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GREECE'S INTEGRATION INTO GLOBAL VALUE CHAINS

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ABSTRACT

This paper investigates Greece's involvement in GVCs using the decomposition suggested by Wang et al. (2013, 2018) and applied to the World Input-Output Database (WIOD). In general, we find that domestic value added is high in service sectors and much lower in manufacturing, in line with the results from the literature. However, we find evidence of both upstream and downstream activity in different sectors. In particular, upstreamness is found in crop and animal production, mining and quarrying, the manufacture of basic metals, and wholesale and retail trade. Downstreamness is common in accommodation and food services. Two sectors – manufacture of food products and manufacture of pharmaceuticals – have seen a rise in the importance of domestic value added in exports. That is, the products are increasingly being made from start to finish, providing high levels of domestic value added in exports. Finally, there are sectors which display the characteristics of both upstreamness and downstreamness. These include the manufacture of textiles, wood and wood products, paper and paper products and, most importantly, petroleum and chemicals, which exhibit the greatest degree of GVC integration of any sector in Greece. The consolidation of these trends towards greater integration – either in manufacturing or in services and distribution – is likely to be of benefit for the Greek economy, allowing it to improve the quality of its exports as well as lowering their price.

Keywords: global value chains, Greece, upstreamness, downstreamness

JEL classification: F23, L14

Η ΣΥΜΜΕΤΟΧΗ ΤΗΣ ΕΛΛΑΔΟΣ ΣΤΙΣ ΠΑΓΚΟΣΜΙΕΣ ΑΛΥΣΙΔΕΣ ΑΞΙΑΣ

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ΠΕΡΙΛΗΨΗ

Στην παρούσα μελέτη διερευνάται η συμμετοχή της Ελλάδος στις παγκόσμιες αλυσίδες αξίας σύμφωνα με την ανάλυση που προτείνουν οι Wang et al. (2013, 2018) και η οποία εφαρμόζεται στη βάση δεδομένων World Input-Output Database (WIOD). Το γενικό συμπέρασμα της μελέτης είναι ότι η εγχώρια προστιθέμενη αξία είναι υψηλή στους κλάδους των υπηρεσιών και πολύ χαμηλότερη στη μεταποίηση, συμβαδίζοντας με τα αποτελέσματα της βιβλιογραφίας. Ωστόσο, τα αποτελέσματα καταδεικνύουν συμμετοχή κλάδων οικονομικής δραστηριότητας τόσο στα αρχικά στάδια (upstreamness) όσο και στα τελικά στάδια (downstreamness) της παγκόσμιας παραγωγικής αλυσίδας. Συγκεκριμένα, οι κλάδοι της φυτικής και ζωικής παραγωγής, της παραγωγής ορυχείων-λατομείων, της παραγωγής βασικών μετάλλων και του χονδρικού και λιανικού εμπορίου συμμετέχουν στα αρχικά στάδια της παγκόσμιας παραγωγικής αλυσίδας. Η συμμετοχή στα τελικά στάδια της παγκόσμιας αλυσίδας παραγωγής παρατηρείται συνήθως στον κλάδο καταλυμάτων και δραστηριοτήτων υπηρεσιών εστίασης. Δύο κλάδοι – η βιομηχανία τροφίμων και η παραγωγή βασικών φαρμακευτικών προϊόντων και φαρμακευτικών παρασκευασμάτων – καταγράφουν αύξηση του ποσοστού της εγχώριας προστιθέμενης αξίας στις εξαγωγές. Αυτό σημαίνει ότι η παραγωγή των εν λόγω προϊόντων γίνεται σε αυξανόμενο βαθμό από την αρχή έως το τέλος, προσδίδοντας υψηλότερη εγχώρια προστιθέμενη αξία στις εξαγωγές. Τέλος, υπάρχουν κλάδοι που συμμετέχουν τόσο στα αρχικά όσο και στα τελικά στάδια της παγκόσμιας αλυσίδας παραγωγής. Σε αυτούς τους κλάδους περιλαμβάνονται η παραγωγή κλωστοϋφαντουργικών υλών, ειδών ενδυμασίας, δέρματος και δερμάτινων ειδών, η βιομηχανία ξύλου και κατασκευής προϊόντων από ξύλο, η βιομηχανία χαρτοποιίας και κατασκευής χαρτινων προϊόντων και κυρίως οι κλάδοι παραγωγής οπτάνθρακα και προϊόντων διύλισης πετρελαίου και παραγωγής χημικών ουσιών και προϊόντων, οι οποίοι έχουν στην Ελλάδα την υψηλότερη συμμετοχή στις παγκόσμιες αλυσίδες αξίας. Η ισχυροποίηση της τάσης μεγαλύτερης συμμετοχής στις παγκόσμιες αλυσίδες αξίας – είτε στη μεταποίηση είτε στους κλάδους υπηρεσιών και διανομής – ενδέχεται να αποφέρει οφέλη στην ελληνική οικονομία, καθιστώντας δυνατή τη βελτίωση της ποιότητας των εξαγωγών της, καθώς και τη μείωση των τιμών εξαγωγών.

