. In the terminology of Baldwin and Venables (2013) this analysis is focused on the 'snake'-type of production where single bits of value are added sequentially to the product, neglecting the 'spider-type' production in which several parts are coming together to form a product.

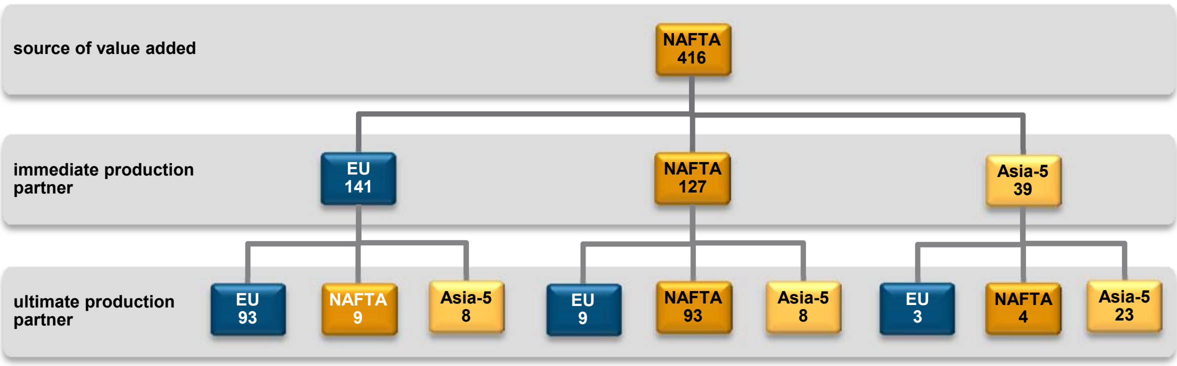
[26] Production linkages to EFTA countries and other countries covered in the WIOD are not shown. For this reason, the numbers at each level do not sum up to the number indicated in the level above. For example, in the case of the EU, VC trade involving the EU (EUR 463 bn), NAFTA (EUR 36 bn) and Asia-5 (EUR 40 bn) do not add up to the EU's total VC trade (EUR 947 bn) because some of these EUR 947 bn of total VC trade is with EFTA (EUR 32 bn) and other countries.

Figure 21 / VC trade linkages between main regional factories, total economy, 2014, in EUR billion

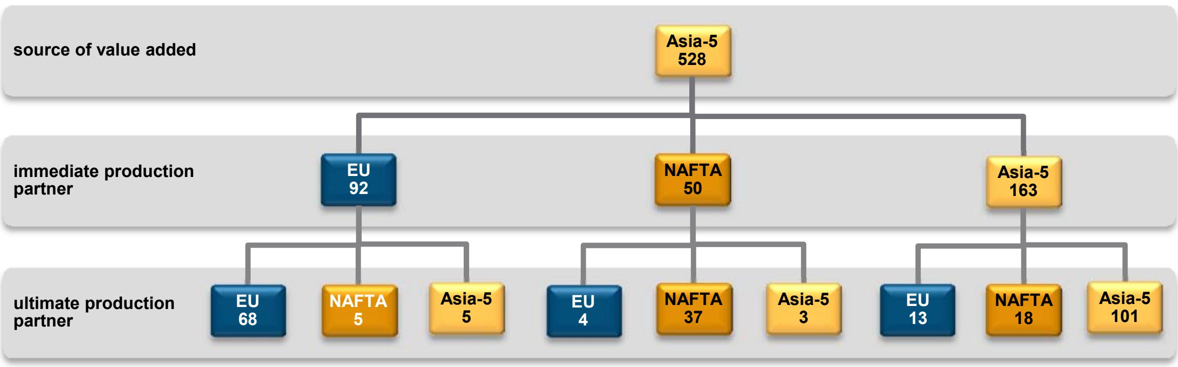
(a) Production linkages (VC trade) of the EU



(b) Production linkages (VC trade) of NAFTA



(c) Production linkages (VC trade) of the Asia-5



Note: Numbers refer to DVAre between the respective regional blocs. Numbers in the lower layers do not add up to the number in the above layer because EFTA and other countries are not shown.
Source: WIOD Release 2016. wiiw calculations.

Note also that the VC trade with partners outside the three trading blocs shown in the figure is most important for the Asia-5; this is due to the fact that some intra-regional partners are part of Rest of the World in the WIOD database. In 2014 it amounted to approximately EUR 220 billion in VC trade, which is much more than for the EU-28 despite the fact that for the latter also VC trade with EFTA is significant and EFTA members were defined to be not part of 'Factory Europe'

It has already been mentioned that the economic size of the trading blocs and the number of potential production partners in the region are influencing the indicators such as the share of RVC trade versus GVC trade. One way of taking into consideration these factors is the revealed export preferences (RXP) index, which was presented in the previous subsection. It will also be an appropriate metric for comparing the geographic orientation of the three trading blocs. More precisely, what is useful in this context is the intra-regional RXP index where the reporting region coincides with the partner region, which in the case of VC trade are the two production partners (immediate production partner and ultimate production partner). This intra-regional RXP index ($RXP_{r,r}$) is equivalent to the regional introversion index *(RII)* suggested in Iapadre (2006).

Therefore, the methodology used for the comparison between the trading blocs based on the RII is fully consistent with the RXP index investigated in Section 4.1. Hence, for any region *r* the RII is defined as

$$RII = \frac{HI_{r,r} - \left[\left(1 - \frac{X_{r,r}}{X_{r,world}}\right) / \left(1 - X_{world^{ex\,r},r} / X_{world^{ex\,r},world}\right)\right]}{HI_{r,r} + \left[\left(1 - \frac{X_{r,r}}{X_{r,world}}\right) / \left(1 - X_{world^{ex\,r},r} / X_{world^{ex\,r},world}\right)\right]}$$

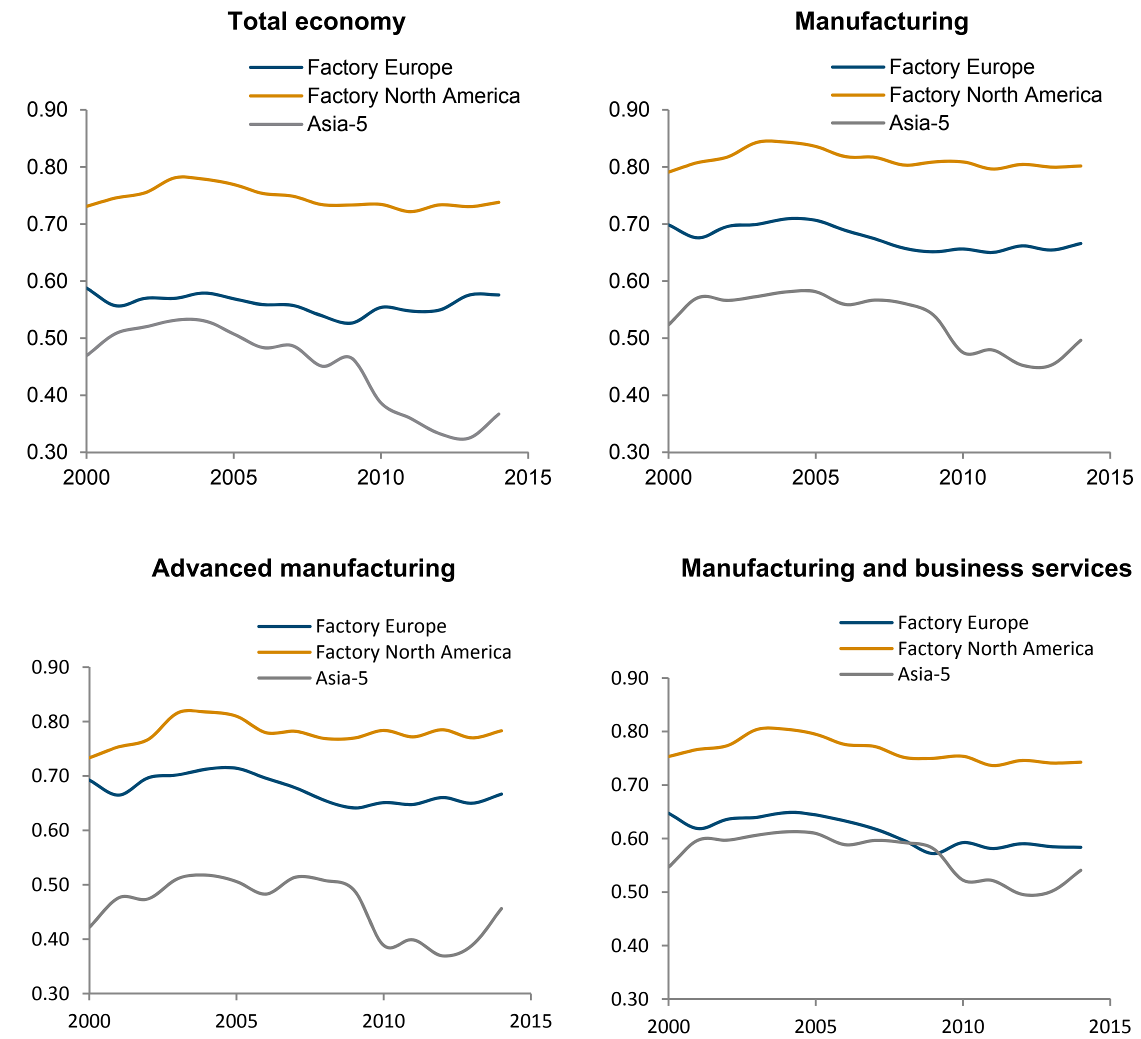
which, in analogy to the RXP index, can be written more compactly as:

$$RII = \frac{HI_{r,r} - HE_{r,r}}{HI_{r,r} + HE_{r,r}}$$

The application of this RII to the EU-28, NAFTA and Asia-5, which represent Factory Europe, Factory North America and Factory Asia-5 respectively, establishes a clear ranking between the three factories with respect to the intra-regional focus in international production cooperation. The strongest regional inversion exists in Factory North America, where this index amounted to 0.74 in 2014 for value added originating from any sector in the economy. This is almost exactly the same value as back in the year 2000 with, however, an interim high around the years 2003 and 2004. With an index of around 0.7, regional introversion is slightly lower in the EU-28. In the case of Factory Europe, the RII was declining slightly between 2000 and 2009 when it went down to 0.53, but it increased again to reach 0.58 in 2014. Finally, the RII is considerably lower when considering the Asia-5. This is partly explained by a relatively strong decline in the RII of Factory Asia-5, at least when the total economy is considered, between 2003 and 2012 when a low of 0.33 was reached. Since then, a slight recovery has been recorded.

Figure 22 illustrates that the ranking is quite consistent across the four aggregates shown. In general, regional introversion seems to be highest when value added from the manufacturing sector is considered. Also, the difference between regional introversion in the EU-28 and in NAFTA varies across the aggregates. More precisely, the difference between the two trading blocs is much smaller in the case of manufacturing and advanced manufacturing than in the total economy. In contrast, in manufacturing and business services, the EU-28's RII is much closer to that of the Asia-5 with the former even dropping briefly below the latter in 2009.

Figure 22 / Comparison of regional introversion across regional 'Factories', 2000-2014



Note: RII calculation based on DVAre for pairs of immediate production partner – ultimate production partner.
Source: WIOD Release 2016. wiiw calculations.

The main reason for the high value for NAFTA is, first of all, the very strong dependence of the Mexican economy on the United States, which is also reflected in the RII. Secondly, for the EU-28, the fact that some important regional partners (especially the EFTA members) are not included in Factory Europe tends to lower the RII. The same is true for Asia-5 because some important regional trading partners cannot be identified individually in the data.

Moreover, it should be stressed that the level of the RII per se is not necessarily a good or a bad thing. A high RII can be seen as an advantage as it signals strong regional integration. At the same time, it may also indicate that there are high barriers to production sharing with partner countries from outside the region. Likewise, it can indicate that the members of the region are not capable of linking into GVCs, i.e. value chains that involve extra-regional partners. Hence, as long as it is unclear whether RVC trade and GVC trade have systematically different implications for countries' economic performance, it is difficult to interpret changes in the RII. Further, it needs to be taken into account that the RII is also influenced by demand patterns. If a region is increasingly exporting value added to extra-regional destinations, this will impact the international organisation of production as was shown in the previous subsection. This helps explaining, for example, the strong decline in the RII of Asia-5 (+ China and composition effect).

Taken together, the results from the analysis of the RII and of the different types of VC trade can be seen as evidence for the fact that Factory Europe is very well developed. In particular, geographic proximity of countries, the absence of tariff barriers and the comparatively low regulatory cross-country barriers within the Single Market have led to a situation where joint production within Factory Europe is more developed than in the two other Factories. Certainly, this outcome is also driven by the fact that within the EU there are much more regional partners to engage with in international production sharing. At the same time, the regional introversion index showed that, when this latter factor is controlled for, the EU is not a closed bloc as compared, for instance, to NAFTA.

5. Involvement in value chains, specialisation and competitiveness

5.1. INTRODUCTION

This section addresses the potential consequences of countries' participating in value chains for specialisation patterns, on the one hand, and competitiveness, on the other hand.

Changes in the specialisation patterns will be captured by the share of manufacturing value added in GDP. If participation in value chains – be they regional or global – facilitates the build-up of manufacturing capacity it becomes an interesting tool for European industrial policy as already alluded to in the European Commission's latest Industrial Policy Communication[27]. Since the specialisation patterns regarding manufacturing also reflect structural change, this set of regressions will be referred to as the '*structural models*'. With regards to competitiveness, two indicators are considered. Firstly, the relationship between labour productivity (both economy-wide and manufacturing-specific) and value chain trade is investigated. Labour productivity growth serves as a direct measure of competitiveness although it is acknowledged that competitiveness at the country or industry level is a more complex phenomenon than at the firm level. This analysis is labelled *'competitiveness model'*. A second commonly-used measure for competitiveness is the ability to sell in international markets. This is an export-oriented view on competitiveness which boils down to an economy's export performance. In line with the value added perspective in this task, changes in world market shares of value added exports serve as an export performance measure. This third investigation constitutes an '*export competitiveness model*'.

In all three models – the structural model, the competitiveness model and the export competitiveness model – the main interest is with the relationship of value chain integration, on the one hand, and structural change (affecting the extent of manufacturing activity), competitiveness and export competitiveness respectively, on the other hand. Importantly, the value chain trade measure in the econometric work is an *intensity*. More precisely, for each country it is the re-exported domestic value added *(DVAre)* – explained in the previous sections – in relation to value added exports. The reason to focus on such an intensity measure is that the analysis should indicate to what extent (forward) participation in VCs is affecting manufacturing change and competitiveness *relative* to trade in general. This focus on VC trade intensities instead of levels of VC trade is explained by the fact that VC integration is a particular form of trade and as such can be expected to foster both specialisation in manufacturing – which is the main tradables-producing sector in EU Member States – as well as productivity growth and in particular world market shares. Therefore the more interesting question which is addressed here is whether VC integration has any merits in addition to trade in general.

This question is investigated econometrically first of all for the world as a whole for the three models mentioned above. This reveals some general patterns for the impact of VC trade on structural change

27 See: 'For a European Industrial Renaissance' (European Commission, 2014).

and competitiveness for the 43 countries in the sample. In a second step, the sample is reduced to the 28 EU Member States, which are all covered in the WIOD 2016 Release. For the EU-specific regressions a linear model and a non-linear model are estimated. The non-linearities are introduced by inserting an interaction term between the VC intensity measure and a dummy variable for the economies forming the Central European Manufacturing Core (CEMC). This additional flexibility in the model allows for the possibility that value chains have differentiated effects on EU Member States' specialisation patterns which is essential both from an industrial policy as well as a cohesion perspective. The following subsection explains in more detail the three types of models to be estimated.

5.2. SPECIALISATION IN MANUFACTURING: STRUCTURAL MODELS

The structural models aim at revealing the relationship between changes in the specialisation patterns which is proxied by changes in the value added share of manufacturing and the VC intensity. The econometric approach investigating this specialisation-value chain nexus is similar to that in Stöllinger (2016), with the basic model taking the following form:

Eq.1 $$\Delta SPEC_{c,t}^{mf} = \alpha + \beta_1 \cdot VC_{c,t-1}^{mf} + \iota \cdot SPEC_{c,t-1}^{mf} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

where $\Delta SPEC_{c,t}^{mf}$ is the change in the manufacturing share of country *c* between time *t* and *t-1.* Throughout the section, *c* denotes the country index and *t* is the time index. In order to exploit the relatively short time period available (2000-2014) the model is estimated in annual changes.

The main explanatory variable is the VC trade intensity measure ($VC_{c,t-1}^{mf}$). Since it is crucial for understanding the estimation results, it should be emphasised again that this measure is the *DVAre* expressed in per cent of country *c*'s value added exports.[28] The VC trade intensity enters the regression with a time lag of one period so that, for example, the change in the manufacturing share occurring between 2000 and 2001 is explained by the VC trade intensity in the year 2000.[29]

The variable $SPEC_{c,t-1}^{mf}$ captures the initial conditions, i.e. the initial value added share of manufacturing. The initial share of manufacturing is intended to control for potential level effects as countries with initially higher manufacturing shares may also be more prone to 'de-industrialise'. According to this type of convergence hypothesis, which Rodrik (2013) has recently shown to hold unconditionally for manufacturing industries at the global level, the initial share of manufacturing is negatively correlated with the change in the manufacturing share. Put differently, countries with initially low shares of manufacturing in GDP should see the relative size of the sector increase by more (or decrease by less) than countries which initially had higher shares – if this convergence hypothesis holds true. For this reason a negative sign for the coefficient of $SPEC_{c,t-1}^{mf}$ is expected.

28 If the sector is the total economy, then these are the gross exports. If the sector is manufacturing, this is the value added (both foreign and domestic) created in manufacturing industries that is exported.

29 The reverse causality issue is already remedied by the fact that the dependent variable is in differences.

Since the three definitions of the manufacturing sector introduced earlier[30] are investigated, it is useful to point out that in all cases the initial conditions correspond to the respective 'aggregate' under consideration.

The matrix $X_{c,t-1}$ comprises a set of control variables while μ_c and δ_t are country and time fixed effects respectively and $\varepsilon_{c,t}$ denotes the error term. The control variables included are an exchange rate measure; the share of advanced labour in total labour as a measure for human capital; the gross expenditure on R&D in per cent of GDP, i.e. R&D intensity; GDP per capita; and population as an additional control for country size (on top of the country fixed effect).

When estimating the structural model for the global sample, the role of the exchange rate is captured by the overvaluation measure developed by Dollar (1992) and used, for example, in McMillan and Rodrik (2011) in their regression explaining their measure of (economy-wide) structural upgrading and also in Stöllinger (2016) who also investigates the GVC–structural change nexus. In essence, this measure of exchange rate overvaluation exploits the empirical regularity that the price level of consumption in an economy is correlated with the GDP per capita by regressing the former on the latter in a panel regression including time fixed effects for the period 2000-2014 for all countries available in the Penn World Tables, version 9 (PWT 9). The difference between the predicted price level and the actual price level indicates the degree of exchange rate overvaluation. The rationale for including the real exchange rate into the structural model is that in open economies, the real exchange rate is an important determinant of export competitiveness. Since the manufacturing sector is the main tradables-producing sector for EU economies, a rising real exchange rate can be expected to hamper exports and to result in negative manufacturing structural change. Therefore a negative coefficient for the real exchange rate is expected.

For the EU Member States, full information on the unit labour cost-based real effective exchange rate (based on 28 partner countries) is available from Eurostat, which is why for the EU-specific structural model this indicator is used. More precisely, since the real effective exchange rate is reported as an index, the year-to-year changes in this index enter the model.

To control for the possibility that structural change regarding the manufacturing sector is affected by the availability of skilled labour, the share of 'advanced labour' in the total labour force is included. The definition of advanced labour follows the International Standard Classification of Education (ISCED), which comprises the skill categories 5-6 in the ISCED-97 and the categories 5-8 in the ISCED-2011. The data source is the ILO for the global sample and Eurostat for the EU-28 sample.

A further control is the R&D intensity, which is intended to capture the fact that the manufacturing sector accounts for the lion's share of the R&D expenditures by firms (see European Commission, 2013; Stöllinger et al., 2013). Therefore it can be expected that higher R&D intensities are positively correlated with the evolution of the manufacturing share. The data come mainly from the OECD database, supplemented with information from the World Bank's World Development Indicators (WDI).