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I INTRODUCTION

One salient feature of economic globalisation over the past decades has been the rise of global value chains (GVCs), where the different stages of production and distribution of goods and services have become increasingly fragmented and dispersed across countries. This has been made possible by advances in information, communication and transportation technologies, together with institutional and market reforms that have allowed countries to participate in global economic activity. The expansion of GVCs, through increased outsourcing and offshoring¹ of intermediate inputs to foreign suppliers, has fundamentally changed international trade, creating opportunities but also risks for both advanced and emerging market economies. The advent of the global financial crisis in 2008-09 halted this expansion, which had already been slowing, and triggered a streamlining of GVCs, with firms reducing the complexity and length of their supply chains (OECD 2013; ECB 2016).

In particular, GVCs have been undergoing a number of structural shifts, which are occurring against the backdrop of trade protectionism and policy uncertainty. First, GVCs are becoming less global and more regional around core advanced but also emerging market economies, while there is a shift towards onshoring of production to key export markets to better cater for rising domestic consumption. Second, GVCs, and the accompanying foreign direct investment, are increasingly less

driven by considerations of labour cost minimisation (ECB 2016), a trend that is expected to be amplified in the future due to automation and artificial intelligence. Third, GVCs are growing more service-² and knowledge-intensive, with capitalised spending on R&D and intangible assets such as brands, software, and intellectual property making up a larger share of revenue (McKinsey 2019). This, in principle, would favour countries with high-skilled labour forces, innovation-oriented businesses, strong legal and regulatory frameworks, and good institutional governance.

An extensive body of literature has analysed the impact on countries and firms from their participation in GVCs, which can be beneficial in various ways. Evidence shows that greater GVC participation is typically associated with higher investment, productivity gains, economic growth and employment creation (Saito et al. 2013; Ignatenko et al. 2019). GVC integration increases competition, allocative efficiency and technological spillovers, facilitating the upgrading of products, processes and skills. The benefits can spread more widely in the economy, as technology and expertise are transferred from lead global firms to local

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1 Outsourcing by a firm occurs when part of the production process (including perhaps services involved in the production process) is conducted by another firm. Offshoring is outsourcing conducted in another country.

2 Ignatenko et al. (2019) note that the so-called servicification of manufacturing exports has been an important trend. More specifically, when measured in value added terms, the share of services exports in world exports is almost twice as large as what official statistics on gross exports show.

firms and workers, encouraging the latter's engagement in the supply network and exporting activity. Brumm et al. (2019) show that economies with greater participation in GVCs improve their current account balances in the form of higher external surpluses or lower external deficits. Their result is robust even after controlling for country size, trade openness or domestic manufacturing intensity.

There are multiple channels through which GVC participation increases productivity, including a finer division of labour across countries (Grossman and Rossi-Hansberg 2008), greater input variety (Halpern et al. 2015), learning externalities, and lower production costs which free up funds for R&D investment (Glass and Saggi 2001). A handful of studies at the industry level document that service offshoring positively affects productivity in advanced economies (see, for example, Crinò 2008; Amiti and Wei 2009; Winkler 2010). Other studies at the firm level in advanced and emerging market economies corroborate that international outsourcing increases productivity (see, for example, Görg et al. 2008; Kasahara and Rodrigue 2008; Fariñas and Martín-Marcos 2010; Jabbour 2010; Ito et al. 2011; Montalbano et al. 2018). Schwörer (2013), combining industry and firm data for a number of European countries, finds that offshoring of services and non-core manufacturing has led to productivity gains, which are driven particularly by multinational firms, whereas offshoring of core manufacturing activities have had no such effects.