Following Chenery (1960), Chenery and Syrquin (1975) and more recently Haraguchi and Rezonja (2011) the initial GDP per capita (in logarithmic form) is included as a control for general demand

30 These are the manufacturing sector as commonly defined (NACE Rev. 2 sector C); advanced manufacturing industries; and an expanded manufacturing sector which includes business services).

conditions. Chenery and Syrquin (1975) estimate a model explaining changes in the industry share[31] and find a positive coefficient for GDP per capita and a negative one for the squared term[32]. This suggests that the higher demand associated with higher income supports structural change in favour of the industrial sector and that this effect weakens with a higher level of incomes. However, there is also the de-industrialisation hypothesis (Clark, 1940), which suggests that with rising incomes, the economic structure will shift increasingly towards services to the detriment of the manufacturing sector. According to Baumol (1967), these de-industrialisation tendencies are due to faster productivity growth in manufacturing. According to the de-industrialisation hypothesis, the coefficient of the initial GDP per capita should have a negative sign, i.e. the opposite result as that obtained by Chenery and Syrquin (1975).

GDP per capita data are taken from the WDI in the case of the global sample and from Eurostat in the EU-specific estimations.

Finally, the population of each country is included (in logarithmic form) in order to have an additional control for country size, although the regressions already include a country fixed effect. As for GDP per capita, the population data come from the WDI in the case of the global sample and from Eurostat in the EU-specific estimations.

For the EU-28 sample a more flexible model than that in equation Eq. 1 is estimated. The additional flexibility is introduced via an interaction term between the VC trade intensity variable and a dummy variable for the countries belonging to the CEMC. The interaction term allows for a differentiated impact of VC integration on specialisation in manufacturing for the members of the CEMC and the remainder of the EU Member States. This non-linear regression takes the form

Eq. 2 $$\Delta SPEC_{c,t}^{mf} = \alpha + \beta \cdot VC_{c,t-1}^{mf} + \gamma \cdot VC_{c,t-1}^{mf} \times CEMC + \iota \cdot SPEC_{c,t-1}^{mf} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

where $CEMC$ is a dummy variable taking the value 1 for Austria, the Czech Republic, Germany, Hungary, Poland and Slovakia and 0 for all other Member States.

In addition to the models in Eq. 1 and Eq. 2, several variants of the structural model are estimated which distinguish between regional value chains and global value chains as defined in section 2.4. In this respect, a model including exclusively the RVC intensity defined as a country's RVC trade over that country's total VAX; a model including exclusively the GVC intensity defined as a country's GVC trade over that country's total VAX; and a model containing both elements are estimated.[33] This distinction is made in order to see whether it is possible to identify a qualitative difference between GVC integration and RVC integration with respect to the impact of specialisation in manufacturing activities.

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31 Chenery and Syrquin (1975) use changes in the share of industry and not changes in the manufacturing sector as a dependent variable (see their regression 5b in Table 5, p. 38).

32 The latter is omitted in the structural model employed in this section.

33 This way of defining regional and global VC trade intensity ensures that $\frac{RVC}{VAX} + \frac{GVC}{VAX} = \frac{VC}{VAX}$. Moreover, defining the RVC trade intensity and the GVC trade intensity as RVC trade and GVC trade as ratios to regional and global VAX is problematic as VAX include also direct exports for which the distinction between regional and global makes less sense. The only way to proceed in this direction would have been to assign all directly exported value added (in the form of final goods) to the regional part of VAX because production is done uniquely by the reporting country and hence 'within the region'. This would bias the measure and result in high GVC intensities and very low RVC intensities.

Moreover, the structural model for the EU-28 also incorporates additional control variables. These are average wages in the manufacturing sector (in logarithmic form), which are taken from Eurostat. Moreover, the potential influences of government effectiveness, obtained from the World Bank's World Governance Indicators (WGI), and of labour regulations, taken from the Fraser Institute's Economic Freedom Database, are included into the model. The latter index, which ranges from 0 to 10, is to be understood as freedom from regulation. Hence, a country is assigned high marks in the labour market regulation indicator if it allows market forces to determine wages and establish the conditions of hiring and firing.[34]

5.3. LABOUR PRODUCTIVITY: COMPETITIVENESS MODELS

The theoretical literature on offshoring, which is tightly linked to value chain trade, provides some clear predictions for the implications of offshoring with regards to labour productivity. Already in the one-sector model by Feenstra and Hanson (1996), offshoring increases productivity in the 'headquarter economy' because activities are outsourced as long as the differences in wages between the offshoring economy and the economy where the activities are offshored to equal the costs of offshoring which differ across activities. This implies that up to the 'marginal activity' that is offshored, there is a productivity gain for firms re-locating parts of their production abroad. Similarly, also in the more general, multi-sector offshoring model by Grossman and Rossi-Hansberg (2008) *"improvements in the technology for offshoring low-skill tasks are isomorphic to (low-skilled) labor-augmenting technological progress"* (p. 1979) so that wages (and hence labour productivity) in the headquarter economies increases. Hence, increased VC trade – if it mirrors reduced costs of offshoring brought about by improved communication technologies and lower trade costs – should entail increases in productivity. Therefore, in contrast to structural change, where the implications depend strongly on the the types of activities (or 'tasks') offshored and the sectors which are offshoring, the offshoring literature predicts a positive relationship between VC trade and labour productivity growth. This can be shown in the data. The question to be explored in this section though is, to which extent VC trade is fostering labour productivity relative to trade in general. Since trade models also predict productivity gains from overall trade due to improved allocative efficiency, it is a priori not entirely clear whether VC trade particularly prone to foster labour productivity. Therefore an econometric model for analysing the relationship between labour productivity – which also serves as a measure of competitiveness – and VC integration, which strongly resembles the structural model, is set up. Given data restrictions for data on labour productivity, this model is estimated at the level of the total economy and for the manufacturing sector as commonly defined. The basic regression takes the following form:

Eq. 3 $$\Delta lnLP^{i}_{c,t} = \alpha + \beta \cdot VC^{i}_{c,t-1} + \iota \cdot lnLP^{i}_{c,t-1} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

where $\Delta lnLP^{i}_{c,t}$ refers to the log growth rate of labour productivity of country *c* between time *t* and *t-1*. The index *i* indicates the sector, which in this case may be the total economy or the manufacturing sector.

The competitiveness model also controls for initial conditions ($lnLP^{i}_{c,t}$) but it omits the GDP per capita because of the high correlation with labour productivity. Moreover, since there are no trade and specialisation patterns involved, there is no need to control for the exchange rate. From the set of control

34 See https://www.fraserinstitute.org/economic-freedom/approach

variables mentioned in the context of the structural model, the share of advanced labour in the labour force and the R&D intensity is maintained. A higher R&D intensity is expected to support labour productivity growth. Similarly, a positive impact of the advanced labour share on labour productivity is expected.

Also in this case, for the EU-28 sample the model features an interaction term between the VC trade intensity and the dummy variable for the CEMC:

Eq. 4 $$\Delta lnLP_{c,t}^{i} = \alpha + \beta \cdot VC_{c,t-1}^{i} + \gamma \cdot VC_{c,t-1}^{i} \times CEMC + \iota \cdot lnLP_{c,t-1}^{i} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

With regards to the additional control variables, some specifications of the model described by Eq.4 will also include the average wage (in logarithmic form) – either for the total economy or the manufacturing sector, depending on the aggregate under consideration –, government effectiveness and labour market regulations. In addition, also capital intensity, i.e. gross fixed capital formation in per cent of GDP, is included because a larger capital base should equally support labour productivity growth.

5.4. WORLD MARKET SHARES: EXPORT COMPETITIVENESS MODELS

The regression model for the export competitiveness models mirrors that of the structural model and the competitiveness model above but using the world market shares in value added exports ($\Delta wmsVAX_{c,t}^{i}$). This results in the following model:

Eq. 5 $$\Delta wmsVAX_{c,t}^{i} = \alpha + \beta \cdot VC_{c,t-1}^{i} + \iota \cdot wmsVAX_{c,t-1}^{i} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

For the regressions at the global level, the control variables comprise the exchange rate overvaluation, the share of advanced labour and the R&D intensity.

In line with the approach for the structural model and the competitiveness model, there is also a non-linear version of the export competitiveness model which is estimated for the EU-28:

Eq. 6 $$\Delta wmsVAX_{c,t}^{i} = \alpha + \beta \cdot VC_{c,t-1}^{i} + \gamma \cdot VC_{c,t-1}^{i} \times CEMC + \iota \cdot wmsVAX_{c,t-1}^{i} + X_{c,t-1} \cdot \varphi + \delta_t + \mu_c + \varepsilon_{c,t}$$

In addition to the controls used in the estimation for the global sample, where the exchange rate overvaluation is replaced by the unit labour cost-based real effective exchange rate, also the average wage (in logarithmic form), labour market regulations and government effectiveness are included into the model.

For both the competitiveness models and the export competitiveness models, specifications that differentiate between RVC trade intensity and GVC trade intensity are run.

5.5. RESULTS

Estimation results at the global level

The results are first reported for the global sample (comprising 43 reporting economies), starting with the structural models (Table 8). Two sets of results are reported. A first one in which the control variables are limited to the initial conditions and the exchange rate overvaluation and a second model which contains the full set of controls.

The main result that emerges from the regressions is that VC trade intensity overall does not seem to affect changes in the value added share of manufacturing. However, in the more parsimonious model, a weakly significant and positive effect for the GVC trade intensity is obtained. This is regardless of whether only the GVC trade intensity or both, RVC and GVC trade intensity are included in the model. However, the statistical significance is lost in the specification with the full set of controls. Also, the coefficient even of the GVC trade intensity is not statistically significant for the specifications for the advanced manufacturing industries and the manufacturing sector including business services.[35]

Table 8 / Structural models, manufacturing, global sample

Aggregate: **Manufacturing**
Sample: **Global**
Dependent Variable: **Δvalue added share of manufacturing**

	Model SPEC 1				Model SPEC 2			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	VC	RVC	GVC	RVC+GVC	VC	RVC	GVC	RVC+GVC
VC intensity	0.0486				0.0417			
	(0.0292)				(0.0314)			
RVC intensity		0.0352		0.0330		0.0256		0.0244
		(0.0302)		(0.0303)		(0.0320)		(0.0334)
GVC intensity			0.0769*	0.0753*			0.0699	0.0692
			(0.0388)	(0.0398)			(0.0448)	(0.0453)
share manufacturing	-0.2233***	-0.2259***	-0.2142***	-0.2188***	-0.2638***	-0.2650***	-0.2596***	-0.2612***
	(0.0392)	(0.0377)	(0.0372)	(0.0378)	(0.0565)	(0.0549)	(0.0563)	(0.0562)
real FX overevaluation	-0.0123***	-0.0123***	-0.0124***	-0.0123***	-0.0092	-0.0089	-0.0090	-0.0092
	(0.0041)	(0.0041)	(0.0041)	(0.0041)	(0.0056)	(0.0056)	(0.0055)	(0.0056)
advanced labour share					0.0218	0.0220	0.0199	0.0207
					(0.0132)	(0.0135)	(0.0138)	(0.0140)
R&D intensity					0.3659**	0.3535**	0.3817**	0.3780**
					(0.1753)	(0.1746)	(0.1856)	(0.1814)
ln GDP per capita					-0.0109**	-0.0114**	-0.0102**	-0.0104**
					(0.0052)	(0.0054)	(0.0050)	(0.0051)
ln population					-0.0477**	-0.0483**	-0.0484***	-0.0479***
					(0.0177)	(0.0179)	(0.0174)	(0.0174)
constant	0.0270***	0.0360***	0.0267***	0.0241***	0.9223***	0.9468***	0.9284***	0.9182***
	(0.0089)	(0.0071)	(0.0069)	(0.0083)	(0.3279)	(0.3346)	(0.3197)	(0.3207)
Observations	602	602	602	602	555	555	555	555
R-squared	0.3787	0.3754	0.3781	0.3795	0.4089	0.4062	0.4091	0.4098
R-sq. dj.	0.312	0.309	0.312	0.312	0.337	0.334	0.337	0.337
F-test	19.41	21.82	19.53	19.45	23.77	22.58	25.49	23.90

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period.

35 These results are not reported.

While the model is relatively disappointing as concerns the VC intensities, the other outcomes are mainly as expected. In particular, a strong negative coefficient is obtained for the initial share of manufacturing, signalling a convergence effect with regards to specialisation in manufacturing as suggested by Rodrik (2013). Moreover, an overvalued exchange rate is suggested to hamper the specialisation in manufacturing. The effect of the exchange rate overvaluation disappears, however, when introducing the R&D intensity, advanced labour share, GDP per capita and population. The R&D intensity is supporting the value added share of manufacturing, while the coefficient of GDP per capita is negative, supporting the hypothesis that countries tend to move out of manufacturing as they grow richer.

Proceeding to the competitiveness models for the total economy[36] (Table 9), the pattern obtained resembles to some extent the one in the structural models. In particular with regard to the VC trade intensity, the more parsimonious version of the competitiveness model (model COMP 1) delivers no significant estimates for the overall VC trade intensity, but there is a positive and mildly statistically significant effect of GVC trade intensity on real labour productivity growth when only the GVC trade intensity is included. In the second model (COMP 2), which takes on board the share of advanced labour in the labour force and the R&D intensity, the GVC intensity is also positive and statistically significant at the 10% level, this time in both specifications, the one including only the GVC trade intensity and also the one that includes both GVC and RVC trade intensity.

Table 9 / Competitiveness models, total economy, global sample

Aggregate: Total economy
Sample: Global
Dependent Variable: Labour productivity growth

	Model COMP 1				Model COMP 2			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	VC	RVC	GVC	RVC+GVC	VC	RVC	GVC	RVC+GVC
VC intensity	-0.0173				0.0090			
	(0.0623)				(0.0560)			
RVC intensity		-0.1713		-0.1485		-0.1438		-0.1144
		(0.1137)		(0.1024)		(0.0966)		(0.0792)
GVC intensity			0.1681*	0.1400			0.1764*	0.1516*
			(0.0918)	(0.0901)			(0.0917)	(0.0842)
ln labour productivity	-0.0503*	-0.0497*	-0.0455	-0.0461*	-0.0935***	-0.0910***	-0.0883***	-0.0870***
	(0.0275)	(0.0261)	(0.0279)	(0.0265)	(0.0274)	(0.0268)	(0.0281)	(0.0277)
advanced labour share					0.0084	0.0022	0.0027	-0.0013
					(0.0220)	(0.0232)	(0.0242)	(0.0253)
R&D intensity					0.0904	0.0146	0.2091	0.1391
					(0.4019)	(0.3978)	(0.4119)	(0.4095)
constant	0.5747*	0.5811**	0.4897	0.5160*	1.0440***	1.0377***	0.9611***	0.9653***
	(0.3042)	(0.2872)	(0.3133)	(0.2955)	(0.2996)	(0.2855)	(0.3139)	(0.3046)
Observations	602	602	602	602	555	555	555	555
R-squared	0.6366	0.6406	0.6399	0.6428	0.6099	0.6130	0.6141	0.6160
R-sq. dj.	0.599	0.603	0.602	0.605	0.565	0.569	0.570	0.571
F-test	9.210	9.135	9.237	9.293	28.52	24.47	18.54	20.30

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period.

36 At the global level only economy-wide real labour productivity data are available.

Finally, the results for the export competitiveness models are reported in Table 10. As in the structural model, the export competitiveness model picks up the expected convergence tendencies in international trade as evidenced by the negative coefficient of the initial world market share in VAX and the negative impact of an overvalued real exchange rate. At the same time the export competitiveness model is unsuccessful in detecting any relationship between VC trade intensity and world market shares in value added exports, be it regional or global VC integration. One way of interpreting this result is that integration in VCs is not facilitating the capture of additional world market shares. Put differently, there is no evidence for the possibility that VC integration provides a great potential for countries to make inroads into global markets in terms of domestic value added as mentioned, for example, in Collier and Venables (2007).

Table 10 / Export competitiveness models, total economy, global sample

Aggregate: **Total economy**
Sample: **Global**
Dependent Variable: **Δworld market share of VAX**

	Model EXCO 1				Model EXCO 2			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	VC	RVC	GVC	RVC+GVC	VC	RVC	GVC	RVC+GVC
VC intensity	-0.0074				0.0023			
	(0.0084)				(0.0073)			
RVC intensity		-0.0077		-0.0086		-0.0009		0.0002
		(0.0116)		(0.0123)		(0.0083)		(0.0090)
GVC intensity			-0.0043	-0.0059			0.0051	0.0052
			(0.0047)	(0.0057)			(0.0060)	(0.0070)
wms VAX	-0.0408	-0.0410	-0.0408	-0.0408	-0.1888***	-0.1857***	-0.1898***	-0.1899***
	(0.0415)	(0.0423)	(0.0431)	(0.0415)	(0.0286)	(0.0297)	(0.0310)	(0.0289)
real FX overevaluation	-0.0032***	-0.0032***	-0.0032***	-0.0032***	-0.0021**	-0.0021**	-0.0020**	-0.0020**
	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
advanced labour share					0.0034	0.0033	0.0032	0.0032
					(0.0022)	(0.0021)	(0.0020)	(0.0020)
R&D intensity					0.0537**	0.0504**	0.0547**	0.0549**
					(0.0262)	(0.0244)	(0.0263)	(0.0264)
ln GDP per capita					0.0050***	0.0049***	0.0050***	0.0050***
					(0.0016)	(0.0015)	(0.0016)	(0.0016)
ln population					0.0057*	0.0058*	0.0054	0.0054
					(0.0033)	(0.0033)	(0.0033)	(0.0033)
constant	0.0031	0.0020	0.0019*	0.0030	-0.1442**	-0.1449**	-0.1405**	-0.1406**
	(0.0026)	(0.0016)	(0.0010)	(0.0023)	(0.0680)	(0.0686)	(0.0683)	(0.0685)
Observations	602	602	602	602	555	555	555	555
R-squared	0.4840	0.4831	0.4816	0.4841	0.3792	0.3790	0.3798	0.3798
R-sq. dj.	0.429	0.428	0.426	0.428	0.304	0.304	0.304	0.303
F-test	3.447	3.360	4.107	4.101	32.79	36.64	41.97	43.10

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period.

Estimation results for the EU-28

This section repeats and expands the analysis at the global level for the EU Member States. Apart from additional control variables, the regressions include non-linearities in the form of interaction terms between the VC intensities and a dummy variable for the members of the CEMC.

Table 11 / Structural models, manufacturing, EU-28 sample (model 1)

Aggregate:	**Manufacturing**							
Sample:	**EU-28**							
Dependent Variable:	**Δvalue added share of manufacturing**							
	Model SPEC 1							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0372	0.0270						
	(0.0409)	(0.0388)						
VC intensity x CEMC		0.1310**						
		(0.0617)						
RVC intensity			0.0308	0.0222			0.0322	0.0350
			(0.0423)	(0.0407)			(0.0430)	(0.0454)
RVC intensity x CEMC				0.1573				-0.0310
				(0.1213)				(0.1161)
GVC intensity					0.0477	0.0328	0.0500	0.0368
					(0.0665)	(0.0698)	(0.0684)	(0.0721)
GVC intensity x CEMC						0.2599**		0.2779**
						(0.0996)		(0.1033)
share manufacturing	-0.2257***	-0.2523***	-0.2268***	-0.2398***	-0.2202***	-0.2520***	-0.2243***	-0.2559***
	(0.0530)	(0.0573)	(0.0509)	(0.0544)	(0.0497)	(0.0530)	(0.0504)	(0.0543)
Δreal FX (ULC based)	-0.0201**	-0.0205**	-0.0202**	-0.0198**	-0.0201**	-0.0216***	-0.0201**	-0.0217***
	(0.0084)	(0.0079)	(0.0085)	(0.0084)	(0.0082)	(0.0076)	(0.0083)	(0.0077)
constant	0.0277**	0.0264**	0.0334***	0.0305***	0.0308***	0.0317***	0.0266**	0.0277**
	(0.0120)	(0.0123)	(0.0103)	(0.0107)	(0.0079)	(0.0091)	(0.0113)	(0.0118)
Observations	364	364	364	364	364	364	364	364
R-squared	0.4316	0.4391	0.4306	0.4338	0.4306	0.4406	0.4316	0.4418
R-sq. dj.	0.357	0.364	0.356	0.358	0.356	0.365	0.355	0.363
F-test	46.20	49.29	38.19	52.26	49.53	81.71	47.75	121.2

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

Table 11 reports the first set of results for a structural model which includes the same set of controls as the one at the global level. First of all, it is reassuring that the real exchange rate development, which is now proxied by changes in the ULC-based real effective exchange rate, delivers again the expected negative sign. Likewise, the negative and highly statically significant coefficient of the manufacturing share is evidence for the convergence tendencies within manufacturing production (see Rodrik, 2013). When it comes to the VC intensities, the results are mixed. To start with, there is no evidence for a general EU-wide positive impact of VC trade intensity on the specialisation in manufacturing – neither for the overall VC trade intensity, nor for the GVC and RVC trade intensity as evidenced by the linear models throughout all specifications. This changes, though, when differentiated effects for the countries belonging to the CEMC and the other EU Member States are allowed for. According to the non-linear version of specification (1), a one percentage point increase in the VC trade intensity would accelerate the shift into (or reduce the shift out of) the manufacturing sector by 0.16 (0.027+0.131) percentage points for the members of the CEMC. No such effect is detectible for the other EU Member States. These results confirm the findings in Stöllinger (2016) which are based, however, on different measures of value chain integration. The result also holds when RVC and GVC trade intensities are considered separately. In this case the model assigns a positive impact of VC integration to the GVC trade intensity which is statistically significant at the 5% level, irrespective of whether or not the RVC trade intensity is included. In terms of magnitudes, the effect is about twice as large when the GVC intensity is considered compared to the overall VC intensity.

Table 12 / Structural models, manufacturing, EU-28 sample (model 2)

Aggregate: **Manufacturing**
Sample: **EU-28**
Dependent Variable: **Δvalue added share of manufacturing**

	Model SPEC 2							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	-0.0060	-0.0188						
	(0.0369)	(0.0365)						
VC intensity x CEMC		0.1834**						
		(0.0804)						
RVC intensity			0.0134	0.0046			0.0173	0.0332
			(0.0386)	(0.0396)			(0.0388)	(0.0467)
RVC intensity x CEMC				0.1485				-0.1087
				(0.1426)				(0.1012)
GVC intensity					-0.0571	-0.0929	-0.0600	-0.0960
					(0.0895)	(0.0917)	(0.0892)	(0.0898)
GVC intensity x CEMC						0.4072***		0.4664***
						(0.1201)		(0.1198)
share manufacturing	-0.3921***	-0.4364***	-0.3938***	-0.4088***	-0.3932***	-0.4509***	-0.3948***	-0.4508***
	(0.0963)	(0.1029)	(0.0958)	(0.1023)	(0.0926)	(0.0929)	(0.0923)	(0.0935)
Δreal FX (ULC based)	-0.0230**	-0.0248***	-0.0230**	-0.0236**	-0.0224**	-0.0244***	-0.0222**	-0.0241***
	(0.0101)	(0.0085)	(0.0101)	(0.0095)	(0.0101)	(0.0081)	(0.0102)	(0.0082)
advanced labour share	0.0411*	0.0507**	0.0426*	0.0444**	0.0439*	0.0610**	0.0456*	0.0644**
	(0.0209)	(0.0235)	(0.0216)	(0.0215)	(0.0226)	(0.0278)	(0.0235)	(0.0291)
R&D intensity	0.5861**	0.4912**	0.5787**	0.5573**	0.5936**	0.4417*	0.5886**	0.4264*
	(0.2502)	(0.2280)	(0.2476)	(0.2411)	(0.2450)	(0.2161)	(0.2446)	(0.2100)
ln GDP per capita	-0.0385***	-0.0445***	-0.0385***	-0.0389***	-0.0408***	-0.0532***	-0.0410***	-0.0548***
	(0.0106)	(0.0113)	(0.0107)	(0.0105)	(0.0117)	(0.0137)	(0.0119)	(0.0143)
ln population	-0.0871***	-0.0994***	-0.0886***	-0.0916***	-0.0884***	-0.1078***	-0.0899***	-0.1107***
	(0.0267)	(0.0288)	(0.0261)	(0.0269)	(0.0244)	(0.0263)	(0.0250)	(0.0267)
ln wage manufacturing	0.0154**	0.0178***	0.0152**	0.0157***	0.0156**	0.0193***	0.0154**	0.0191***
	(0.0057)	(0.0056)	(0.0057)	(0.0055)	(0.0058)	(0.0059)	(0.0058)	(0.0060)
labour market regulation	0.0021**	0.0022**	0.0019*	0.0020*	0.0020**	0.0022**	0.0019*	0.0020**
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0009)	(0.0009)	(0.0010)	(0.0009)
government effectiveness	-0.0056	-0.0061	-0.0057	-0.0060	-0.0060	-0.0065*	-0.0061	-0.0065*
	(0.0036)	(0.0037)	(0.0036)	(0.0037)	(0.0038)	(0.0038)	(0.0038)	(0.0038)
constant	1.6552***	1.8853***	1.6791***	1.7241***	1.7017***	2.1009***	1.7291***	2.1634***
	(0.4903)	(0.5240)	(0.4912)	(0.5010)	(0.4469)	(0.4829)	(0.4587)	(0.4899)
Observations	330	330	330	330	330	330	330	330
R-squared	0.5578	0.5689	0.5579	0.5601	0.5587	0.5775	0.5589	0.5789
R-sq. dj.	0.482	0.494	0.482	0.483	0.483	0.504	0.482	0.502
F-test	24.04	51.21	21.56	33.96	20.66	33.16	18.14	27.58

This result is robust to the inclusion of further control variables as shown in Table 12. In fact, the addition of further control variables suggests that the relationship with VC trade intensity and GVC trade intensity, respectively, is even stronger. In the case of the latter, an increase by 1 percentage point would accelerate manufacturing specialisation by 0.37 percentage points for the CEMC members. Note that despite this stronger result no overall effect for any of the VC measures is detected for the EU members as a whole (i.e. in the linear models).[37]

Also some of the additional control variables are worth mentioning in this context. First of all, the regression result suggests that lower wages do not help to increase the manufacturing share. In contrast, the coefficient of the wage variable is positive and statistically significant at the 1% and 5% level, respectively, depending on the specification.[38] Hence, it is higher, not lower wages that are associated with increases in the value added shares of manufacturing. In combination with the positive coefficient obtained for the R&D intensity and the advanced labour share, this is fully compatible with the view that for European manufacturing to be successful it ought to opt for the high road strategy (Aiginger and Vogel, 2015) for competitiveness, i.e. high wages and high quality, instead of the low road strategy based on low wages and low energy prices. At the same time, more flexible labour markets, i.e. less labour market regulations reflecting a high score in the Economic Freedom index, are equally suggested to foster specialisation in manufacturing.

Taken together, the result suggests that integration in value chains, and in particular in global value chains, supports the development of the manufacturing sector only in a subset of EU Member States which are already relatively strongly specialised in manufacturing production and which have all been gaining market share in EU-wide value added exports since the year 2000. As such, the results can be seen as evidence for strong agglomeration forces which are due to a variety of factors, including potentially geographic proximity, skill complementarities, increasing returns to scale and path dependencies in location choices of FDI investors. At the same time, the convergence results also indicate that the specialisation processes are rather complex and that in parallel to these implied agglomeration effects there is also convergence detectable between countries with different value added shares of manufacturing. Hence, various agglomeration and convergence forces seem to be at play, together with institutional factors such as labour market regulations, which all impact on manufacturing specialisation.

The main results regarding the relationships between changes in the manufacturing share and VC trade integration also hold when only advanced manufacturing industries or a broader manufacturing sector which also comprises business services are considered (see Appendix 4).

Following the investigation of the relationship between VC intensity and the specialisation in manufacturing, the role of VC integration for competitiveness as proxied by labour productivity is analysed.

The results for the first competitiveness models are presented in Table 13. In contrast to the structural model, and also in comparison to the competitiveness model at the global level, VC trade intensity does not seem to matter for labour productivity growth. The strong convergence effect suggesting that countries with initially lower labour productivity experience higher labour productivity growth remains intact also in this context but all the VC trade intensity measures fail to pick up any effect. This result may come as a surprise given the existing results in the literature, especially the findings of Kummritz

[37] An EU-wide effect of VC integration is found solely in the specifications using the enlarged manufacturing sector which includes business services (see Appendix 4).

[38] It should be mentioned though that there is a relatively high (0.91) correlation between GDP per capita and manufacturing wages.

(2016), who reports a statistically significant relationship between labour productivity and his measures of forward and backward production integration. Importantly, however, the hypothesis tested therein differs from the analysis here as it is performed on levels of VC trade instead of intensities (for further explanations see Box 2).

Table 13 / Competitiveness models, total economy, EU-28 sample (model 1)

Aggregate: **Total economy**
Sample: **EU-28**
Dependent Variable: **labour productivity growth**

	Model COMP 1							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	-0.0154	-0.0125						
	(0.0541)	(0.0538)						
VC intensity x CEMC		-0.0419						
		(0.1225)						
RVC intensity			0.0081	0.0014			0.0086	-0.0109
			(0.0616)	(0.0603)			(0.0602)	(0.0594)
RVC intensity x CEMC				0.0566				0.1198
				(0.2136)				(0.2119)
GVC intensity					-0.0955	-0.0892	-0.0956	-0.0802
					(0.1594)	(0.1625)	(0.1602)	(0.1653)
GVC intensity x CEMC						-0.2941		-0.3439
						(0.1978)		(0.2105)
ln labour productivity	-0.1191***	-0.1187***	-0.1188***	-0.1191***	-0.1239***	-0.1244***	-0.1241***	-0.1248***
	(0.0143)	(0.0141)	(0.0141)	(0.0137)	(0.0189)	(0.0197)	(0.0191)	(0.0195)
constant	1.2780***	1.2764***	1.2700***	1.2722***	1.3380***	1.3503***	1.3393***	1.3518***
	(0.1581)	(0.1580)	(0.1497)	(0.1465)	(0.2173)	(0.2286)	(0.2188)	(0.2269)
Observations	366	366	366	366	366	366	366	366
R-squared	0.6397	0.6398	0.6397	0.6398	0.6401	0.6414	0.6401	0.6417
R-sq. dj.	0.594	0.593	0.594	0.593	0.595	0.595	0.593	0.593
F-test	36.83	35.86	34.98	32.65	39.77	42.11	37.00	34.71

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

BOX 2 / PRODUCTIVITY AND INTERNATIONAL VALUE CHAIN INTEGRATION

Recalling that value chain (VC) trade is a particular type of trade, i.e. the one involving at least two border crossings, leads to the expectation that VC trade and labour productivity should be positively related. This relationship could be nurtured by productivity gains through specialisation along comparative advantages and through fixed cost spreading in the case of increasing returns to scale. In fact, this relationship has been tested by Kummritz (2016), who found a positive relationship between the logarithm of labour productivity and the logarithm of his forward production integration measure (the domestic value added in foreign exports). Using the OECD Inter-Country Input-Output (ICIO) Tables comprising some 60 countries, he reports a statistically highly significant coefficient for the (log of) domestic value added in foreign exports on (the log of) labour productivity in the order of 0.78 for the country-level model.

Table 14 indicates that the inclusion of a large set of additional control variables does not alter the result. Neither real investments nor investment in R&D (both expressed in per cent of GDP) seem to affect labour productivity growth. Not even the economy-wide wages are capable of explaining a part of labour productivity growth. Switching from the economy-wide analysis to the manufacturing-specific level does not change the results either. These results are therefore not reported.

Table 14 / Competitiveness models, total economy, EU-28 sample (model 2)

Aggregate: Total economy
Sample: EU-28
Dependent Variable: labour productivity growth

	Model COMP 2							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	-0.0159	-0.0074						
	(0.0984)	(0.1036)						
VC intensity x CEMC		-0.1010						
		(0.1483)						
RVC intensity			0.0586	0.0682			0.0715	0.0729
			(0.1196)	(0.1350)			(0.1109)	(0.1244)
RVC intensity x CEMC				-0.0696				-0.0307
				(0.2327)				(0.2266)
GVC intensity					-0.2757	-0.2695	-0.2868	-0.2833
					(0.2207)	(0.2243)	(0.2212)	(0.2315)
GVC intensity x CEMC						-0.3300		-0.3103
						(0.2820)		(0.2729)
ln labour productivity	-0.1248***	-0.1244***	-0.1240***	-0.1244***	-0.1363***	-0.1341***	-0.1367***	-0.1349***
	(0.0388)	(0.0391)	(0.0347)	(0.0347)	(0.0419)	(0.0427)	(0.0413)	(0.0426)
advanced labour share	0.0089	0.0051	0.0101	0.0093	0.0142	0.0065	0.0159	0.0083
	(0.0510)	(0.0527)	(0.0519)	(0.0522)	(0.0500)	(0.0534)	(0.0510)	(0.0543)
R&D intensity	0.3380	0.4002	0.3670	0.3807	0.3927	0.5432	0.4255	0.5722
	(0.5790)	(0.6071)	(0.5798)	(0.5870)	(0.5788)	(0.6298)	(0.5830)	(0.6403)
ln wage (total economy)	0.0070	0.0074	0.0065	0.0071	0.0038	0.0021	0.0030	0.0016
	(0.0157)	(0.0158)	(0.0164)	(0.0164)	(0.0143)	(0.0144)	(0.0148)	(0.0149)
investment intensity	0.0273	0.0261	0.0276	0.0252	0.0232	0.0299	0.0230	0.0283
	(0.0620)	(0.0613)	(0.0603)	(0.0587)	(0.0650)	(0.0658)	(0.0641)	(0.0640)
labour regulation	0.0022	0.0022	0.0016	0.0016	0.0023	0.0023	0.0018	0.0019
	(0.0027)	(0.0027)	(0.0028)	(0.0028)	(0.0023)	(0.0023)	(0.0028)	(0.0029)
government effectiveness	-0.0027	-0.0030	-0.0034	-0.0036	-0.0013	-0.0017	-0.0019	-0.0023
	(0.0113)	(0.0113)	(0.0112)	(0.0112)	(0.0110)	(0.0109)	(0.0110)	(0.0108)
constant	1.2462***	1.2433***	1.2336***	1.2348***	1.4307***	1.4306***	1.4374***	1.4396***
	(0.3181)	(0.3194)	(0.2551)	(0.2549)	(0.3833)	(0.3888)	(0.3754)	(0.3866)
Observations	333	333	333	333	333	333	333	333
R-squared	0.6424	0.6429	0.6428	0.6429	0.6452	0.6468	0.6459	0.6475
R-sq. dj.	0.586	0.586	0.587	0.585	0.590	0.590	0.589	0.588
F-test	50.19	91.89	58.74	89.44	34.28	60.72	51.38	840.9

BOX 2 / (CONTINUED) PRODUCTIVITY AND INTERNATIONAL VALUE CHAIN INTEGRATION

How does that fit to the comparatively disappointing outcomes in the competitiveness models reported in Table 13 and Table 14? The explanation is that the hypothesis under investigation is completely different. The purpose of the investigation in this section is geared towards the identification of any stimulating effects of VC integration beyond the general effects of trade. This is why the VC intensity, that is, the VC trade measure relative to the value added exports (VAX), was chosen as the main explanatory variable. The regression model in this box demonstrates that also for the EU-28 sample, a positive relationship between the log-level of VC trade and the log-level of labour productivity can be detected (specification B1).

However, specification B2 also shows that this effect is not very different from that of trade in general, proxied by VAX. In fact, when the two trade measures enter the regression model simultaneously (specification B3), only the VAX are found to be statistically significant, with the VC trade measure losing its statistical significance. Specification B4 then shows that in this regression set-up, the VC intensity delivers a negative coefficient, indicating that the impact of VC trade on labour productivity is smaller than that of the overall VAX.

Table 15 / Labour productivity and trade, total economy, EU-28

Aggregate: **Total economy**
Sample: **EU-28**
Dependent Variable: **ln labour productivity**

	(B1) VC trade	(B2) VAX	(B3) VC trade + VAX	(B4) VC intensity
ln VC	0.2102***		-0.0865	
	(0.0528)		(0.1022)	
ln VAX		0.2213***	0.3001***	
		(0.0621)	(0.1077)	
VC intensity				-0.9758**
				(0.4074)
advanced labour share	-0.2225	-0.2060	-0.1998	-0.2090
	(0.3463)	(0.3668)	(0.3747)	(0.3616)
R&D intensity	0.5553	0.1858	0.0534	0.1341
	(2.1680)	(2.3486)	(2.3879)	(2.6481)
government effectiveness	0.0976**	0.0980**	0.1058**	0.2452***
	(0.0457)	(0.0471)	(0.0432)	(0.0514)
constant	8.5174***	8.0982***	8.0396***	10.3699***
	(0.4271)	(0.5700)	(0.5659)	(0.1286)
Observations	368	368	368	368
R-squared	0.9960	0.9965	0.9965	0.9937
R-sq. dj.	0.995	0.996	0.996	0.993
F-test	40.23	49.13	47.58	29.97

Note: All specifications include country and time fixed effects. *, ** and ***; indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period.

The last model that remains to be investigated is the export competitiveness model dealing with the potential impact of VC intensity on world market shares of value added trade. The results for the total economy are reported in Table 16 (model 1) and Table 17 (model 2). In the first export competitiveness model (Table 16) no effects for the overall VC intensity can be identified (specification 1). However, the split into RVC intensity and GVC intensity would in this context suggest that a high RVC intensity helps a Member State gain additional world market shares. This is true for all Member States (linear model, specification 2) and even more so for the members of the CEMC as indicated by the positive interaction term (non-linear model, specification 2). At the same time, specification 3 delivers a negative coefficient for the GVC trade intensity which is suggested to be uniform across EU Member States. This negative coefficient also remains in specification 4 which includes simultaneously RVC and GVC trade intensities. It has, however, a counterweight in the form of a positive coefficient of the RVC trade intensity, including the interaction term with the CEMC dummy. Taking the two together, it seems again that VC trade intensity does not have a more than proportionate effect on world market shares.

Table 16 / Export competitiveness Models, total economy, EU-28 sample (model 1)

Aggregate: **Total economy**
Sample: **EU-28**
Dependent Variable: **Δworld market share of VAX**

	Model EXCO 1							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0013	0.0014						
	(0.0017)	(0.0018)						
VC intensity x CEMC		-0.0016						
		(0.0054)						
RVC intensity			0.0080*	0.0071*			0.0077**	0.0057**
			(0.0042)	(0.0039)			(0.0035)	(0.0027)
RVC intensity x CEMC				0.0112*				0.0204**
				(0.0065)				(0.0091)
GVC intensity					-0.0139**	-0.0127**	-0.0136**	-0.0115*
					(0.0064)	(0.0058)	(0.0064)	(0.0057)
GVC intensity x CEMC						-0.0267		-0.0354*
						(0.0193)		(0.0204)
wms VAX	-0.0684***	-0.0678***	-0.0757***	-0.0784***	-0.0748***	-0.0726***	-0.0824***	-0.0837***
	(0.0150)	(0.0139)	(0.0169)	(0.0167)	(0.0150)	(0.0192)	(0.0176)	(0.0231)
Δreal FX (ULC based)	-0.0007	-0.0007	-0.0007	-0.0006	-0.0009	-0.0008	-0.0008	-0.0005
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0008)	(0.0008)	(0.0007)
constant	0.0006	0.0007	0.0000	-0.0003	0.0030***	0.0034**	0.0020**	0.0021**
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0010)	(0.0014)	(0.0008)	(0.0010)
Observations	364	364	364	364	364	364	364	364
R-squared	0.3829	0.3830	0.3894	0.3916	0.3917	0.3991	0.3981	0.4112
R-sq. dj.	0.302	0.300	0.310	0.310	0.312	0.318	0.317	0.328
F-test	45.19	81.57	41.44	42.89	36.63	16.12	31.13	16.42

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

Qualitatively, the results seem to be similar as more control variables are added into the model (Table 17). One difference is worth mentioning, though, which is the fact that the positive coefficients for the RVC trade intensity as well as the negative coefficient for the GVC trade intensity are statistically significant only for the interaction term between the respective VC measure and the CEMC dummy.

Moreover, the negative effect for the RVC trade intensity comes out stronger in terms of statistical significance in both, specification 2 and specification 4.