In the presence of productivity gains, some papers show that GVC participation can have positive effects on the labour market, decreasing unemployment and increasing wages even of the unskilled workers under certain conditions (see, for example, Grossman and Rossi-Hansberg 2008; Mitra and Ranjan 2010; Kohler and Wrona 2010).

As regards investment, while involvement in GVCs may contribute to attracting investment, evidence is mixed, as investment crucially depends on broader policy and institu-

tional frameworks (OECD, WTO and UNCTAD 2013).

The spread of GVCs could make it easier for SMEs to participate in trade, as the break-up of the production process makes it feasible for a specialised firm to find niche markets (*Global Value Chain Development Report 2019*). There is evidence that the internet reduces search costs, facilitating more exchanges of goods, services, know-how and technology, thus increasing firm productivity. Cross-border e-commerce platforms are also providing new opportunities for SMEs and even micro firms.

At the same time, GVC participation can generate economic and social costs that need to be carefully managed. These costs include an increase in income inequality, partly due to compositional changes in the labour market (Timmer et al. 2013, 2014; Farole 2016), as well as making a country more vulnerable to monetary policy spillovers and external shocks. Wang et al. (2017a) conclude that the deeper and more intense a country-sector's participation in GVCs the stronger the impact of a global economic shock, while Burstein et al. (2008) and Ng (2010) provide evidence of strong correlations between countries' GVC links and business cycle co-movement. An interesting finding in the literature is the critical role played by "global hub" sectors (i.e. large suppliers or users of inputs that tie otherwise unrelated sectors together) in propagating shocks through GVCs (Frohm and Gunnella 2017). Moreover, Criscuolo and Timmis (2017) argue that the position within a GVC determines a country's resilience to different types of shocks; for example, downstream industries are relatively more vulnerable to supply shocks, while upstream industries that are farther from final consumers are more exposed to demand shocks.

GVCs also make trade wars particularly expensive, amplifying the effects of tariffs (Blanchard 2019; Huidrom et al. 2019). Because tariffs are (typically) applied to the gross value of

a good, rather than just the value added, every border crossing increases the total tariff bill associated with production. In addition, through GVCs, the costs and benefits of higher tariffs may extend well beyond the direct “intentional” targets to countries and firms worldwide, including the country imposing the tariff. Finally, all else equal, higher tariffs give firms an incentive to consolidate their GVCs into fewer countries and border crossings, potentially excluding and thus harming smaller open economies.

Overall, the net gain or loss from GVC participation in terms of a country’s GDP growth and employment depends on a host of factors, not least the stage of the country’s development and its production structure, exchange rate regime and financial integration. The gains from GVC participation are not automatic and there is a large degree of heterogeneity. The findings of the literature suggest that countries that favourably position themselves in GVCs not only exploit their proximity to expected consumers, raw materials and critical input suppliers, but also implement the right domestic regulations and policies. Ignatenko et al. (2019) point out that “moving up” to more high-tech sectors and higher income as a result of GVC participation does take place but is not universal, suggesting that gains are likely conditional on other factors.

The extent of both outsourcing and offshoring varies by country and sector. There are differences in GVCs in terms of average production length, intensity of participation, and relative positions of countries or sectors in the value chain. Ignatenko et al. (2019) suggest that physical proximity as well as standard country-pair characteristics, such as common border, common language and colonial linkages, are important determinants of GVC participation, particularly for the manufacturing sector. Additional policy-related variables in the gravity equation specification, i.e. preferential trade agreements, lower exchange rate volatility, and common currency, also increase GVC participation.