Table 17 / Export competitiveness Models, total economy, EU-28 sample (model 2)

Aggregate:	**Total economy**							
Sample:	**EU-28**							
Dependent Variable:	**Δworld market share of VAX**							
	Model EXCO 2							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0025	0.0024						
	(0.0036)	(0.0036)						
VC intensity x CEMC		0.0031						
		(0.0032)						
RVC intensity			0.0063	0.0052			0.0066	0.0046
			(0.0048)	(0.0046)			(0.0047)	(0.0042)
RVC intensity x CEMC				0.0148**				0.0211***
				(0.0065)				(0.0076)
GVC intensity					-0.0053	-0.0050	-0.0059	-0.0043
					(0.0045)	(0.0043)	(0.0047)	(0.0044)
GVC intensity x CEMC						-0.0114		-0.0202*
						(0.0110)		(0.0110)
wms VAX	-0.1320***	-0.1332***	-0.1359***	-0.1392***	-0.1276***	-0.1261***	-0.1351***	-0.1369***
	(0.0264)	(0.0256)	(0.0275)	(0.0274)	(0.0211)	(0.0230)	(0.0273)	(0.0306)
Δreal FX (ULC based)	-0.0011	-0.0011	-0.0011	-0.0010	-0.0011	-0.0010	-0.0010	-0.0009
	(0.0010)	(0.0010)	(0.0010)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0009)
advanced labour share	0.0025	0.0027	0.0028	0.0030	0.0026	0.0022	0.0030	0.0026
	(0.0023)	(0.0024)	(0.0024)	(0.0024)	(0.0023)	(0.0024)	(0.0024)	(0.0024)
R&D intensity	0.0122	0.0107	0.0153	0.0131	0.0122	0.0164	0.0167	0.0206
	(0.0124)	(0.0127)	(0.0122)	(0.0125)	(0.0117)	(0.0119)	(0.0120)	(0.0129)
ln wage (total economy)	0.0012	0.0012	0.0012	0.0012	0.0010	0.0010	0.0011	0.0010
	(0.0008)	(0.0008)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
labour market regulation	-0.0001	-0.0001	-0.0001	-0.0001	-0.0000	-0.0000	-0.0001	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
government effectiveness	0.0004*	0.0005*	0.0004	0.0004*	0.0004	0.0004	0.0003	0.0004
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
constant	-0.0117	-0.0120	-0.0115*	-0.0121*	-0.0088	-0.0082	-0.0096	-0.0098
	(0.0074)	(0.0074)	(0.0067)	(0.0068)	(0.0064)	(0.0062)	(0.0069)	(0.0068)
Observations	335	335	335	335	335	335	335	335
R-squared	0.4620	0.4623	0.4644	0.4672	0.4623	0.4636	0.4657	0.4717
R-sq. dj.	0.376	0.374	0.379	0.380	0.376	0.376	0.378	0.381
F-test	308.2	420.4	198.0	194.2	377.7	229.0	280.9	362.3

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

Another interesting aspect is that the negative coefficient of the RVC trade intensity disappears as one considers the manufacturing sector only. Table 18 contains the results for model 2 of the export competitiveness model, this time with both world export market shares and the VC trade intensities limited to manufacturing value added.

Table 18 / Export competitiveness Models, manufacturing, EU-28 sample (model 2)

Aggregate:	Manufacturing							
Sample:	EU-28							
Dependent Variable:	Δworld market share of VAX							
	Model EXCO 2							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0061	0.0060						
	(0.0053)	(0.0053)						
VC intensity x CEMC		0.0026						
		(0.0064)						
RVC intensity			0.0046	0.0037			0.0040	0.0025
			(0.0061)	(0.0060)			(0.0058)	(0.0053)
RVC intensity x CEMC				0.0142				0.0226*
				(0.0122)				(0.0131)
GVC intensity					0.0112	0.0113	0.0108	0.0101
					(0.0081)	(0.0081)	(0.0081)	(0.0078)
GVC intensity x CEMC						-0.0034		-0.0146
						(0.0112)		(0.0102)
wms VAX	-0.1742***	-0.1757***	-0.1705***	-0.1733***	-0.1713***	-0.1700***	-0.1744***	-0.1729***
	(0.0551)	(0.0549)	(0.0542)	(0.0551)	(0.0507)	(0.0499)	(0.0549)	(0.0561)
Δreal FX (ULC based)	-0.0002	-0.0003	-0.0002	-0.0002	-0.0003	-0.0003	-0.0003	-0.0002
	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0014)	(0.0014)	(0.0014)	(0.0013)
advanced labour share	0.0059	0.0060*	0.0059	0.0061*	0.0053	0.0052	0.0056	0.0055
	(0.0035)	(0.0035)	(0.0035)	(0.0035)	(0.0033)	(0.0034)	(0.0036)	(0.0035)
R&D intensity	0.0483*	0.0473*	0.0501*	0.0482*	0.0484*	0.0495*	0.0477*	0.0494*
	(0.0245)	(0.0246)	(0.0246)	(0.0245)	(0.0238)	(0.0242)	(0.0241)	(0.0247)
ln wage manufacturing	0.0016	0.0016	0.0015	0.0016	0.0017	0.0017	0.0017	0.0017
	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
labour market regulation	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
government effectiveness	0.0005	0.0005	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Constant	-0.0181	-0.0184	-0.0164	-0.0174*	-0.0189*	-0.0187*	-0.0191*	-0.0198*
	(0.0109)	(0.0109)	(0.0097)	(0.0098)	(0.0107)	(0.0105)	(0.0110)	(0.0108)
Observations	330	330	330	330	330	330	330	330
R-squared	0.4400	0.4402	0.4379	0.4395	0.4398	0.4399	0.4407	0.4436
R-sq. dj.	0.349	0.347	0.347	0.346	0.349	0.347	0.347	0.346
F-test	79.25	90.14	127.0	247.9	76.77	70.26	72.31	91.71

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

The table reveals that, while the RVC trade intensity also seems to matter more than the GVC trade intensity when the manufacturing sector is considered (which is the opposite outcome from the structural model), the estimated coefficient is positive and weakly statistically significant. So it seems that the effect of VC integration also depends on the aggregate under consideration. For the export competition model this means that the results are rather shaky, though the model focusing on manufacturing may be read as supporting by and large the outcome of the structural model, which suggested that VC trade intensity helps the members of the CEMC to increase their manufacturing share. The difference that remains, however, is that the export competition model assigns a VC trade intensity effect to RVCs while in the structural model the effect is captured by GVCs.

6. Exports, value chain trade and the income elasticity of trade

6.1. INTRODUCTION

Since 2011, (global as well as EU) exports have developed rather sluggishly – after an extended period of growth until the early 2000s (but particularly since the 1990s), the deep but short-lived crisis-induced Great Trade Collapse in 2008/09 and the rather quick rebound shortly thereafter. As already mentioned in Section 3, for all these developments GVCs are considered to play a non-negligible role, both as a key source of export growth since the 1990s as well as a propagating and amplifying mechanism of economic developments, such as the crisis of 2008/09 (Freund, 2009). This 'Global Trade Slowdown' has become the subject of economic debate that seeks to identify its underlying causes (see Constantinescu et al., 2015 or Hoekman, 2015). In particular, Section 3 has demonstrated for the EU-28 that in the aftermath of the crisis, the domestic value added component in exports has gained importance, but not to the detriment of VC trade.

In this context, the next section takes a closer look at the Trade Slowdown phenomenon from the perspective of the EU-28 and not only investigates the prevalence and extent of the Trade Slowdown but also sheds light on the roles played by both the domestic value added component in exports and VC trade. For this purpose, the ensuing analysis takes a stepwise and comparative approach. First, for gross exports (EXP), value added exports (VAX) and re-exported domestic value added (DVAre), it establishes whether there has been a systematic change in the relationship between GDP and export growth, as captured by export- and import-to-GDP elasticities. The latter demand-side perspective has so far been neglected in this line of literature but is of utmost importance for export growth. Second, a comparison of results then sheds light on the role played by the domestic value added component in exports and VC trade for the potential EU-28 Trade Slowdown.

6.2. METHODOLOGICAL APPROACH

For this purpose, the following export gravity equation is specified:

Eq. 7
$$lnEXP_{ijt} = \alpha_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnPOP_{it} + \beta_4 lnPOP_{jt} + \sum_{k=2}^{K} \gamma_k D_k + \sum_{k=2}^{K} \delta_k D_k * lnGDP_{it} + \sum_{k=2}^{K} \tau_k D_k * lnGDP_{jt} + \varphi_{ij} + \epsilon_{ijt}$$

where $lnEXP_{ijt}$ denotes exports from country i to country j at time t, measured in terms of the logarithm of either (i) gross exports (EXP), (ii) value added exports (VAX), or (iii) re-exported domestic value added (DVAre). The VAX indicator explicitly accounts for the value added embodied in intermediate flows and avoids double counting so characteristic of gross exports while the DVAre indicator is a sub-component of VAX and a forward production integration measure (VC trade), which exclusively comprises domestic value added. Furthermore, $lnGDP_{it}$ and $lnGDP_{jt}$ refer to the logarithm of real GDP (in USD) of country i and j, respectively. The analysis of gross exports uses the logarithm of gross output (in USD) of country i and j instead. $lnPOP_{it}$ and $lnPOP_{jt}$ are the logarithm of the population of country i and j, respectively. D_k are dummy variables for four different time periods which correspond to and capture particular developments in export growth before, during and after the crisis. --In particular, D_1 refers to the pre-crisis period between 2000 and 2008 (as reference period), D_2 captures the crisis period of 2009 which triggered the Great Trade Collapse and saw both national GDPs, but even more so trade collapse temporarily, D_3 and D_4 refer to the two post-crisis recovery periods 2010-2011 and 2012-2014, respectively, during which trade rebounded, particularly during the former period. $D_k * lnGDP_{it}$ and $D_k * lnGDP_{jt}$ are interaction terms between either of the k different time dummies D_k and the logarithm of real GDP of countries i and j, respectively. Hence, β_1 and β_2 in equation (3-5-1) measure the elasticities of exports to own (exporter) and foreign (importer) GDP for the reference period 2000 to 2003, respectively. In contrast, δ_2 to δ_4 as well as τ_2 to τ_4 measure the change in the elasticities of exports to own and foreign GDP, respectively, relative to the pre-crisis reference period and capture whether, how and how permanently gross and value added export elasticities have changed on the eve of, during as well as in the aftermath of the Great Trade Collapse. Finally, φ_{ij} refers to time-invariant country-pair fixed effects while ϵ_{ijt} is the error term.

The gravity analysis looks at four different industry aggregates[39], namely (i) the economy as a whole, (ii) the manufacturing sector, (iii) advanced manufacturing industries, and (iv) an extended manufacturing sector (including business services). Furthermore, it differentiates between three types of EU-28 exports according to the region of destination, namely (i) total EU-28 exports (as EU-28 exports to both EU-28 and non-EU-28 Member States), (ii) intra-EU-28 exports (as EU-28 exports to other EU-28 Member States only), and (iii) extra-EU-28 exports (as EU-28 exports to non-EU-28 Member States only).

6.3. RESULTS FOR GROSS EXPORTS

Table 19 reports results for gross exports for the period 2000 to 2014. Columns (1) to (3) refer to the total economy, columns (4) to (6) to the total manufacturing sector, columns (7) to (9) to advanced manufacturing while columns (10) to (12) refer to extended manufacturing (including business services). Furthermore, columns (1), (4), (7) and (10) refer to total EU-28 exports, columns (2), (5), (8) and (11) to intra-EU-28 exports only while columns (3), (6), (9) and (12) refer to extra-EU-28 exports only.

Generally, in the pre-crisis period from 2000 to 2008, elasticities of gross exports to own and foreign GDP (gross-output-based) are diverse and differ by industry aggregate considered but almost consistently lie below 1. For the economy as a whole as well as advanced manufacturing, the home market effect dominates the foreign market effect. In particular, for the economy as a whole, the elasticities of exports to own GDP range between 0.9 and 1.0, which is slightly above the elasticities of exports to foreign GDP, which lie between 0.7 and 0.8. The difference in the elasticities of exports to own and foreign GDP is more pronounced for advanced manufacturing, where the elasticities of exports to own GDP are slightly above 1 whereas the elasticities of exports to foreign GDP range between 0.6 and 0.8 only. In contrast, the foreign market effect is slightly stronger than the home market effect for total manufacturing and extended manufacturing. Furthermore, elasticities of exports to own and foreign GDP also differ by the region of destination of exports. Patterns are particularly diverse as concerns the elasticity of exports to own GDP. For both total manufacturing and extended manufacturing, the elasticity

39 All as defined in Appendix 3.

of exports to own GDP is strongest for extra-EU-28 exports, followed by total EU-28 exports and intra-EU-28 exports. By contrast, the order is reversed for total manufacturing where the elasticity of exports to own GDP is strongest for intra-EU-28 exports, followed by total EU-28 exports and, finally, extra-EU-28 exports. For advanced manufacturing the elasticity of exports to own GDP is strongest for intra-EU-28 exports, followed by extra-EU-28 export and total EU-28 exports. Furthermore, as concerns the foreign market effect, except for advanced manufacturing, the elasticity of exports to foreign GDP is strongest for intra-EU-28 exports, followed by total exports and extra-EU-28 exports.

Table 19 / Gravity regression results: gross exports, 2000-2014

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra
VARIABLES	Total economy			Manufacturing			Advanced manufacturing			Extended manufacturing		
$lnGO_{it}$	0.902***	0.935***	0.856***	0.724***	0.697***	0.766***	1.008***	1.120***	1.043***	0.798***	0.778***	0.824***
	(0.036)	(0.052)	(0.059)	(0.038)	(0.053)	(0.064)	(0.053)	(0.079)	(0.082)	(0.038)	(0.054)	(0.062)
$lnGO_{jt}$	0.761***	0.782***	0.709***	0.829***	0.856***	0.739***	0.751***	0.618***	0.712***	0.806***	0.851***	0.708***
	(0.034)	(0.049)	(0.055)	(0.038)	(0.050)	(0.064)	(0.048)	(0.071)	(0.077)	(0.036)	(0.051)	(0.058)
$lnPop_{it}$	-2.107***	-1.490***	-3.123***	-3.814***	-3.251***	-4.799***	-4.164***	-3.482***	-5.017***	-2.895***	-2.113***	-4.231***
	(0.306)	(0.376)	(0.487)	(0.282)	(0.325)	(0.493)	(0.399)	(0.478)	(0.696)	(0.307)	(0.383)	(0.465)
$lnPop_{it}$	-0.551**	-0.328	-0.689	-0.781***	-1.200***	0.001	-0.766**	-1.463***	-0.462	-0.261	-0.241	-0.014
	(0.257)	(0.336)	(0.488)	(0.243)	(0.302)	(0.548)	(0.332)	(0.405)	(0.683)	(0.254)	(0.336)	(0.511)
$D2*lnGO_{it}$	-0.060***	-0.080***	-0.024	-0.011	-0.015	-0.006	-0.046***	-0.057***	-0.016	-0.033***	-0.046***	-0.012
	(0.011)	(0.014)	(0.016)	(0.009)	(0.012)	(0.015)	(0.012)	(0.015)	(0.019)	(0.010)	(0.014)	(0.014)
$D3*lnGO_{it}$	-0.072***	-0.091***	-0.040**	-0.037***	-0.047***	-0.021	-0.079***	-0.090***	-0.052**	-0.059***	-0.078***	-0.027*
	(0.011)	(0.013)	(0.019)	(0.010)	(0.012)	(0.018)	(0.013)	(0.016)	(0.023)	(0.011)	(0.014)	(0.016)
$D4*lnGO_{it}$	-0.083***	-0.112***	-0.035*	-0.054***	-0.067***	-0.032	-0.102***	-0.123***	-0.057**	-0.074***	-0.101***	-0.031
	(0.013)	(0.015)	(0.021)	(0.012)	(0.015)	(0.020)	(0.015)	(0.018)	(0.027)	(0.012)	(0.015)	(0.019)
$D2*lnGO_{jt}$	-0.031***	-0.036***	-0.027	0.003	0.001	-0.031	-0.010	-0.023*	-0.060**	-0.022**	-0.029**	-0.025
	(0.010)	(0.012)	(0.019)	(0.008)	(0.010)	(0.020)	(0.011)	(0.014)	(0.024)	(0.009)	(0.012)	(0.019)
$D3*lnGO_{jt}$	-0.031***	-0.033***	-0.060***	0.011	0.016	-0.013	-0.011	-0.033**	-0.048*	-0.019*	-0.024*	-0.029
	(0.010)	(0.013)	(0.021)	(0.008)	(0.010)	(0.021)	(0.011)	(0.014)	(0.027)	(0.010)	(0.013)	(0.021)
$D4*lnGO_{jt}$	-0.036***	-0.040***	-0.063***	0.009	0.006	-0.024	-0.017	-0.061***	-0.058*	-0.025**	-0.033**	-0.033
	(0.011)	(0.014)	(0.022)	(0.010)	(0.012)	(0.024)	(0.013)	(0.017)	(0.030)	(0.011)	(0.013)	(0.023)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	-9.581***	-11.918***	-5.625***	-4.613***	-5.078***	-5.147**	-7.627***	-7.567***	-6.745**	-8.523***	-10.147***	-6.415***
	(0.934)	(1.076)	(1.998)	(0.805)	(0.886)	(2.090)	(1.109)	(1.207)	(2.681)	(0.972)	(1.165)	(2.031)
Observations	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720
R-squared	0.975	0.976	0.976	0.978	0.982	0.972	0.969	0.971	0.966	0.977	0.980	0.974

Note: Within-group robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All refers to EU-28 exports to all (EU-28 and non-EU-28 MS), intra refers to EU-28 exports to EU-28 MS only while extra refers to EU-28 exports to non-EU-28 MS only.
Source: WIOD.

However, after 2008, elasticities of exports to both own and foreign GDP were lower and continuously deteriorated relative to the 2000-2008 reference period. Furthermore, except for total extra-EU-28 exports, elasticities of exports to own GDP experienced a considerably more pronounced drop and declined almost twice as strongly as elasticities of exports to foreign GDP. Moreover, the observable decreases in export elasticities were far from uniform and differed not only across the four industry aggregates but also across the regions of destination of EU-28 exports considered. In particular, elasticities of exports to own GDP continuously declined in all industry aggregates but total and extended manufacturing, where own income export elasticities remained unchanged. In contrast, elasticities of exports to foreign GDP declined most consistently in the economy as a whole but underwent mostly positive but insignificant changes in total manufacturing.[40] As concerns regional differences, elasticities of exports, particularly to own GDP, experienced a more pronounced drop in intra-EU-28 exports, which was between two to three times higher as compared to extra-EU-28 exports.

Furthermore, population size and EU-28 exports are negatively related. This is particularly true for own EU-28 population size whose elasticities are rather pronounced and range between -1.5 and -5. The own EU-28 population effect is generally strongest in advanced manufacturing and is consistently most pronounced for extra-EU-28 exports. In contrast, with elasticities ranging between -0.6 and -1.5, foreign population size only exerts a very limited negative effect on EU-28 exports and even fails to have any significant effect at all in extended manufacturing.

6.4. RESULTS FOR VALUE ADDED EXPORTS

Table 20 reports the results for value added exports for the period 2000 to 2014. Again, columns (1) to (3) refer to the total economy, columns (4) to (6) to the total manufacturing sector, columns (7) to (9) to advanced manufacturing while columns (10) to (12) refer to extended manufacturing (including business services). Furthermore, columns (1), (4), (7) and (10) refer to total EU-28 exports, columns (2), (5), (8) and (11) to intra-EU-28 exports only while columns (3), (6), (9) and (12) refer to extra-EU-28 exports only.

For the pre-crisis period between 2000 and 2008, elasticities of value added exports to own and foreign GDP are very similar to those of gross exports reported in Table 19. In particular, except for advanced manufacturing whose elasticities of value added exports to own GDP are slightly above 1, elasticities of value added exports to own and foreign GDP lie – partly well – below 1. Again, the home market effect tends to dominate the foreign market effect; differences are, however, minor, except for the case of advanced manufacturing. Elasticities of exports to own and foreign GDP again differ by the region of destination of EU-28 exports and are exactly in the same order as for gross exports.