In this paper we focus on the case of Greece. Over the crisis, Greece has become a more export-oriented country. The share of total exports in GDP rose from 19% in 2009 to 36% in 2018. Exports of goods and services (excluding shipping) have risen by 60% in real terms since their trough in 2009, much higher than euro area exports as a whole. At the same time, the Greek current account deficit as a percentage of GDP has declined by 17 percentage points since the beginning of the crisis, suggesting that increased GVC participation may have been behind part of this rebalancing. Indeed, results presented in the recent Occasional Paper produced by the ECB Working Group on GVCs (ECB 2019) suggest that the trade rebalancing of Greece may have been supported by changes in its GVC activities. In view of the recent protracted recession and timid recovery of the Greek economy, it makes sense to explore whether the Greek economy is making progress in terms of GVC participation and whether we can thus expect gains in terms of growth in the near future. As the Greek economy is small, it is necessary to understand where it is positioned within the various GVCs and what vulnerabilities this implies. Once its position and degree of participation in the various GVCs has been identified, the next step is to understand their underlying determinants and thus what policies may have an impact on the gains to be expected from GVC participation. The sectoral analysis presented in this paper aims to shed light on the above questions and guide policy choices.

The results suggest that Greece has become more integrated into GVCs along with its increased openness. This result is evident when we break down gross exports into value added in intermediate and final goods exports. Increased integration is evident not just in terms of manufacturing, but also in distribution and services. Moreover, different sectors reflect differing degrees of upstreamness and downstreamness.

The rest of the paper is organised as follows: In the next section, we briefly review the lit-

erature on decomposing gross exports into their various components and what this tells us about participation in GVCs. In the third section, we discuss issues of data and methodology. The fourth section presents some results and the final section concludes. Information on data sources and definitions are provided in Appendix A and B, respectively.

2 DECOMPOSING GROSS EXPORTS AND GVCs

Drawing on input-output tables, a number of studies have developed analytical methodologies and metrics to measure countries' and sectors' integration into GVCs. Goods and services now often get exported and reimported several times before being consumed by final users. Figures for gross exports thus involve more double counting. A truer picture of the value of exports to a specific country is rather given by measuring value-added exports. This observation has led to a large bibliography which seeks to divide gross exports into various components. An examination of these components allows value added to be assigned more accurately to each country. It also allows us to understand how countries fit into the chain – whether they produce the technology behind the product, whether they produce different parts, whether they are largely involved in assembling items, or whether they focus more on sales and the marketing of the final product.

Hummels et al. (1998, 2001) were among the first to explore the impact of what they termed vertical specialisation (VS) on trade. Vertical specialisation is defined as occurring when goods are produced in two or more countries with different countries specialising in different stages of the production process. They calculated the level and growth of VS-based trade, defined as the import content of exports. In Hummels et al. (1998), they focus on four case studies: the US-Canada trade agreement in 1965; US-Mexico trade and the role of *maquiladoras*, which are Mexican plants that are exempted from Mexican tariffs

on inputs they use from the US; Japanese manufacturing companies outsourcing to Southeast Asian countries; and, finally, Opel's move into Spain. They find strong evidence of an increasing trend in the volume of imports embodied in exports. They then generalise this result using the OECD Input-Output Database for various years between 1968 and 1990. The results confirm that increased VS is a more general phenomenon. There are, however, wide differences between countries, with large countries generally having lower levels of VS than small ones, since they can more easily retain all stages of production. In the Hummels et al. (2001) paper, these results are confirmed, and they then go on to ask whether the increase in VS is due to VS increasing in the same sector or the sectoral composition of exports moving more towards sectors with higher VS. They find that the former is more important in explaining the overall rise.

Hummels et al. (2001) note that vertical specialisation is wider as a concept than the import content of exports. Exports produced in one country could go on to be used as inputs to another country's exports. This they call VS1. However, to calculate VS1, bilateral trade data are also required. Daudin et al. (2009) are able to calculate VS1 and also VS1* which is the part of VS1 that returns to the original country. If VS1 is higher than VS, this suggests that a country takes part more in exporting inputs for further exports. Such countries could be primary producers or manufacturers of industrial inputs for processing. By contrast, when VS is greater than VS1, a country is more focused on exporting final goods which have used significant import content (e.g. assembling countries). They also discuss the extent to which VS and VS1 will vary across sectors. They use data from the Global Trade Analysis Project (GTAP) covering up to 113 regions and 55 sectors in 1997, 2001 and 2004. Their results show that it is important to look at value-added exports rather than gross exports if we are to understand interconnectedness of global production. Moreover, they then explore what value-added export measures tell

us about the regionalisation of trade compared to standard measures. If regional trade is measured using standard exports, one can conclude that all continents are regionalised. However, they are less regionalised when using value added data. Furthermore, standard trade statistics overestimate the importance of external demand for industrial products and underestimate it for services.

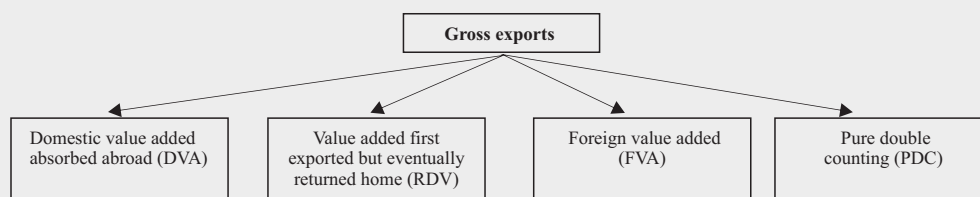
Koopman et al. (2014) go further in decomposing gross exports. First, they identify domestic value added in a country's exports, which is further decomposed into domestic value added in final goods exports, domestic value added in intermediate exports, which then return home as imports of final goods, and domestic value added in intermediate exports, which return home as inputs to final goods that are then exported. The second and third cases are double counted in gross export statistics. This double counting is equivalent to the VS1 measure of Hummel et al. (2001). Second, there is the foreign value added in a country's exports (equivalent to VS). Foreign value added can be further decomposed into foreign value added in the country's final goods exports and intermediate goods exports. Using these conceptual breakdowns, they decompose gross exports for a number of countries. Comparing the cases of the US and Mexico is useful. The US has a large domestic value added in exports – in 2004, it stood at just under 75%. Its foreign value added is 13%. The amount of foreign value added and the amount of domestic value added which return back to the US is 11%, i.e. relatively large. Thus most of US exports are domestic value added; this fact is consistent with the fact that the US is a large country and that it heads GVCs. By contrast, Mexico has much lower domestic value added (52%) and a high foreign value added in final goods exports (48%), reflecting its high level of GVC integration and its role downstream in global production chains.

In a series of papers, Wang, Wei and Zhu (2013, 2018) and Wang, Wei, Yu and Zhu (2017a, 2017b) generalise the Koopman et al.