As concerns changes in home- and foreign-income elasticities of exports after 2008 – relative to the pre-crisis period – there are certain similarities between gross exports and value added exports: First, after 2008, elasticities of value added exports to own and foreign GDP followed a similar, continuously deteriorating trend. This stresses that income elasticities of both gross exports as well as value added exports have consistently been falling over the past years. Second, except for the economy as a whole, home-income elasticities of exports again underwent a more pronounced decline than foreign-income elasticities of exports. Third, with respect to regional differences, income elasticities of exports experienced the most pronounced drop in intra-EU-28 exports, particularly as far as home-income elasticities are concerned. Taken together, the latter two points indicate that the home-income effect has increasingly lost importance for both, EU-28 exports, in general, and intra-EU-28 exports, in particular. However, changes in value added and gross exports to GDP elasticities also differ in some important respects: First and most importantly, declines in both home- and foreign-income elasticities were more pronounced with regard to value added exports than to gross exports. This indicates that the post-crisis decline in the (home- and foreign-) income elasticities of exports was predominantly driven by the even

40 This is in line with Stehrer et al. (2016) where, for the manufacturing sector as a whole, elasticities of gross exports to foreign GDP were positive and increasing for total, extra- as well as intra-EU-28 exports. Differences in extra-EU-28 export elasticities to foreign GDP are the result of differences in data source and sample size.

stronger decline in the (home- and foreign-) income elasticities of the domestic value added component in exports. Second, drops in the home- and foreign-income elasticities of value added exports are more consistent across the four industry aggregates analysed, particularly as far as home elasticities are concerned.

Table 20 / Gravity regression results: value added exports, 2000-2014

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra
	Total economy			Manufacturing			Advanced manufacturing			Extended manufacturing		
$lnGDP_{it}$	0.921***	0.958***	0.886***	0.704***	0.665***	0.775***	1.005***	1.104***	1.080***	0.804***	0.786***	0.844***
	(0.036)	(0.055)	(0.059)	(0.037)	(0.054)	(0.062)	(0.051)	(0.079)	(0.079)	(0.037)	(0.055)	(0.060)
$lnGDP_{jt}$	0.734***	0.757***	0.680***	0.818***	0.859***	0.709***	0.756***	0.630***	0.695***	0.778***	0.829***	0.673***
	(0.035)	(0.053)	(0.054)	(0.037)	(0.052)	(0.062)	(0.047)	(0.073)	(0.072)	(0.035)	(0.054)	(0.055)
$lnPop_{it}$	-2.051***	-1.465***	-2.976***	-3.889***	-3.362***	-4.791***	-3.861***	-3.214***	-4.583***	-2.838***	-2.055***	-4.133***
	(0.305)	(0.375)	(0.481)	(0.277)	(0.322)	(0.484)	(0.389)	(0.467)	(0.674)	(0.310)	(0.391)	(0.462)
$lnPop_{jt}$	-0.422	-0.032	-0.981**	-0.755***	-1.005***	-0.348	-0.766**	-1.382***	-0.751	-0.097	0.117	-0.306
	(0.263)	(0.341)	(0.491)	(0.242)	(0.309)	(0.539)	(0.323)	(0.404)	(0.651)	(0.263)	(0.348)	(0.495)
$D2*lnGDP_{it}$	-0.061***	-0.080***	-0.029**	-0.023***	-0.026**	-0.018	-0.063***	-0.078***	-0.030*	-0.047***	-0.060***	-0.025*
	(0.010)	(0.013)	(0.014)	(0.009)	(0.011)	(0.014)	(0.011)	(0.014)	(0.018)	(0.010)	(0.013)	(0.014)
$D3*lnGDP_{it}$	-0.077***	-0.096***	-0.044**	-0.056***	-0.067***	-0.037**	-0.105***	-0.120***	-0.072***	-0.079***	-0.100***	-0.043***
	(0.010)	(0.012)	(0.018)	(0.010)	(0.012)	(0.016)	(0.012)	(0.015)	(0.020)	(0.010)	(0.013)	(0.016)
$D4*lnGDP_{it}$	-0.087***	-0.117***	-0.038**	-0.069***	-0.085***	-0.043**	-0.127***	-0.151***	-0.077***	-0.092***	-0.122***	-0.042**
	(0.012)	(0.014)	(0.019)	(0.011)	(0.014)	(0.017)	(0.014)	(0.017)	(0.024)	(0.011)	(0.014)	(0.017)
$D2*lnGDP_{jt}$	-0.036***	-0.046***	-0.031*	0.001	-0.005	-0.037*	-0.010	-0.025*	-0.062***	-0.028***	-0.042***	-0.027
	(0.010)	(0.013)	(0.018)	(0.008)	(0.010)	(0.021)	(0.011)	(0.014)	(0.023)	(0.010)	(0.013)	(0.019)
$D3*lnGDP_{jt}$	-0.041***	-0.050***	-0.070***	0.003	0.002	-0.024	-0.014	-0.039***	-0.049*	-0.032***	-0.045***	-0.040*
	(0.010)	(0.013)	(0.021)	(0.008)	(0.010)	(0.021)	(0.011)	(0.014)	(0.025)	(0.010)	(0.014)	(0.021)
$D4*lnGDP_{jt}$	-0.048***	-0.059***	-0.069***	0.001	-0.010	-0.031	-0.019	-0.066***	-0.055*	-0.039***	-0.059***	-0.039*
	(0.011)	(0.014)	(0.022)	(0.009)	(0.011)	(0.022)	(0.012)	(0.016)	(0.028)	(0.011)	(0.014)	(0.023)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	-9.091***	-11.614***	-3.763*	-3.453***	-4.177***	-2.591	-7.402***	-7.376***	-5.664**	-8.065***	-9.986***	-4.320**
	(0.938)	(1.071)	(1.983)	(0.803)	(0.896)	(2.017)	(1.076)	(1.179)	(2.530)	(1.001)	(1.187)	(1.974)
Observations	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720
R-squared	0.976	0.976	0.978	0.980	0.984	0.975	0.971	0.972	0.969	0.978	0.980	0.977

Note: Within-group robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All refers to EU-28 exports to all (EU-28 and non-EU-28 MS), intra refers to EU-28 exports to EU-28 MS only while extra refers to EU-28 exports to non-EU-28 MS only.
Source: WIOD.

Similar to results for gross exports, the relationship between population size and EU-28 value added exports is negative. Again, the own EU-28 population effect is consistently above 1 (in absolute terms) and well exceeds the foreign population effect in all industry aggregates considered. With respect to regional differences, own EU-28 population effects are strongest for extra-EU-28 value added exports while foreign population effects tend to be strongest for intra-EU-28 trade.

6.5. RESULTS FOR RE-EXPORTED DOMESTIC VALUE ADDED

Table 21 reports results for VC trade (in terms of re-exported domestic value added) for the period 2000 to 2014. Columns (1) to (3) again refer to the total economy, columns (4) to (6) to the total manufacturing sector, columns (7) to (9) to advanced manufacturing while columns (10) to (12) refer to extended manufacturing (including business services). Furthermore, columns (1), (4), (7) and (10) refer to total

EU-28 exports, columns (2), (5), (8) and (11) to intra-EU-28 exports only while columns (3), (6), (9) and (12) refer to extra-EU-28 exports only.

As concerns the pre-crisis period between 2000 and 2008, elasticities of re-exported domestic value added to own and foreign GDP are of similar magnitude to those of gross exports (Table 19) or value added exports (Table 20). Particularly, elasticities of re-exported domestic value added to both own and foreign GDP lie partly well below 1, with the former again dominating the latter, except for the case of manufacturing as a whole. Elasticities to own and foreign GDP again differ by the region of destination of EU-28 exports. However, as concerns VC trade, the foreign market effect is consistently stronger for extra-EU-28 exports than for intra-EU-28 exports.

Table 21 / Gravity regression results: re-exported domestic value added (DVAre), 2000-2014

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra	All	Intra	Extra
Variables	Total economy			Manufacturing			Advanced manufacturing			Extended manufacturing		
$\ln GDP_{it}$	0.821***	0.838***	0.807***	0.706***	0.703***	0.749***	0.883***	0.983***	0.920***	0.812***	0.819***	0.839***
	(0.016)	(0.023)	(0.025)	(0.018)	(0.027)	(0.029)	(0.028)	(0.041)	(0.041)	(0.017)	(0.026)	(0.025)
$\ln GDP_{jt}$	0.784***	0.768***	0.786***	0.838***	0.819***	0.824***	0.719***	0.577***	0.768***	0.805***	0.781***	0.799***
	(0.014)	(0.021)	(0.020)	(0.017)	(0.026)	(0.024)	(0.025)	(0.037)	(0.037)	(0.015)	(0.025)	(0.021)
$\ln Pop_{it}$	-1.667***	-1.699***	-1.597***	-3.570***	-3.509***	-3.631***	-2.383***	-2.023***	-2.666***	-2.113***	-1.984***	-2.278***
	(0.122)	(0.163)	(0.167)	(0.136)	(0.183)	(0.189)	(0.242)	(0.322)	(0.353)	(0.143)	(0.196)	(0.185)
$\ln Pop_{it}$	-0.504***	-0.673***	-0.306	-0.572***	-0.898***	-0.399*	-0.666***	-1.093***	-1.067***	-0.495***	-0.754***	-0.366*
	(0.097)	(0.122)	(0.189)	(0.114)	(0.147)	(0.227)	(0.178)	(0.222)	(0.364)	(0.105)	(0.135)	(0.193)
$D2^*\ln GDP_{it}$	-0.043***	-0.050***	-0.030***	-0.004	-0.008*	0.004	-0.006	-0.004	-0.003	-0.046***	-0.052***	-0.034***
	(0.003)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)	(0.004)	(0.005)	(0.005)
$D3^*\ln GDP_{it}$	-0.055***	-0.063***	-0.039***	-0.024***	-0.027***	-0.016***	-0.032***	-0.031***	-0.025***	-0.070***	-0.078***	-0.055***
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.006)
$D4^*\ln GDP_{it}$	-0.057***	-0.065***	-0.042***	-0.023***	-0.027***	-0.014	-0.037***	-0.037***	-0.028**	-0.072***	-0.080***	-0.055***
	(0.005)	(0.007)	(0.007)	(0.006)	(0.008)	(0.009)	(0.007)	(0.009)	(0.012)	(0.006)	(0.008)	(0.008)
$D2^*\ln GDP_{jt}$	0.008***	0.015***	-0.016**	0.015***	0.018***	-0.025***	0.013***	0.005	-0.029**	0.013***	0.016***	-0.017**
	(0.003)	(0.004)	(0.008)	(0.003)	(0.005)	(0.008)	(0.005)	(0.007)	(0.012)	(0.003)	(0.005)	(0.008)
$D3^*\ln GDP_{jt}$	0.004	0.011**	-0.028***	0.016***	0.019***	-0.030***	0.014**	0.002	-0.035**	0.011***	0.014**	-0.025***
	(0.003)	(0.005)	(0.008)	(0.003)	(0.005)	(0.008)	(0.006)	(0.008)	(0.014)	(0.004)	(0.005)	(0.008)
$D4^*\ln GDP_{jt}$	0.002	0.004	-0.022**	0.013***	0.013*	-0.023*	0.013*	-0.011	-0.024	0.010**	0.007	-0.019*
	(0.004)	(0.005)	(0.010)	(0.005)	(0.006)	(0.012)	(0.007)	(0.010)	(0.018)	(0.004)	(0.006)	(0.010)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	-10.027***	-9.924***	-10.456***	-6.299***	-5.777***	-6.807***	-10.331***	-10.177***	-8.180***	-10.034***	-9.806***	-10.125***
	(0.313)	(0.361)	(0.774)	(0.374)	(0.421)	(0.924)	(0.604)	(0.648)	(1.471)	(0.360)	(0.437)	(0.814)
Observations	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720	18,060	11,340	6,720
R-squared	0.995	0.995	0.995	0.995	0.995	0.994	0.991	0.991	0.991	0.995	0.995	0.995

Note: Within-group robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All refers to EU-28 exports to all (EU-28 and non-EU-28 MS), intra refers to EU-28 exports to EU-28 MS only while extra refers to EU-28 exports to non-EU-28 MS only.
Source: WIOD.

Additionally, regarding changes in home- and foreign-income elasticities of re-exported domestic value added after 2008, there are certain similarities to value added exports. For instance, relative to the pre-crisis period, elasticities of re-exported domestic value added to own GDP have also fallen during the post-crisis period. From a regional perspective, the decline in the own market effect was stronger for intra-EU-28 exports than extra-EU-28 exports. However, the extent of the decline was much weaker and only half to one third as strong as for value added exports. Furthermore, the decline also seems to be levelling off already, as indicated by the more or less unchanging coefficients of the interaction terms between the last two periods. Hence, taken together, this indicates that VC trade played only a negligible role – if any at all – for the relatively strong decline in the home-income elasticities of value added exports. In contrast, a somewhat different picture emerges for the post-crisis foreign market effect, which is associated with the region of destination of EU-28 exports. For extra-EU-28 exports, the familiar decline in the elasticities of re-exported domestic value added to foreign GDP is observable. However, the fall in the coefficients (in absolute terms) of the interaction terms between the periods 2010-2011 and 2012-2014 suggests that a rebound is already under way. For intra-EU-28 exports, on the other hand, elasticities of re-exported domestic value added to foreign GDP have increased relative to the pre-crisis period, which made foreign GDP a relatively more important determinant of VC trade. However, the unchanging or partly falling coefficients of the interaction terms suggest that this process has also levelled off already. These findings together again indicate that VC trade played no role for the relatively strong decline in the foreign-income elasticities of value added exports.

Similar to the results for gross exports and value added exports, the relationship between population size and EU-28 re-exported domestic value added is negative, with an own EU-28 population effect that is consistently above 1 (in absolute terms) and well exceeds the foreign population effect in all industry aggregates considered. Again, with respect to regional differences, own EU-28 population effects are strongest for extra-EU-28 exports while foreign population effects tend to be strongest for intra-EU-28 exports.

7. Summary and Policy Implications

The availability of new international input-output data for a set of 43 countries including all EU Member States, allowed for a first thorough analysis of the developments of value chain trade since the Great Recession of 2008/2009. Based on a forward production integration measure for value chain trade, which is the re-exported domestic value added, the data confirms the conjecture that the expansion of international value chains has come to a halt in the post-crisis period (2011-2014). The comparison of the dynamics of different exports flows can serve as suggestive evidence that in the EU-28, despite the levelling off of value chain integration, so far there has been no massive dismantling of international value chains. At the global level a more worrying trend is discernible since VC trade was growing at a lower pace than value added exports and gross exports in the post-crisis period. This constellation may signal that some value chains are on the retreat. Therefore future developments need to be observed vigilantly and, if the current trend persisted, the underlying causes need to be identified. This is because there are numerous reasons for why VC trade loses dynamism, ranging from more nationalistic economic policies, over a lack of new impetus from global trade liberalisation to reduced incentives for offshoring activities by multinational firms due to a declining share of labour cost in total costs. For the EU it seems that the European Single Market, due to the guaranteed free movement of goods, services and investments and accompanying regulations such as the competition rules, acts as a reinsurance mechanism against potential protectionist tendencies which would be one explanation why the growth of VC trade could keep pace with overall trade.

Another aspect that is highlighted in this study is the geographical scope of value chains where the stylised facts established by the literature would suggest that regional value chains are most prevalent. The approach in this study exploits the complexity of VC trade which implies that more than one partner countries are involved. Apart from the source country, which is the origin of the value added, an immediate production partner and the ultimate production partner, i.e. the last link in the production chain, can be identified. Obviously there is also the country of final demand which is where the value added is absorbed. By identifying the production partners that are involved in joint production, VC trade can be separated into regional value chain (RVC) trade on the one hand, and global value chain (GVC) trade on the other. The former includes all VC trade which involves only partners from within the region of the source country. European RVCs include VC trade where only EU Member States act as producers. In contrast, all European GVC trade is VC trade which involves also third countries as production partners. With this way of defining the regional scope of value chains the existing stylised fact that VC trade is mainly regional in scope is challenged to some extent. According to this definition the split between RVC trade and GVC trade for the EU-28 is about half-half with only modest shifts towards GVC trade between 2000 and 2014.

One of the most striking results in the context of RVCs and GVCs is the extent to which demand is shaping the organisation of production. In models of offshoring, the extent of production relocation and hence cross-border production sharing is typically determined by the trade-off between the coordination costs of offshoring and the advantages resulting from the wage differential. The empirical data, however, suggest that the demand patterns are strongly influencing the decisions where to locate production.

Qualitatively this result is not surprising since also within international VCs trade costs are incurred but quantitatively it is. In fact, the influence of final demand is so strong that it is fair to summarise that the EU's RVCs produce to serve intra-EU demand while European GVCs produce to satisfy extra-EU demand.

The extent of a country's inclination to engage in production sharing can be assessed with the help of revealed export preferences (RXP) which is a form of a trade specialisation index. The data reveals a strong tendency of Member States to engage in joint production with other EU Member States, highlighting the role of geographic proximity. Exceptions in this context are Greece, which is actually less involved in RVC trade than the average country in the world, and Ireland, which has also only a small positive RXP index. But distance is not the whole story as the example of Switzerland demonstrates. Located amidst EU Member States, its RXP index is strongly positive but still much lower than that of all its neighbouring countries such as Austria, Germany, France and Italy. This suggests that the Single Market, in addition to geographic proximity, facilitates cross-border production sharing, possibly due to lower non-tariff barriers within the Single Market.

In order to put the extent of RVC trade of EU Member States in perspective, 'Factor Europe' is compared to 'Factory North America' (comprising the United States, Canada and Mexico) and 'Factory Asia' (comprising Japan, Korea, China, Indonesia and Taiwan). Such a comparison reveals that 'Factory Europe' is by far the largest of the three regional factories, and about five times larger than Factory North America. For comparison, the EU's total VC trade is only about twice as large as that of NAFTA members. This confirms the high degree of economic and institutional integration that has been reached in the EU which facilitated the development of 'Factory Europe'. Apart from geographic proximity of countries, the absence of tariff barriers and the comparatively low regulatory cross-country barriers within the Single Market have led to a situation where joint production within Factory Europe is more developed than in the other main regional Factories. At the same time, the regional introversion index (RII), which indicates how much countries of a trading bloc trade more with each other than with other countries, shows that EU is not a closed bloc by international standards. In fact, it is in between NAFTA, which is the most inwards oriented bloc by this metric, and Factory Asia. It is worth emphasising that the level of the RII per se is not necessarily a good nor a bad thing. A high RII can be seen as an advantage as it signals strong regional integration. At the same time, it may also indicate that there are high barriers to production sharing with partner countries from outside the region. Likewise, it can indicate that the members of the region are not capable of linking into GVCs, i.e. value chains that involve extra-regional partners. Hence, as long as it is unclear whether RVC trade and GVC trade have systematically different implications for countries' economic performance, it is difficult to interpret changes in the RII.

The implications of RVC on the one hand and GVC on the other hand are indeed hard to assess, where the primary interest in this report is with the implications of VCs for structural change and competitiveness. A first question here is to what extent VC trade as a whole is indeed qualitatively different from overall trade. This can be addressed by looking at the economic impact of the VC trade *intensity*, i.e. the ratio of VC trade over VAX. In this context structural change is measured by changes in the value added share of manufacturing in total GDP, while labour productivity and world market shares in value added exports serve as measures of competitiveness. The key insight is that there seem to be little extra effects from VC trade *in addition* to the effects of overall trade. Clearly, VC trade is conducive to labour productivity growth in Member States, but so is value added trade (i.e. overall trade). Hence, there are no additional productivity gains to be expected from VC trade *relative* to trade in general. With regards to structural change, there is one interesting result which suggests that higher VC trade intensity is not fostering the manufacturing sector across Member States in general. However, there is a positive effect of VC trade intensity for the members of the CE Manufacturing Core (comprising Germany, Austria, the Czech Republic, Slovakia, Poland and Hungary) which seems to stem from the GVC part of VC trade. This result is compatible with the view that for international production sharing to be successful – even if regional production sharing plays an important role – it should not take place in an entirely self-contained manner. Instead, a balanced approach to production integration should be pursued, where the advantages of RVCs such as geographic proximity and reduced trade costs within the Single Market should be fully exploited without renouncing on global production co-operations in cases where lower costs or better quality can be achieved.

For the EU as a whole, the asymmetric effect detected by the structural model also points towards strong agglomeration forces which, however, seem to coexist with a strong convergence effect too. Especially the agglomeration forces, which play out strongly due to a variety of factors including path dependencies, increasing returns to scale, skill complementarities and geographic proximity, should be carefully monitored. Due attention should be paid to this phenomenon as specialisation patterns and, in particular, the manufacturing sector in its role as the main tradables-producing sector for EU Member States also have wider macroeconomic implications.