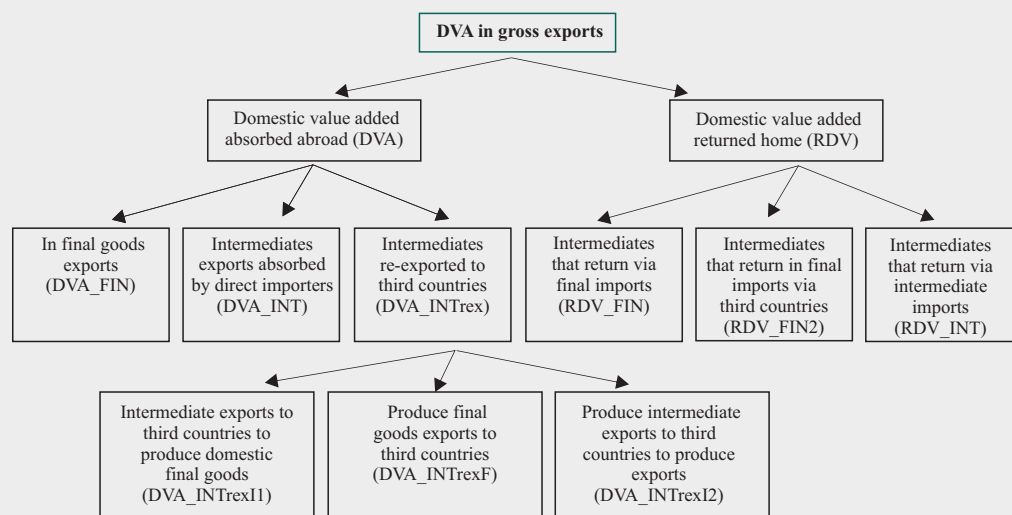
(2014) framework to allow it to be applied at a sectoral/bilateral level. Chart 1, which is taken from Wang et al. (2013), illustrates the division of gross exports into 16 separate components. They are particularly critical of the literature that focuses on forward and backward linkages (Johnson and Noguera 2012; Johnson 2014) and proposes the so-called VAX ratio, based on either forward linkages or backward linkages. Indeed, they show that various VAX measures found in the literature cannot be used when looking at sectoral trade, bilateral trade, or sectoral-bilateral trade. By contrast, examining their 16 components allows for a comprehensive analysis of how a country is integrated into GVCs. Thus a high and rising level of pure double-counted (PDC) terms is indicative of greater integration into GVCs and reflects the toing and froing as goods pass repeatedly across borders before becoming final goods. Other elements can tell us whether countries are downstream – mainly assemblers – foreign value added in final goods (FVA_FIN) will be high and rising and pure double counting (PDC) falling. Additionally, domestic value added in final goods (DVA_FIN) will be high and rising. As countries move up the production chain – upstream integration – FVA_FIN will be falling, PDC rising and returned domestic value (RDV) high; domestic value added in intermediate goods (DVA_INT) and foreign value added in intermediate goods (FVA_INT) will be high and rising. They use these concepts to examine the automobile industry in the US, as well as electrical and optical equipment in Mexico and various Asian countries (Japan, Korea, Taiwan, China, India and Indonesia). Japan, Korea and Taiwan exhibit low and declining FVA_FIN, stable FVA_INT and rapidly expanding PDC in electrical and optical equipment exports, suggesting that they are quite upstream; the other three countries, by contrast, still have a large share of FVA_FIN, though in the case of China FVA_FIN has been declining and PDC rising as it moves up the production chain. Indonesia likewise has rapidly expanding FVA_INT and PDC. India, by contrast, has a high and rising level of

Chart I Gross exports accounting

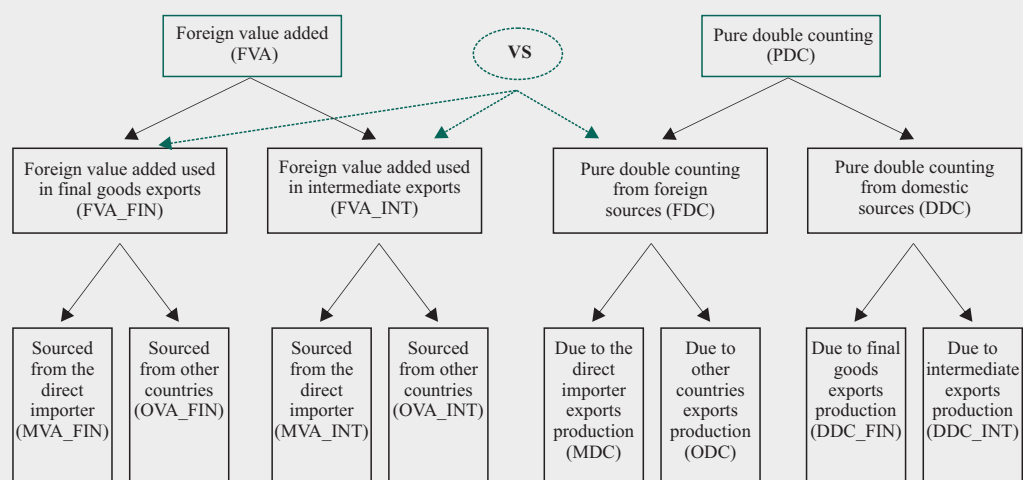
A. Major categories



B. Domestic value added



C. Foreign value added



Source: Wang et al. (2013).

FVA_FIN, whilst FVA_INT has been declining, reflecting its integration into GVCs at a later date.³

Borin and Mancini (2015, 2017) refine the original decomposition of Koopman et al. (2014) and Wang et al. (2013). Koopman et al. consider only aggregate trade and not bilateral trade. Moreover, while Wang et al. consider bilateral trade, their approach is not internally consistent, since they mix up two different ways to account for value added in exports: the source-based approach, which calculates value added from the perspective of the country generating the value added; and the sink-based approach, which takes the perspective of the country of final demand. Borin and Mancini explore the case of Italy and show that Italy is strongly integrated into “Factory Europe”. In some sectors (basic metals, chemicals, and coke and refined petroleum products), Italy is relatively downstream; in others (textiles, wearing apparel, leather products), it is upstream.

The strong regional component of GVCs has been investigated by Los et al. (2013). This relates to the so-called “Factory Europe”, “Factory America” and “Factory Asia” (Santoni and Taglioni 2015). Los et al. find that whilst regionalism is still present in 2011, it has weakened relative to 1995. Others use network analysis to illustrate the regional aspect. Large countries are at the centre, with small countries at the edge engaged in either providing raw materials or assembling final goods. In 1995, they find the US and Germany to be core countries. They remain so in 2011 but are also joined by China (Amador and Cabral 2015, 2016).

Damjanovic and Banerjee (2017) focus on Slovenia and show that the economy has become ever more integrated into production chains. Increasingly, it is specialising in manufactured intermediate goods, which have high value added in exports (fabricated metals, wood production, and mineral products). It also has downstream integration involving assembly-line businesses (transport, motor

vehicles, pharmaceuticals), which generate much lower domestic value added.

Kummritz (2014) and Kummritz and Quast (2016) focus on forward and backward linkages for a large group of countries and sectors. Kummritz (2014) examines the link between participation in GVCs and development (where development is measured by domestic value added) and finds a positive effect. Kummritz and Quast (2016) focus on sectoral differences in the degree of fragmentation of production. Sectors such as motor vehicles, other transport equipment, metals, and computers and electronics have high foreign value added. By contrast, agriculture, mining and quarrying, R&D, and business services are upstream in supply chains and far from final demand. They generate higher domestic value added.

Wang et al. (2017a) examine four aggregated sectors, namely agriculture, mining, manufacturing and services. They find that mining has a strong upstream position in global production networks, manufacturing is the industry that has been most deeply integrated into GVCs and services have the lowest GVC participation intensity, but their participation rate has grown faster than agriculture in recent years.

³ Wang et al. (2017a) have also provided a methodology to decompose production activities at the country, sector, or country-sector level into different types depending on whether they are for domestic demand without involving trade, “traditional” trade (without involving trade in intermediate goods), simple GVC activities, or complex GVC activities. GVCs are basically “trade in intermediate products”. The distinction between simple and complex GVC activities is determined by the number of national border crossings, so they can be phrased as “value-added activities cross one or more than one national border”. Applying their tools to the most up-to-date inter-country input-output database (WIOD 2016), they show that complex GVC was the most important driving force for globalisation and co-moves strongly with the growth of global GDP, both in booms and in recessions. Wang et al. also provide a pair of GVC participation indices based on whether the production factor content crosses national borders for production and taking into account both forward and backward industrial linkages. The first GVC participation index describes the domestic value added generated from a country-sector’s GVC activities through downstream firms as a share of that country-sector’s total value added. The second participation index measures the percentage of a country-sector’s total production of final goods and services that represent the value added that is involved in GVC activities through upstream firms. The relative values of the two indices indicate a country-sector’s position in the global production network. For instance, a higher degree of forward participation than backward participation implies that the country/sector is more actively engaged in upstream production activities in GVCs.

Breaking down manufacturing into sub-sectors, the authors find that “transportation equipment” (mainly represented by automobiles) is a typical GVC industry. Due to the complexity of its production process, input demand and cost structure vary widely in different production stages and locations. Furthermore, as it is a dynamic process, the comparative advantage of each production location constantly changes, and along with it the intensity of GVC participation of each country.

For the utility and service industries, a large proportion of their value added is exported indirectly (e.g. “electricity, gas and water” and “retail trade”), in contrast to, for example, “leather and footwear,” which is a typical “direct” exporting sector.

The construction sector is less integrated into GVCs, partly because it may be difficult to export directly due to the limitation of cross-border factor mobility. Its factor content, however, is often embodied in other sectors’ exports involving international production sharing indirectly. Similar phenomena exist in many services sectors, such as transportation and public services.