Interesting insights also come from a gravity analysis of various types of exports of EU Member States which takes a closer look at the Trade Slowdown phenomenon from the perspective of the EU-28 and sheds light on the different roles played by various types of exports in this context. Generally, results point to a break in the relationship between trade and (own and foreign) income, with, however, diverse patterns that differ by industry aggregate and region of destination of EU-28 exports considered. More specifically, it demonstrates that, in line with the related literature, in the aftermath of the crisis, elasticities of exports to *own* GDP have fallen continuously. This decline in export elasticities to own GDP was most pronounced for advanced manufacturing and two to three times stronger for intra-EU-28 exports as compared to extra-EU-28 exports. Likewise, elasticities of exports to *foreign* GDP have followed a similar continuous downward trend. However, relative to export elasticities to own GDP, the decline in elasticities of exports to foreign GDP was only half as strong and clearly less consistent across industry aggregates considered. In a regional context, the drop in elasticities of exports to foreign GDP was less consistent across industry aggregates but, if significant, somewhat stronger for extra-EU-28 exports.

Hence, these results corroborate the notion of 'peak trade' and suggest that the EU-28 trade slowdown is structural in nature and therefore more permanent; thus, no full return to pre-crisis export to income elasticities – but some further upward adjustments (Altomonte et al., 2016) – can be expected. This implies that, if GDP growth picks up, associated export growth is not as strong as before the crisis. Furthermore, intra-EU-28 exports – and therefore trade within the Single Market – consistently experienced the most pronounced fall in export to GDP elasticities. This emphasises that, relative to the pre-crisis period, the EU Single Market has become a considerably less important source of recent (and future) EU export growth.

Importantly, a comparison of results for gross exports, value added exports (VAX) and VC trade highlights that the post-crisis decline in the (home- and foreign-) income elasticities of exports was predominantly driven by the even stronger decline in the (home- and foreign-) income elasticities of the domestic value added component in exports. However, VC trade played no significant role for these persistent and sizeable losses in (home- and foreign-) income elasticities of value added exports.

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9. Appendix

9.1. APPENDIX 1: LIST OF COUNTRIES AND COUNTRY GROUPINGS

country	ISO-2 code	broad groups	narrow groups	geographic region
AUS	AU	non-EU	non-EU	Other
AUT	AT	West/North EU	CE Manufacturing Core	EU
BEL	BE	West/North EU	other EU	EU
BGR	BG	Central and Eastern EU	enlarged CEMC	EU
BRA	BR	non-EU	non-EU	Other
CAN	CA	non-EU	non-EU	NAFTA
CHE	CH	non-EU	non-EU	EFTA
CHN	CN	non-EU	non-EU	Asia-5
CYP	CY	South EU	EU South	EU
CZE	CZ	Central and Eastern EU	CE Manufacturing Core	EU
DEU	DE	West/North EU	CE Manufacturing Core	EU
DNK	DK	West/North EU	other EU	EU
ESP	ES	South EU	EU South	EU
EST	EE	Central and Eastern EU	other EU	EU
FIN	FI	West/North EU	other EU	EU
FRA	FR	West/North EU	Western deindustrialiser	EU
GBR	GB	West/North EU	Western deindustrialiser	EU
GRC	GR	South EU	EU South	EU
HRV	HR	Central and Eastern EU	EU South	EU
HUN	HU	Central and Eastern EU	CE Manufacturing Core	EU
IDN	ID	non-EU	non-EU	Asia-5
IND	IN	non-EU	non-EU	Other
IRL	IE	South EU	other EU	EU
ITA	IT	South EU	Western deindustrialiser	EU
JPN	JP	non-EU	non-EU	Asia-5
KOR	KO	non-EU	non-EU	Asia-5
LTU	LT	Central and Eastern EU	other EU	EU
LUX	LU	West/North EU	Benelux	EU
LVA	LV	Central and Eastern EU	other EU	EU
MEX	MX	non-EU	non-EU	NAFTA
MLT	MT	South EU	EU South	EU
NLD	NL	West/North EU	other EU	EU
NOR	NO	non-EU	non-EU	EFTA
POL	PL	Central and Eastern EU	CE Manufacturing Core	EU
PRT	PT	South EU	EU South	EU
ROU	RO	Central and Eastern EU	enlarged CEMC	EU
RUS	RU	non-EU	non-EU	Other
SVK	SK	Central and Eastern EU	CE Manufacturing Core	EU
SVN	SI	Central and Eastern EU	other EU	EU
SWE	SE	West/North EU	other EU	EU
TUR	TR	non-EU	non-EU	Other
TWN	TW	non-EU	non-EU	Asia-5
USA	US	non-EU	non-EU	NAFTA
ZROW	-	non-EU	non-EU	Other

9.2. APPENDIX 2: LIST OF INDUSTRIES

NACE Rev 2. Industry code	Industry description
A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B	Mining and quarrying
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31-C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment
D35	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
F	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59-J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
J61	Telecommunications
J62-J63	Computer programming, consultancy and related activities; information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L68	Real estate activities
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74-M75	Other professional, scientific and technical activities; veterinary activities
N	Administrative and support service activities
O84	Public administration and defence; compulsory social security
P85	Education
Q	Human health and social work activities
R-S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organisations and bodies

9.3. APPENDIX 3: INDUSTRY AGGREGATES

Economy

NACE Rev. 2 Sectors A-U

Manufacturing

NACE Rev. 2 Sector C

Advanced manufacturing industries

NACE Rev. 2 Industry C21

NACE Rev. 2 Industry C26

NACE Rev. 2 Industry C27

NACE Rev. 2 Industry C28

NACE Rev. 2 Industry C29

NACE Rev. 2 Industry C30

Manufacturing and business services

NACE Rev. 2 Sector C

NACE Rev. 2 Industry J62-J63

NACE Rev. 2 Industry M69-M70

NACE Rev. 2 Industry M71

NACE Rev. 2 Industry M72

NACE Rev. 2 Industry M73

NACE Rev. 2 Industry M74-M75

9.4. APPENDIX 4: ADDITIONAL DESCRIPTIVE RESULTS

Figure A 1 / RVC trade share in % of total VC trade by Member States

Source: WIOD Release 2016. wiiw calculations.

Table A 1 / Regional value chain-trade (EU-28 = 100), shares and p.p. change

Manufacturing				Advanced manufacturing				Manufacturing and business services		
	2000	2014	PP. Change		2000	2014	PP. Change		2000	2014	PP. Change
AT	4.1	4.4	0.4	AT	4.2	4.7	0.5	AT	3.6	3.8	0.3
BE	5.9	4.3	-1.6	BE	3.3	2.3	-1.0	BE	5.8	4.8	-1.0
BG	0.0	0.3	0.2	BG	0.0	0.2	0.2	BG	0.0	0.3	0.2
CY	0.0	0.0	0.0	CY	0.0	0.0	0.0	CY	0.0	0.1	0.1
CZ	1.6	4.2	2.6	CZ	1.5	5.2	3.7	CZ	1.4	3.4	2.0
DE	26.8	30.4	3.6	DE	31.5	36.6	5.1	DE	25.9	27.2	1.3
DK	1.5	1.2	-0.2	DK	1.5	1.3	-0.3	DK	1.4	1.2	-0.2
EE	0.1	0.2	0.1	EE	0.1	0.2	0.1	EE	0.1	0.2	0.1
ES	4.5	4.5	0.1	ES	3.8	3.6	-0.2	ES	4.7	4.0	-0.6
FI	2.5	1.5	-1.0	FI	1.8	1.0	-0.8	FI	2.1	1.4	-0.7
FR	11.7	9.3	-2.4	FR	10.9	8.9	-2.0	FR	13.0	10.6	-2.4
GB	13.2	6.3	-6.9	GB	15.2	6.1	-9.1	GB	14.2	9.3	-4.9
GR	0.2	0.3	0.1	GR	0.1	0.0	0.0	GR	0.2	0.3	0.1
HR	0.2	0.3	0.1	HR	0.1	0.2	0.0	HR	0.1	0.3	0.1
HU	1.0	2.2	1.2	HU	1.5	3.2	1.6	HU	0.9	1.9	1.0
IE	1.8	1.2	-0.6	IE	3.0	1.5	-1.5	IE	1.6	1.5	-0.1
IT	9.8	9.7	0.0	IT	9.5	8.9	-0.7	IT	9.9	8.9	-1.0
LT	0.1	0.4	0.3	LT	0.1	0.1	0.0	LT	0.1	0.3	0.2
LU	0.3	0.2	-0.1	LU	0.1	0.1	0.0	LU	0.3	0.4	0.1
LV	0.1	0.1	0.1	LV	0.0	0.0	0.0	LV	0.0	0.1	0.1
MT	0.0	0.0	0.0	MT	0.1	0.0	0.0	MT	0.1	0.1	0.0
NL	6.5	5.9	-0.6	NL	4.1	3.8	-0.3	NL	7.0	8.3	1.3
PL	2.0	4.9	2.9	PL	1.7	4.2	2.5	PL	1.8	4.3	2.4
PT	0.8	1.1	0.3	PT	0.6	0.8	0.2	PT	0.7	0.9	0.2
RO	0.3	1.4	1.1	RO	0.3	1.7	1.4	RO	0.3	1.3	1.0
SE	4.3	3.4	-0.9	SE	4.3	3.4	-0.9	SE	4.0	3.3	-0.7
SI	0.4	0.7	0.3	SI	0.3	0.6	0.3	SI	0.3	0.6	0.3
SK	0.5	1.7	1.2	SK	0.3	1.6	1.3	SK	0.4	1.4	1.0

Source: WIOD Release 2016. wiiw calculations.

Table A 2 / Global value chain-trade (EU-28 = 100), shares and p.p. change

Manufacturing				Advanced manufacturing				Manufacturing and business services			
	2000	2014	PP. Change		2000	2014	PP. Change		2000	2014	PP. Change
AT	2.8	3.5	0.7	AT	2.3	3.5	1.2	AT	2.4	3.0	0.5
BE	4.4	3.6	-0.8	BE	2.4	1.8	-0.6	BE	4.4	4.2	-0.2
BG	0.0	0.3	0.3	BG	0.0	0.2	0.2	BG	0.0	0.3	0.2
CY	0.0	0.0	0.0	CY	0.0	0.0	0.0	CY	0.0	0.1	0.0
CZ	0.8	2.2	1.4	CZ	0.6	2.4	1.8	CZ	0.8	1.7	1.0
DE	27.3	32.1	4.8	DE	30.8	38.1	7.3	DE	25.9	28.3	2.4
DK	1.4	1.4	0.0	DK	1.4	1.4	0.1	DK	1.4	1.4	0.0
EE	0.1	0.2	0.1	EE	0.0	0.1	0.1	EE	0.0	0.2	0.1
ES	4.2	5.1	0.9	ES	2.7	3.4	0.8	ES	4.3	4.6	0.3
FI	2.5	1.9	-0.7	FI	1.9	1.4	-0.4	FI	2.1	1.7	-0.4
FR	12.4	9.5	-2.9	FR	12.7	8.9	-3.8	FR	13.5	10.6	-3.0
GB	17.0	9.8	-7.2	GB	20.8	10.9	-9.9	GB	17.9	12.8	-5.2
GR	0.3	0.6	0.3	GR	0.1	0.1	0.0	GR	0.3	0.5	0.2
HR	0.2	0.2	0.0	HR	0.1	0.1	0.0	HR	0.2	0.2	0.1
HU	0.5	1.2	0.6	HU	0.6	1.5	0.9	HU	0.5	1.1	0.6
IE	2.8	2.5	-0.3	IE	4.9	3.8	-1.0	IE	2.6	2.9	0.3
IT	10.3	10.1	-0.2	IT	8.9	9.9	1.0	IT	10.3	8.8	-1.5
LT	0.1	0.4	0.3	LT	0.1	0.1	0.0	LT	0.1	0.3	0.2
LU	0.3	0.2	-0.1	LU	0.1	0.1	0.0	LU	0.4	0.4	0.0
LV	0.1	0.1	0.1	LV	0.0	0.1	0.0	LV	0.1	0.1	0.1
MT	0.1	0.0	0.0	MT	0.1	0.0	-0.1	MT	0.1	0.1	0.0
NL	4.9	4.9	0.1	NL	3.1	3.5	0.4	NL	5.8	7.3	1.5
PL	1.2	3.1	1.8	PL	0.8	2.3	1.5	PL	1.2	2.7	1.5
PT	0.5	0.9	0.3	PT	0.3	0.4	0.1	PT	0.5	0.8	0.3
RO	0.4	1.1	0.7	RO	0.2	0.9	0.7	RO	0.3	1.0	0.7
SE	4.8	3.9	-0.9	SE	4.8	3.8	-1.0	SE	4.5	4.0	-0.5
SI	0.2	0.5	0.2	SI	0.1	0.3	0.2	SI	0.2	0.4	0.2
SK	0.2	0.8	0.6	SK	0.1	0.7	0.6	SK	0.2	0.7	0.5

Source: WIOD Release 2016. wiiw calculations.

9.5. APPENDIX 5: ADDITIONAL REGRESSION RESULTS

Table A 3 / Structural models, advanced manufacturing, EU-28 sample

Aggregate: **Advanced manufacturing**
Sample: **EU-28**
Dependent Variable: **Δvalue added share of advanced manufacturing**

	Model SPEC							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0111	0.0090						
	(0.0161)	(0.0161)						
VC intensity x CEMC		0.0202						
		(0.0463)						
RVC intensity			0.0136	0.0251			0.0126	0.0301
			(0.0206)	(0.0227)			(0.0205)	(0.0235)
RVC intensity x CEMC				-0.0844				-0.0878
				(0.0698)				(0.0772)
GVC intensity					0.0110	-0.0080	0.0091	-0.0169
					(0.0269)	(0.0279)	(0.0268)	(0.0272)
GVC intensity x CEMC						0.1336*		0.1427*
						(0.0735)		(0.0738)
share advanced mf	-0.1841***	-0.1858***	-0.1849***	-0.1896***	-0.1835***	-0.2028***	-0.1843***	-0.2105***
	(0.0413)	(0.0407)	(0.0417)	(0.0423)	(0.0402)	(0.0368)	(0.0407)	(0.0379)
Δreal FX (ULC based)	0.0015	0.0016	0.0015	0.0008	0.0017	0.0015	0.0014	0.0004
	(0.0042)	(0.0043)	(0.0042)	(0.0043)	(0.0041)	(0.0040)	(0.0042)	(0.0042)
advanced labour share	-0.0172	-0.0166	-0.0177	-0.0183	-0.0180	-0.0158	-0.0172	-0.0153
	(0.0136)	(0.0136)	(0.0140)	(0.0144)	(0.0143)	(0.0152)	(0.0135)	(0.0143)
R&D intensity	0.0804	0.0697	0.0822	0.1068	0.0739	0.0391	0.0814	0.0734
	(0.1293)	(0.1291)	(0.1275)	(0.1279)	(0.1252)	(0.1334)	(0.1259)	(0.1367)
ln GDP per capita	-0.0011	-0.0012	-0.0014	-0.0023	-0.0011	-0.0032	-0.0012	-0.0045
	(0.0040)	(0.0042)	(0.0042)	(0.0039)	(0.0042)	(0.0044)	(0.0043)	(0.0039)
ln population	-0.0162	-0.0162	-0.0155	-0.0171	-0.0153	-0.0176	-0.0161	-0.0202
	(0.0143)	(0.0144)	(0.0135)	(0.0135)	(0.0139)	(0.0142)	(0.0144)	(0.0145)
constant	0.2798	0.2815	0.2725	0.3085	0.2669	0.3243	0.2797	0.3795
	(0.2600)	(0.2615)	(0.2519)	(0.2501)	(0.2521)	(0.2562)	(0.2601)	(0.2576)
Observations	363	363	363	363	363	363	363	363
R-squared	0.3105	0.3108	0.3103	0.3131	0.3100	0.3161	0.3105	0.3199
R-sq. dj.	0.210	0.208	0.210	0.211	0.210	0.214	0.208	0.213
F-test	38.54	55.47	32.92	36.21	37.44	26.06	36.72	29.69

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

Table A 4 / Structural models, manufacturing and business services, EU-28 sample

Aggregate: **Manufacturing and business services**
Sample: **EU-28**
Dependent Variable: **Δvalue added share of manufacturing and business services**

	Model SPEC							
	(1)		(2)		(3)		(4)	
	VC intensity		RVC intensity		GVC intensity		RVC+GVC intensity	
	linear	non-linear	linear	non-linear	linear	non-linear	linear	non-linear
VC intensity	0.0777***	0.0750***						
	(0.0237)	(0.0223)						
VC intensity x CEMC		0.1016**						
		(0.0428)						
RVC intensity			0.0836**	0.0787**			0.0800**	0.0850**
			(0.0347)	(0.0340)			(0.0384)	(0.0410)
RVC intensity x CEMC				0.1395				0.0337
				(0.0936)				(0.1070)
GVC intensity					0.0875	0.0768	0.0694	0.0542
					(0.0864)	(0.0887)	(0.0919)	(0.0945)
GVC intensity x CEMC						0.1571**		0.1681*
						(0.0695)		(0.0892)
share mf & bs	-0.3258***	-0.3442***	-0.3305***	-0.3423***	-0.3037***	-0.3187***	-0.3268***	-0.3475***
	(0.0649)	(0.0667)	(0.0614)	(0.0645)	(0.0592)	(0.0575)	(0.0621)	(0.0632)
Δreal FX (ULC based)	-0.0206**	-0.0208**	-0.0201**	-0.0199**	-0.0209**	-0.0214**	-0.0206**	-0.0210**
	(0.0092)	(0.0089)	(0.0093)	(0.0091)	(0.0094)	(0.0092)	(0.0094)	(0.0091)
advanced labour share	0.0166	0.0210	0.0192	0.0200	0.0097	0.0158	0.0170	0.0243
	(0.0191)	(0.0207)	(0.0190)	(0.0190)	(0.0176)	(0.0200)	(0.0185)	(0.0210)
R&D intensity	0.2738	0.2232	0.2869	0.2673	0.2712	0.2161	0.2752	0.2122
	(0.2161)	(0.2198)	(0.2140)	(0.2132)	(0.2208)	(0.2266)	(0.2115)	(0.2234)
ln GDP per capita	0.0046	0.0039	0.0017	0.0022	0.0082	0.0063	0.0042	0.0020
	(0.0075)	(0.0078)	(0.0077)	(0.0077)	(0.0079)	(0.0087)	(0.0088)	(0.0097)
ln population	-0.0602**	-0.0639**	-0.0627**	-0.0637**	-0.0453*	-0.0499*	-0.0608**	-0.0671**
	(0.0261)	(0.0270)	(0.0275)	(0.0279)	(0.0237)	(0.0252)	(0.0284)	(0.0306)
constant	0.9698**	1.0350**	1.0490**	1.0580**	0.7034	0.7948*	0.9837*	1.1074*
	(0.4477)	(0.4606)	(0.4781)	(0.4826)	(0.4160)	(0.4452)	(0.5066)	(0.5471)
Observations	363	363	363	363	363	363	363	363
R-squared	0.4566	0.4612	0.4551	0.4578	0.4478	0.4517	0.4566	0.4620
R-sq. dj.	0.378	0.381	0.376	0.377	0.367	0.370	0.376	0.378
F-test	49.97	60.19	48.38	61.02	119.4	72.30	88.43	86.98

Note: All specifications include country and time fixed effects. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. Within-group robust standard errors in parentheses. All explanatory variables are lagged by one period. Specifications with interaction terms use centred values of the variables forming the interaction term.

9.6. APPENDIX 6: CALCULATION OF VALUE ADDED EXPORTS

The concept of value added exports (VAX) was initially suggested by Johnson and Noguera (2012), though the expositions here follow more closely the discussion in Stehrer (2012) and Stehrer (2013).

Three components are required to calculate the value added exports. For any reporting country *r*, these components are the (industry-specific) value added requirements per unit of gross output, v_i^r, where *i* denotes the industry dimension (with $i \in I$); the Leontief inverse of the global input-output matrix, $\boldsymbol{L}$; and the global final demand vector, f_i^C, where the subscript *C* indicates that the vector comprises the final demand of all countries $c \in C$.

Country *r*'s (industry-specific) value added coefficients are defined as $v_i^r = \frac{value\ added_i^r}{gross\ output_i^r}$. The value added coefficients are arranged in a diagonal matrix of dimension *C·I* x *C·I*[41]. This matrix contains the value added coefficients of reporting country *r* for all industries along the diagonals. The remaining entries of the matrix are zero.

The second element is the Leontief inverse of the global input-output matrix, $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$ where $\boldsymbol{A}$ denotes the matrix of coefficients containing the typical element $a_{i,j}^{r,c}$ – the technical coefficients – which indicates the value of the sales of country *r*'s industry *i* to country *c*'s industry *j* per unit of production of *c*'s industry *j*. The technical coefficients describing the domestic production process in country *r* are found along the diagonal elements while the off-diagonal elements constitute country *r's* imports (from a column perspective). The dimension of the matrix of coefficients and the Leontief matrix is also *C·I* x *C·I.*

The final building block is the (industry-specific) global final demand vector f_i^C, which has the dimension *C·I* × 1. This final demand is split into separate blocks indicating the origin of the demand for the final goods. This split of final demand by demanding country, however, appears *within* the elements in the column vector. As usual, each row is associated with the source of the production that is the subject of the final demand.

In the 3-country-2-sector case, which includes the reporting country *r* and partner countries 2 and 3 and assumes a manufacturing sector (*m*) and a services sector (*s*), the full final demand vector, f_i^C, has the form

$$f_i^C = \begin{pmatrix} f_m^{r,r} + f_m^{r,2} + f_m^{r,3} \\ f_s^{r,r} + f_s^{r,2} + f_s^{r,3} \\ f_m^{2,r} + f_m^{2,2} + f_m^{2,3} \\ f_s^{2,r} + f_s^{2,2} + f_s^{2,3} \\ f_m^{3,r} + f_m^{3,2} + f_m^{3,3} \\ f_s^{3,r} + f_s^{3,2} + f_s^{3,3} \end{pmatrix}$$

where the subscript *C* indicates that the vector comprises the final demand of all countries $c \in C$. The typical element of this vector contains the final demand from all possible sources. For example, the element $f_s^{r,3}$ captures the value of final goods that country 3 demands from the services sector in country *r*. The value added exports comprise only value added that is created in one country but absorbed in another. Therefore the final demand from reporting country *r* itself needs to be eliminated for

[41] In the WIOD 2016 Release there are 44 countries and 56 industries so that the dimension of the matrix is 2464 x 2464.

the calculation of country *r*'s VAX. This is done by setting the demand from country *r* to zero, yielding an adjusted final demand vector, $f_i^{c\neq r}$. This vector has the form:

$$f_i^{c\neq r} = \begin{pmatrix} 0 + f_m^{r,2} + f_m^{r,3} \\ 0 + f_s^{r,2} + f_s^{r,3} \\ 0 + f_m^{2,2} + f_m^{2,3} \\ 0 + f_s^{2,2} + f_s^{2,3} \\ 0 + f_m^{3,2} + f_m^{3,3} \\ 0 + f_s^{3,2} + f_s^{3,3} \end{pmatrix}$$

Reporting country *r*'s value added exports can then be calculated as

$$\text{(A1)} \qquad VAX_i^{r,*} = \boldsymbol{v_i^r} \cdot \boldsymbol{L} \cdot f_i^{c\neq r}$$

where $VAX_i^{r,*}$ is a row vector of dimension *C·I* × 1 which contains the sector-specific value added exports of country *r* to all partner countries.

To further illustrate the calculation, the matrices in equation (A1) are shown in detail for the three countries (reporting country *r* and partner countries 2 and 3) – two sectors case (sectors *m* and *s*):

$$\begin{pmatrix} VAX_{m,*}^{r,*} \\ VAX_{s,*}^{r,*} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} v_m^r & 0 & 0 & 0 & 0 & 0 \\ 0 & v_s^r & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} l_{m,m}^{r,r} & l_{m,s}^{r,r} & l_{m,m}^{r,2} & l_{m,s}^{r,2} & l_{m,m}^{r,3} & l_{m,s}^{r,3} \\ l_{s,m}^{r,r} & l_{s,s}^{r,r} & l_{s,m}^{r,2} & l_{s,s}^{r,2} & l_{s,m}^{r,3} & l_{s,s}^{r,3} \\ l_{m,m}^{2,r} & l_{m,s}^{2,r} & l_{m,m}^{2,2} & l_{m,s}^{2,2} & l_{m,m}^{2,3} & l_{m,s}^{2,3} \\ l_{s,m}^{2,r} & l_{s,s}^{2,r} & l_{s,m}^{2,2} & l_{s,s}^{2,2} & l_{s,m}^{2,3} & l_{s,s}^{2,3} \\ l_{m,m}^{3,r} & l_{m,s}^{3,r} & l_{m,m}^{3,2} & l_{m,s}^{3,2} & l_{m,m}^{3,3} & l_{m,s}^{3,3} \\ l_{s,m}^{3,r} & l_{s,s}^{3,r} & l_{s,m}^{3,2} & l_{s,s}^{3,2} & l_{s,m}^{3,3} & l_{s,s}^{r,3} \end{pmatrix} \cdot \begin{pmatrix} 0 + f_m^{r,2} + f_m^{r,3} \\ 0 + f_s^{r,2} + f_s^{r,3} \\ 0 + f_m^{2,2} + f_m^{2,3} \\ 0 + f_s^{2,2} + f_s^{2,3} \\ 0 + f_m^{3,2} + f_m^{3,3} \\ 0 + f_s^{3,2} + f_s^{3,3} \end{pmatrix}$$

The coefficients in the Leontief matrix represent the total direct and indirect input requirements of any country for producing one dollar worth of output for final demand. For example, the coefficient $l_{m,s}^{r,r}$ indicates the total input requirement of country *r*'s services sector from country *r*'s manufacturing sector for producing one unit of output of sector *s*. Likewise, the coefficient $l_{m,m}^{r,3}$ indicates the input requirement of the manufacturing sector in country 3 per unit of its output that is supplied by country *r*'s manufacturing sector.

The resulting elements, $VAX_{m,*}^{r,*}$ and $VAX_{s,*}^{r,*}$, are the total value added exports of country *r*'s manufacturing and services sector to all other sectors (indicated by the asterisk in the subscript) of all partner countries (indicated by the asterisk in the superscript).

9.7. APPENDIX 7: CALCULATION OF RE-EXPORTED DOMESTIC VALUE ADDED

The starting point for the calculation of the re-exported domestic value added (*DVAre*) is the decomposition of gross exports following the approach in Wang et al. (2013). The DVAre measure is a sub-component of the better-known value added exports (VAX) plus the domestic value added exported but returning home which is not part of VAX. The components which define DVAre are all contained in the key equation (equation (37) on p. 30) in Wang et al. (2013). These elements are characterised by the fact that the value added crosses borders at least twice. They comprise:

(a) The intermediate exports of reporting economy r to a partner country which are ultimately shipped to the destination country in the form of final goods.
(b) The intermediate exports of reporting economy r to a partner country which are ultimately shipped to the destination country in the form of intermediate goods.
(c) The intermediate exports of reporting economy r to a partner country which are consequently re-imported by country r in the form of either final goods or intermediate goods.

Note that all these export flows are exports of intermediates in the first export, while the ultimate export may take the form of a final goods or an intermediate goods export.

While not done explicitly in Wang et al. (2013), the decomposition allows for the identification of four 'roles' that a country can take in trade flows that form part of DVAre. These roles are:

(i) *reporting economy, **r,** which is the source country of the value added exported*
(ii) *immediate production partner, **ipp**, which is the recipient country of the first export by the source country r. The immediate production partner necessarily ships the value added (originating from country r) to another country.*
(iii) *ultimate production partner, **upp**, which is the last country in the production chain, responsible for the last production step and sale. This last sale can be an export or a domestic sale.*
(iv) *destination country, **dest**, which is the country of final demand, i.e. the country of absorption.*

In this categorisation the first three roles are all 'producers' because they are involved in the production process. In contrast, the role 'destination' is not part of the producers since it is the country of absorption. Certainly, for a particular trade flow, a particular country can take several roles. A simple example is a re-import, in which case the reporting country is identical to the country of absorption.

In technical terms, there are three terms of interest in the decomposition by Wang et al. (2013). In all these terms the notation is slightly adjusted to fit the description of the roles above. In particular, the index r denotes the reporting country and so on. So for any export flow ϕ, the indication $\phi^{r,ipp}$ means an export from the reporting country to the immediate production partner. Wang et al. (2013) indicate their decomposition at the bilateral level between reporting economy *r* and the immediate production partner, *ipp*:

(a) *Exports of intermediates with the ultimate export being an intermediate goods export, which are labelled* $DVAreex_{inter}^{r,ipp}$

$$DVAreex_{inter}^{r,ipp} = (V^r L^{rr})^T \# (A^{r,ipp} \sum_{upp \neq r,ipp}^{C} L^{ipp,upp} \cdot F^{upp,upp})$$

where $'\#'$ denotes an elementwise multiplication, V^r is the value added coefficient and L^{rr} the domestic Leontief inverse. Furthermore, $A^{r,ipp}$ is the sub-matrix of the global direct input coefficient matrix containing the elements representing inter-industry sales from reporting economy *r* to the immediate production partner, *ipp*. $L^{ipp,upp}$ is the global Leontief matrix with the elements representing direct and indirect inter-industry sales from the immediate production partner to the ultimate production partner, *upp*. Finally, is $F^{upp,upp}$ is the final demand involving purchases by the ultimate production partner – which here is equal to the country of destination so that $F^{upp,upp} = F^{dest,dest}$ – from itself. Hence, in this case the final sale is a domestic transaction and not an export. In other words, the country where the last production step is undertaken and the country of absorption are identical.

(b) *Exports of intermediates with the ultimate export being a final goods export, which are labelled* $DVAreex_{final}^{r,ipp}$

There are two types of re-exports of intermediates. In the first cases the immediate production partner, *ipp*, sells on the final good directly to the destination country, *dest*:

$$DVAreex_{final(1)}^{r,ipp} = (V^r L^{rr})^T \# (A^{r,ipp} \cdot L^{ipp,ipp} \sum_{dest \neq r,ipp}^{C} F^{ipp,dest})$$

In the second case the immediate production partner, *ipp*, sells on an intermediate good to another production partner, *upp*, which ultimately sells the final good to the destination country, *dest:*

$$DVAreex_{final(2)}^{r,ipp} = (V^r L^{rr})^T \# (A^{r,ipp} \sum_{upp \neq r,ipp}^{C} L^{ipp,upp} \sum_{dest \neq r,upp}^{C} F^{upp,dest})$$

In this second case, there are (at least)[42] three border crossings.

(c) *Exports of intermediates which return home to the reporting economy*

$$DVAreimp_{total}^{r,ipp} = (V^r L^{rr})^T \#(A^{r,ipp} \cdot L^{ipp,ipp} \cdot F^{ipp,r} + A^{r,ipp} \sum_{upp \neq r,ipp}^{C} L^{ipp,upp} \cdot F^{upp,r} + A^{r,ipp} \cdot L^{ipp,r} \cdot F^{r,r})$$

Note that within the re-imports there are actually also these three sub-types of imports, i.e. the value added that returns home to the reporting economy directly in the form of final goods, value added that returns home to the reporting economy via a first (*ipp*) and a second production partner (*upp*), and value added that is re-imported in the form of intermediate goods.

42 There are 'at least' three border crossings as potentially there may be additional countries that the value added passes on its way from the reporting economy to the destination country. This may happen 'within' the $B^{ipp,upp}$ shipment which cannot be further tracked with this approach.

In contrast to the focus in Wang et al. (2013) on the bilateral flows between the reporting country and the immediate production partner, the approach in this study requires all 'roles' described above. Also, with regards to bilateral exports, the view is that the main interest should be with flows between the reporting economy and the destination country, i.e. $\phi^{r,dest}$ as usual in trade analysis even if this flow is indirect via other countries. Hence, the geographic split of exports will be according to destination countries. The information on the immediate and the ultimate production partner will be used to identify the regional versus global VC trade. Hence, in essence the same bilateral *DVAre* flows are used but they are aggregated differently.

The way the calculations are performed ensures that the *DVAre* originating from all source countries is covered and that all 'roles' remain identifiable. This poses some problems of dimensionality so that the usual matrix algebra used to calculate, for example, VAX needs to be adjusted.

The general approach is to calculate all possible combinations of trade flows between the quadruples (*r-ipp-upp-dest*) using matrix algebra and then single out the combinations necessary to single out the three types of *DVAre*.

Hence the matrix calculations will yield a 'magnified' DVAre measure, $\boldsymbol{D\widehat{VAre}}$, which contains all possible combinations of quadruples, some of which need to be dropped later on because they actually do not form part of *DVAre*.

The general approach to calculate these 'magnified DVAre', $D\widehat{VAre}$, is the following:

$$\boldsymbol{D\widehat{VAre}} = \boldsymbol{v}^{r} \cdot \boldsymbol{L}^{rr} \# (\boldsymbol{A}^{r} \cdot \boldsymbol{B} \cdot \boldsymbol{F}^{dest})$$

where $'\#'$ denotes again an elementwise multiplication. $\boldsymbol{L}^{rr}$ is the (blockdiagonal) domestic Leontief inverse. Post-multiplication of the value added coefficient matrix $\boldsymbol{v}^{r}$ with the domestic Leontief inverse ensures that only value added embodied in intermediate exports is considered. The result of $v^{r} \cdot \boldsymbol{L}^{rr}$ constitutes the first part in the calculation of *DVAre*.

The second part of the calculation entails the sub-matrix of the global direct input coefficient matrix ($\boldsymbol{A}^{r}$) for the reporter *r*, the global Leontief inverse, $\boldsymbol{B}$, and the final demand coming from each of the potential destination countries, represented by the final demand matrix $\boldsymbol{Y}^{dest}$. In the $A^{r,}$ matrix, the reporting country *r* is selling to the immediate production partner (*ipp*). In the case of the Leontief inverse the ultimate production partner (upp) is selling to the final destination country (*dest*). Y^{dest} is the (destination-specific) final demand matrix, which is also a block-diagonal matrix.

As for the first part of the calculation, $\boldsymbol{v}^{r} \cdot \boldsymbol{L}^{rr}$, the actual calculation is performed using the value added coefficient matrices with the full country industry dimension (*C x I*) and containing the value added coefficient of all reporters (i.e. no values are set to zero). Because of the issue of dimensionality, the value added coefficient matrix for each reporting economy *r* is transformed into a row vector. These country-specific row vectors are combined to yield – for the 3-country-2-sector case, assuming a manufacturing sector (*m*) and a services sector (*s*) – a value added coefficient matrix of the form

$$\begin{pmatrix} v_m^r & v_s^r & 0 & 0 & 0 & 0 \\ 0 & 0 & v_m^2 & v_s^2 & 0 & 0 \\ 0 & 0 & 0 & 0 & v_m^3 & v_s^3 \end{pmatrix}$$

Also, the domestic Leontief inverses are inserted as the diagonal blocks into a diagonal matrix of dimension *C x I* to yield the $\boldsymbol{L}^{rr}$ matrix. This matrix has the following form:

$$\begin{pmatrix} l_{m,m}^{r,r} & l_{m,s}^{r,r} & 0 & 0 & 0 & 0 \\ l_{s,m}^{r,r} & l_{s,s}^{r,r} & 0 & 0 & 0 & 0 \\ 0 & 0 & l_{m,m}^{2,2} & l_{m,s}^{2,2} & 0 & 0 \\ 0 & 0 & l_{s,m}^{2,2} & l_{s,s}^{2,2} & 0 & 0 \\ 0 & 0 & 0 & 0 & l_{m,m}^{3,3} & l_{m,s}^{3,3} \\ 0 & 0 & 0 & 0 & l_{s,m}^{3,3} & l_{s,s}^{r,3} \end{pmatrix}$$

The above-described value added coefficient matrix $\boldsymbol{v}_i^r$ is multiplied with the block-diagonal domestic Leontief inverse.

$$[\boldsymbol{v}_i \ \cdot \boldsymbol{L}^{rr}]$$

In the 3-country-2-sector example the following result is obtained:

$$\boldsymbol{vL}^{rr} = \begin{pmatrix} v_m^r & v_s^r & 0 & 0 & 0 & 0 \\ 0 & 0 & v_m^2 & v_s^2 & 0 & 0 \\ 0 & 0 & 0 & 0 & v_m^3 & v_s^3 \end{pmatrix} \cdot \begin{pmatrix} l_{m,m}^{r,r} & l_{m,s}^{r,r} & 0 & 0 & 0 & 0 \\ l_{s,m}^{r,r} & l_{s,s}^{r,r} & 0 & 0 & 0 & 0 \\ 0 & 0 & l_{m,m}^{2,2} & l_{m,s}^{2,2} & 0 & 0 \\ 0 & 0 & l_{s,m}^{2,2} & l_{s,s}^{2,2} & 0 & 0 \\ 0 & 0 & 0 & 0 & l_{m,m}^{3,3} & l_{m,s}^{3,3} \\ 0 & 0 & 0 & 0 & l_{s,m}^{3,3} & l_{s,s}^{r,3} \end{pmatrix}$$

$$= \begin{pmatrix} v_m^r\, l_{m,m}^{r,r} + v_s^r\, l_{s,m}^{r,r} & v_m^r\, l_{m,s}^{r,r} + v_s^r\, l_{s,s}^{r,r} & 0 & 0 & 0 & 0 \\ 0 & 0 & v_m^2\, l_{m,m}^{2,2} + v_s^2\, l_{s,m}^{2,2} & v_m^2\, l_{m,s}^{2,2} + v_s^2\, l_{s,s}^{2,2} & 0 & 0 \\ 0 & 0 & 0 & 0 & v_m^3\, l_{m,m}^{3,3} + v_s^3\, l_{s,m}^{3,3} & v_m^3\, l_{m,s}^{3,3} + v_s^3 l_{s,s}^{3,3} \end{pmatrix}$$

The resulting matrix, $\boldsymbol{L}^{rr}$, is transposed blockwise and post-multiplied with a *C I x1* vector of ones to yield a *1 x C I* column vector of the form.

$$vL^{rr} = \begin{pmatrix} v_m^r\, l_{m,m}^{r,r} + v_s^r\, l_{s,m}^{r,r} \\ v_m^r\, l_{m,s}^{r,r} + v_s^r\, l_{s,s}^{r,r} \\ v_m^2\, l_{m,m}^{2,2} + v_s^2\, l_{s,m}^{2,2} \\ v_m^2\, l_{m,s}^{2,2} + v_s^2\, l_{s,s}^{2,2} \\ v_m^3\, l_{m,m}^{3,3} + v_s^3\, l_{s,m}^{3,3} \\ v_m^3\, l_{m,s}^{3,3} + v_s^3\, l_{s,s}^{3,3} \end{pmatrix}$$

The column vector v^{rr} is the first part of the operation.

The second part requires the matrix multiplication of $\boldsymbol{A}^r$ with the global Leontief inverse $\boldsymbol{L}$ and then with the appropriate (reporter-specific) block-diagonal final demand matrix,· $\boldsymbol{F}^{dest}$.

Using the roles as defined above for each reporting economy *r*, the reporting-country-specific rows of the direct input coefficient A are used to define $\boldsymbol{A^r}$ which has dimension *C·I x C·I***.** In the 3-country-2-sector case this matrix has the form

$$\boldsymbol{A^r} = \begin{pmatrix} a_{m,m}^{r,r} & a_{m,s}^{r,r} & a_{m,m}^{r,2} & a_{m,s}^{r,2} & a_{m,m}^{r,3} & a_{m,s}^{r,3} \\ a_{s,m}^{r,r} & a_{s,s}^{r,r} & a_{s,m}^{r,2} & a_{s,s}^{r,2} & a_{s,m}^{r,3} & a_{s,s}^{r,3} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

The blockwise diagonalisation of this $\boldsymbol{A^r}$ matrix yields

$$\boldsymbol{diag(A^r)} = \begin{pmatrix} a_{m,m}^{r,r} & a_{m,s}^{r,r} & 0 & 0 & 0 & 0 \\ a_{s,m}^{r,r} & a_{s,s}^{r,r} & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{m,m}^{r,2} & a_{m,s}^{r,2} & 0 & 0 \\ 0 & 0 & a_{s,m}^{r,2} & a_{s,s}^{r,2} & 0 & 0 \\ 0 & 0 & 0 & 0 & a_{m,m}^{r,3} & a_{m,s}^{r,3} \\ 0 & 0 & 0 & 0 & a_{s,m}^{r,3} & a_{s,s}^{r,3} \end{pmatrix}$$

This matrix is post-multiplied with the global Leontief matrix L to yield:

$$diag(\boldsymbol{A^r}) \cdot \boldsymbol{L}$$

The details of these matrices are as follows:

$$diag(A^r) \times L = \begin{pmatrix} a_{m,m}^{r,r} & a_{m,s}^{r,r} & 0 & 0 & 0 & 0 \\ a_{s,m}^{r,r} & a_{s,s}^{r,r} & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{m,m}^{r,2} & a_{m,s}^{r,2} & 0 & 0 \\ 0 & 0 & a_{s,m}^{r,2} & a_{s,s}^{r,2} & 0 & 0 \\ 0 & 0 & 0 & 0 & a_{m,m}^{r,3} & a_{m,s}^{r,3} \\ 0 & 0 & 0 & 0 & a_{s,m}^{r,3} & a_{s,s}^{r,3} \end{pmatrix} \begin{pmatrix} l_{m,m}^{r,r} & l_{m,s}^{r,r} & l_{m,m}^{r,2} & l_{m,s}^{r,2} & l_{m,m}^{r,3} & l_{m,s}^{r,3} \\ l_{s,m}^{r,r} & l_{s,s}^{r,r} & l_{s,m}^{r,2} & l_{s,s}^{r,2} & l_{s,m}^{r,3} & l_{s,s}^{r,3} \\ l_{m,m}^{2,r} & l_{m,s}^{2,r} & l_{m,m}^{2,2} & l_{m,s}^{2,2} & l_{m,m}^{2,3} & l_{m,s}^{2,3} \\ l_{s,m}^{2,r} & l_{s,s}^{2,r} & l_{s,m}^{2,2} & l_{s,s}^{2,2} & l_{s,m}^{2,3} & l_{s,s}^{2,3} \\ l_{m,m}^{3,r} & l_{m,s}^{3,r} & l_{m,m}^{3,2} & l_{m,s}^{3,2} & l_{m,m}^{3,3} & l_{m,s}^{3,3} \\ l_{s,m}^{3,r} & l_{s,s}^{3,r} & l_{s,m}^{3,2} & l_{s,s}^{3,2} & l_{s,m}^{3,3} & l_{s,s}^{3,3} \end{pmatrix}$$

$$= \begin{pmatrix} a_{m,m}^{r,r} \cdot l_{m,m}^{r,r} + a_{m,s}^{r,r} \cdot l_{s,m}^{r,r} & a_{m,m}^{r,r} \cdot l_{m,s}^{r,r} + a_{m,s}^{r,r} \cdot l_{s,s}^{r,r} & a_{m,m}^{r,r} \cdot l_{m,m}^{r,2} + a_{m,s}^{r,r} \cdot l_{s,m}^{r,2} & a_{m,m}^{r,r} \cdot l_{m,s}^{r,2} + a_{m,s}^{r,r} \cdot l_{s,s}^{r,2} & a_{m,m}^{r,r} \cdot l_{m,m}^{r,3} + a_{m,s}^{r,r} \cdot l_{s,m}^{r,3} & a_{m,m}^{r,r} \cdot l_{m,s}^{r,3} + a_{m,s}^{r,r} \cdot l_{s,s}^{r,3} \\ a_{s,m}^{r,r} \cdot l_{m,m}^{r,r} + a_{s,s}^{r,r} \cdot l_{s,m}^{r,r} & a_{s,m}^{r,r} \cdot l_{m,s}^{r,r} + a_{s,s}^{r,r} \cdot l_{s,s}^{r,r} & a_{s,m}^{r,r} \cdot l_{m,m}^{r,2} + a_{s,s}^{r,r} \cdot l_{s,m}^{r,2} & a_{s,m}^{r,r} \cdot l_{m,s}^{r,2} + a_{s,s}^{r,r} \cdot l_{s,s}^{r,2} & a_{s,m}^{r,r} \cdot l_{m,m}^{r,3} + a_{s,s}^{r,r} \cdot l_{s,m}^{r,3} & a_{s,m}^{r,r} \cdot l_{m,s}^{r,3} + a_{s,s}^{r,r} \cdot l_{s,s}^{r,3} \\ a_{m,m}^{r,2} \cdot l_{m,m}^{2,r} + a_{m,s}^{r,2} \cdot l_{s,m}^{2,r} & a_{m,m}^{r,2} \cdot l_{m,s}^{r,r} + a_{m,s}^{r,2} \cdot l_{s,s}^{r,r} & a_{m,m}^{r,2} \cdot l_{m,m}^{2,2} + a_{m,s}^{r,2} \cdot l_{s,m}^{2,2} & a_{m,m}^{r,2} \cdot l_{m,s}^{r,r} + a_{m,s}^{r,2} \cdot l_{s,s}^{2,2} & a_{m,m}^{r,2} \cdot l_{m,m}^{2,3} + a_{m,s}^{r,2} \cdot l_{s,m}^{2,3} & a_{m,m}^{r,2} \cdot l_{m,s}^{2,3} + a_{m,s}^{r,2} \cdot l_{s,s}^{r2,3} \\ a_{s,m}^{r,2} \cdot l_{m,m}^{2,r} + a_{s,s}^{r,2} \cdot l_{s,m}^{2,r} & a_{s,m}^{r,2} \cdot l_{m,s}^{r,r} + a_{s,s}^{r,2} \cdot l_{s,s}^{r,r} & a_{s,m}^{r,2} \cdot l_{m,m}^{2,2} + a_{s,s}^{r,2} \cdot l_{s,m}^{2,2} & a_{s,m}^{r,2} \cdot l_{m,s}^{r,r} + a_{s,s}^{r,2} \cdot l_{s,s}^{2,2} & a_{s,m}^{r,2} \cdot l_{m,m}^{2,3} + a_{s,s}^{r,2} \cdot l_{s,m}^{2,3} & a_{s,m}^{r,2} \cdot l_{m,s}^{2,3} + a_{s,s}^{r,2} \cdot l_{s,s}^{2,3} \\ a_{m,m}^{r,3} \cdot l_{m,m}^{3,r} + a_{m,s}^{r,3} \cdot l_{s,m}^{3,r} & a_{m,m}^{r,3} \cdot l_{m,s}^{3,r} + a_{m,s}^{r,3} \cdot l_{s,s}^{3,r} & a_{m,m}^{r,3} \cdot l_{m,m}^{3,2} + a_{m,s}^{r,3} \cdot l_{s,m}^{3,2} & a_{m,m}^{r,3} \cdot l_{m,s}^{3,2} + a_{m,s}^{r,3} \cdot l_{s,s}^{3,2} & a_{m,m}^{r,3} \cdot l_{m,m}^{3,3} + a_{m,s}^{r,3} \cdot l_{s,m}^{r3,3} & a_{m,m}^{r,3} \cdot l_{m,s}^{3,3} + a_{m,s}^{r,3} \cdot l_{s,s}^{3,3} \\ a_{s,m}^{r,3} \cdot l_{m,m}^{3,r} + a_{s,s}^{r,3} \cdot l_{s,m}^{3,r} & a_{s,m}^{r,3} \cdot l_{m,s}^{3,r} + a_{s,s}^{r,3} \cdot l_{s,s}^{3,r} & a_{s,m}^{r,3} \cdot l_{m,m}^{3,2} + a_{s,s}^{r,3} \cdot l_{s,m}^{3,2} & a_{s,m}^{r,3} \cdot l_{m,s}^{3,2} + a_{s,s}^{r,3} \cdot l_{s,s}^{3,2} & a_{s,m}^{r,3} \cdot l_{m,m}^{3,3} + a_{s,s}^{r,3} \cdot l_{s,m}^{3,3} & a_{s,m}^{r,3} \cdot l_{m,s}^{3,3} + a_{s,s}^{r,3} \cdot l_{s,s}^{3,3} \end{pmatrix}$$

Define this matrix as AL^r

$$\boldsymbol{AL^r} = \begin{pmatrix} AL_{m,m}^{r,r} & AL_{m,s}^{r,r} & AL_{m,m}^{r,2} & AL_{m,s}^{r,2} & AL_{m,m}^{r,3} & AL_{m,s}^{r,3} \\ AL_{s,m}^{r,r} & AL_{s,s}^{r,r} & AL_{s,m}^{r,2} & AL_{s,s}^{r,2} & AL_{s,m}^{r,3} & AL_{s,s}^{r,3} \\ AL_{m,m}^{2,r} & AL_{m,s}^{2,r} & AL_{m,m}^{2,2} & AL_{m,s}^{2,2} & AL_{m,m}^{2,3} & AL_{m,s}^{2,3} \\ AL_{s,m}^{2,r} & AL_{s,s}^{2,r} & AL_{s,m}^{2,2} & AL_{s,s}^{2,2} & AL_{s,m}^{2,3} & AL_{s,s}^{2,3} \\ AL_{m,m}^{3,r} & AL_{m,s}^{3,r} & AL_{m,m}^{3,2} & AL_{m,s}^{3,2} & AL_{m,m}^{3,3} & AL_{m,s}^{3,3} \\ AL_{s,m}^{3,r} & AL_{s,s}^{3,r} & AL_{s,m}^{3,2} & AL_{s,s}^{3,2} & AL_{s,m}^{3,3} & AL_{s,s}^{3,3} \end{pmatrix}$$

This is a *CI x CI* matrix, of which there are *C* such matrices, one for each reporter. Note that in this matrix the indices of the elements are to be interpreted as follows: first index indicates the immediate production partner (*ipp*) and the index indicates the last country in the value chain, i.e. the ultimate production partner (*upp*).

In the next step this AL^r matrix is post-multiplied with the global final demand matrix for each of the countries.

The (industry-specific) global final demand vector f has the dimension *C·I* × 1. In the 3-country-2-sector case, it takes the form:

$$f = \begin{pmatrix} f_m^{r,r} + f_m^{r,2} + f_m^{r,3} \\ f_s^{r,r} + f_s^{r,2} + f_s^{r,3} \\ f_m^{2,r} + f_m^{2,2} + f_m^{2,3} \\ f_s^{2,r} + f_s^{2,2} + f_s^{2,3} \\ f_m^{3,r} + f_m^{3,2} + f_m^{3,3} \\ f_s^{3,r} + f_s^{3,2} + f_s^{3,3} \end{pmatrix}$$

This final demand is split into separate blocks indicating the origin of the demand for the final goods. From the WIOD data the information in this vector can also be used to form a *CI x CI* final demand matrix, F. For the 3-country-2-sector case:

$$\boldsymbol{F} = \begin{pmatrix} f_m^{r,r} & f_m^{r,2} & f_m^{r,3} \\ f_s^{r,r} & f_s^{r,2} & f_s^{r,3} \\ f_m^{2,r} & f_m^{2,2} & f_m^{2,3} \\ f_s^{2,r} & f_s^{2,2} & f_s^{2,3} \\ f_m^{3,r} & f_m^{3,2} & f_m^{3,3} \\ f_s^{3,r} & f_s^{3,2} & f_s^{3,3} \end{pmatrix}$$

As usual, each row is associated with the source of the production that is the subject of the final demand. For example, the element $f_s^{r,3}$ captures the value of final goods that country 3 demands from the services sector in country *r*.

This matrix is now split into column vectors for each individual country, f^r. This vector indicates the value added from all sources needed to satisfy final demand of a destination country *dest* and has dimension *CI x 1*:

$$f^{dest} = \begin{pmatrix} f_m^{r,dest} \\ f_s^{r,dest} \\ f_m^{2,dest} \\ f_s^{2,dest} \\ f_m^{3,dest} \\ f_s^{3,dest} \end{pmatrix}$$

Each of the destination-specific column vectors (there are *C* such vectors) are diagonalised and pre-multiplied with each of the AL^r matrices calculated above. Note that there is not only F but there are C such f^{dest} diagonal matrices. In this context f^{dest} is used to avoid confusion with country *r* as the source of the value added (although they can be identical, i.e. in the case of re-imports).

$$\boldsymbol{ALf}^{\boldsymbol{r \to dest}} = \boldsymbol{AL}^{\boldsymbol{r}} \cdot f^{dest}$$

This operation is done not only for the *AL* matrix of country *r* but for all of the *C* countries. The arrow in the superscript of the $\boldsymbol{ALf}^{\boldsymbol{r \to dest}}$ matrix should indicate that the value added will travel from *r* to *dest* via other countries.

For country *r*, and defining country 3 as the destination country (*dest*), the 3-country-2-sector case can be written as follows:

$$AL^{r} f^{dest}$$
$$= \begin{pmatrix} AL^{r,r}_{m,m} & AL^{r,r}_{m,s} & AL^{r,2}_{m,m} & AL^{r,2}_{m,s} & AL^{r,dest}_{m,m} & AL^{r,dest}_{m,s} \\ AL^{r,r}_{s,m} & AL^{r,r}_{s,s} & AL^{r,2}_{s,m} & AL^{r,2}_{s,s} & AL^{r,dest}_{s,m} & AL^{r,dest}_{s,s} \\ AL^{2,r}_{m,m} & AL^{2,r}_{m,s} & AL^{2,2}_{m,m} & AL^{2,2}_{m,s} & AL^{2,dest}_{m,m} & AL^{2,dest}_{m,s} \\ AL^{2,r}_{s,m} & AL^{2,r}_{s,s} & AL^{2,2}_{s,m} & AL^{2,2}_{s,s} & AL^{2,dest}_{s,m} & AL^{2,dest}_{s,s} \\ AL^{dest,r}_{m,m} & AL^{dest,r}_{m,s} & AL^{dest,2}_{m,m} & AL^{dest,2}_{m,s} & AL^{dest,dest}_{m,m} & AL^{dest,dest}_{m,s} \\ AL^{dest,r}_{s,m} & AL^{dest,r}_{s,s} & AL^{dest,2}_{s,m} & AL^{dest,2}_{s,s} & AL^{dest,3}_{s,m} & AL^{dest,dest}_{s,s} \end{pmatrix} \cdot \begin{pmatrix} f^{r,dest}_{m} & 0 & 0 & 0 & 0 & 0 \\ 0 & f^{r,dest}_{s} & 0 & 0 & 0 & 0 \\ 0 & 0 & f^{2,dest}_{m} & 0 & 0 & 0 \\ 0 & 0 & 0 & f^{2,dest}_{s} & 0 & 0 \\ 0 & 0 & 0 & 0 & f^{dest,dest}_{m} & 0 \\ 0 & 0 & 0 & 0 & 0 & f^{dest,dest}_{s} \end{pmatrix}$$
$$= \begin{pmatrix} AL^{r,r}_{m,m} \cdot f^{r,dest}_{m} & AL^{r,r}_{m,s} \cdot f^{r,dest}_{s} & AL^{r,2}_{m,m} \cdot f^{2,dest}_{m} & AL^{r,2}_{m,s} \cdot f^{2,dest}_{s} & AL^{r,dest}_{m,m} \cdot f^{dest,dest}_{m} & AL^{r,dest}_{m,s} \cdot f^{dest,dest}_{s} \\ AL^{r,r}_{s,m} \cdot f^{r,dest}_{m} & AL^{r,r}_{s,s} \cdot f^{r,dest}_{s} & AL^{r,2}_{s,m} \cdot f^{2,dest}_{m} & AL^{r,2}_{s,s} \cdot f^{2,dest}_{m} & AL^{r,dest}_{s,m} \cdot f^{dest,dest}_{m} & AL^{r,dest}_{s,s} \cdot f^{dest,dest}_{m} \\ AL^{2,r}_{m,m} \cdot f^{r,dest}_{m} & AL^{2,r}_{m,s} \cdot f^{r,dest}_{s} & AL^{2,2}_{m,m} \cdot f^{2,dest}_{m} & AL^{2,2}_{m,s} \cdot f^{2,dest}_{m} & AL^{2,dest}_{m,m} \cdot f^{dest,dest}_{m} & AL^{2,dest}_{m,s} \cdot f^{dest,dest}_{m} \\ AL^{2,r}_{s,m} \cdot f^{r,dest}_{m} & AL^{2,r}_{s,s} \cdot f^{r,dest}_{s} & AL^{2,2}_{s,m} \cdot f^{2,dest}_{m} & AL^{2,2}_{s,s} \cdot f^{2,dest}_{m} & AL^{2,dest}_{s,m} \cdot f^{dest,dest}_{m} & AL^{2,dest}_{s,s} \cdot f^{dest,dest}_{m} \\ AL^{dest,r}_{m,m} \cdot f^{r,dest}_{m} & AL^{dest,r}_{m,s} \cdot f^{r,dest}_{s} & AL^{dest,2}_{m,m} \cdot f^{2,dest}_{m} & AL^{dest,2}_{m,s} \cdot f^{2,dest}_{m} & AL^{dest,dest}_{m,m} \cdot f^{dest,dest}_{m} & AL^{dest,dest}_{m,s} \cdot f^{dest,dest}_{m} \\ AL^{dest,r}_{s,m} \cdot f^{r,dest}_{m} & AL^{dest,r}_{s,s} \cdot f^{r,dest}_{s} & AL^{dest,2}_{s,m} \cdot f^{2,dest}_{m} & AL^{dest,2}_{s,s} \cdot f^{2,dest}_{m} & AL^{dest,dest}_{s,m} \cdot f^{dest,dest}_{m} & AL^{dest,dest}_{s,s} \cdot f^{dest,dest}_{m} \end{pmatrix}$$

There are C x C such matrixes for each reporter-destination combinations. The ‘route’ along which the value added travelled from the reporter to the destination can be read directly from the indices of the global Leontief matrix. Therefore, from this $AL^{r} f^{dest}$ matrix all three relevant items for the calculation of the *DVAre* can be identified. In the above example, all elements in the matrix have country *r* as reporter and country *dest* as the destination country. The element $AL^{2,dest}_{s,s} \cdot f^{dest,dest}_{m}$ then is value added originating from country *r* that is exported in the form of intermediates to country 2, which takes the role of the immediate production partner. Country 2 is processing and re-exporting the value added in the form of intermediates to the final destination country in the form of intermediates. The destination country (dest) is responsible for the final production step, so it also has the role of the ultimate production partner.

The final step is to multiply elementwise the first part, $\boldsymbol{vL}^{\boldsymbol{rr}}$**,** with the second part:

$$\boldsymbol{vL}^{\boldsymbol{rr}} \# \boldsymbol{AL}^{\boldsymbol{r}} \cdot f^{dest}$$

This yields the magnified *DVAre*. To obtain the *DVAre* as defined above the required elements of the universe of combinations $\boldsymbol{vL}^{\boldsymbol{rr}} \# \boldsymbol{AL}^{\boldsymbol{r}} \cdot f^{dest}$ need to be singled out. More precisely, the components of *DVAre* defined above are obtained as follows

(a) *Exports of intermediates with the ultimate export being an intermediate goods export, which are labelled* $DVAreex^{r,ipp}_{inter}$

Contains all elements where $r \neq ipp \cap r \neq dest \ \cap [ipp \neq upp \ \cap \ upp = dest]$.

(b) *Exports of intermediates with the ultimate export being a final goods export (*$DVAreex^{r,ipp}_{final}$*)*

$$DVAreex^{r,ipp}_{final(1)}$$

Contains all elements where $r \neq ipp \cap r \neq dest \cap [ipp = upp \cap upp \neq dest]$.

$$DVAreex^{r,ipp}_{final(2)}$$

Contains all elements where $r \neq ipp \cap r \neq dest \cap [ipp \neq upp \cap upp \neq dest]$.

(c) *Exports of intermediates which return home to the reporting economy* ($DVAreimp^{r,ipp}_{total}$)

Contains all elements where $r = dest \cap r \neq ipp$.

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Herausgeber, Verleger, Eigentümer und Hersteller:
Verein „Wiener Institut für Internationale Wirtschaftsvergleiche“ (wiiw),
Wien 6, Rahlgasse 3

ZVR-Zahl: 329995655

Postanschrift: A 1060 Wien, Rahlgasse 3, Tel: [+431] 533 66 10, Telefax: [+431] 533 66 10 50
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Offenlegung nach § 25 Mediengesetz: Medieninhaber (Verleger): Verein "Wiener Institut für Internationale Wirtschaftsvergleiche", A 1060 Wien, Rahlgasse 3. Vereinszweck: Analyse der wirtschaftlichen Entwicklung der zentral- und osteuropäischen Länder sowie anderer Transformationswirtschaften sowohl mittels empirischer als auch theoretischer Studien und ihre Veröffentlichung; Erbringung von Beratungsleistungen für Regierungs- und Verwaltungsstellen, Firmen und Institutionen.

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