Ignatenko et al. (2019) also document that the manufacturing and services sectors participate differently in GVCs. Services, including business and financial services and wholesale trade, have very high forward linkages, reflecting the fact that they are intermediate inputs in their export destinations, and limited backward linkages, reflecting the fact that the production of business and financial services uses limited foreign inputs. By contrast, the largest manufacturing sectors tend to have sizeable foreign inputs (backward linkages).

In short, the degree of participation in or integration into GVCs differs significantly across sectors. Manufacturing enterprises have higher average GVC participation intensity than mining and services. In manufacturing, higher R&D and knowledge intensities are associated with higher GVC participation. In

services, GVC participation is also heterogeneous across industries, with communication, financial and business services as well as trade and transportation services having much higher GVC participation than other domestic services (education, health care, personal services).

2.1 AGGREGATE DATA AND EXISTING EMPIRICAL WORK FOR GREECE

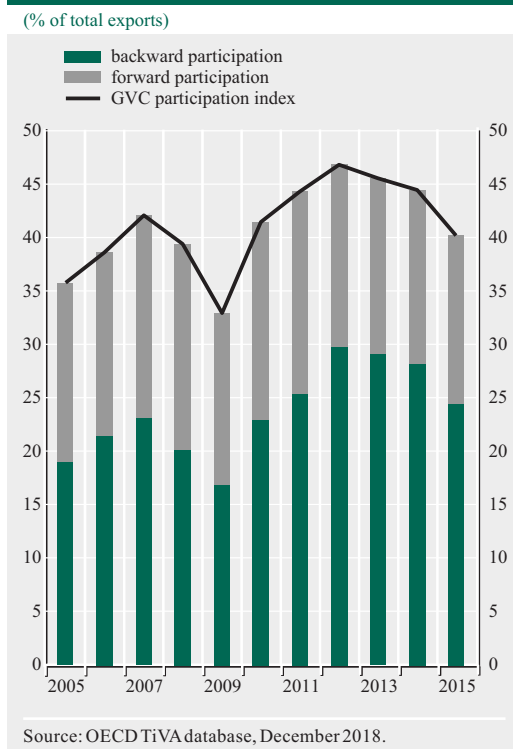
Kalyvitis et al. (2018) estimate the domestic value added of Greek exports for the year 2010 using input-output tables and find significant differences in terms of domestic value added between sectors ranging from 38.3% in “coke and refined petroleum” to 88.1% in “fishing and aquaculture”.

The OECD⁴ provides a comprehensive analysis of trade in value added and GVCs. On the basis of the latest OECD data, Greece is found to have increased its levels of integration into GVCs up until 2007, before slowing down at the onset of the financial crisis. A quick recovery followed, with the GVC participation index rising from 33.0% in 2009 to 46.8% in 2012 and subsequently decelerating to reach 40.3% in 2015 (see Chart 2). The rise in the GVC participation index is attributed to higher backward participation, while forward participation has remained rather stable. This finding is in line with the results presented in the recent ECB Occasional Paper on GVCs (2019). The ECB finds that Greece has moved downstream since 2008. For Greece, they argue that this is largely a composition effect, arising from downstream sectors having gained export share from upstream ones. Looking specifically at the medium-to-high-tech and high-tech sectors, Greece stands out for having a relatively low participation but a more upstream position than for its economy as a whole.

Between 2009 and 2018, the openness of the Greek economy, as defined by the share of exports in GDP, increased significantly from 19% of GDP to 36%. This resulted from the

4 OECD, Trade in Value-Added (TiVA) database, December 2018.

Chart 2 Greece's participation in GVCs



rebalancing of the Greek economy towards tradable sectors of economic activity observed since 2008.⁵ Between 2008 and 2014, there was a significant rise in the exporting performance of sectors in both manufacturing (such as “manufacture of basic pharmaceutical products”, “manufacture of computer, electronic and optical products”, “manufacture of textiles, wearing apparel and leather products”) and services (such as “accommodation and food service activities” and “water transport”). It is therefore of interest to examine the decomposition of gross exports for the recent period. This is our aim in this paper. Additionally, we focus on the sectoral level, since aggregate numbers hide significant differences across sectors.

3 DATA AND METHODOLOGY

To calculate value added in trade and perform the decomposition of gross exports,

access to world input-output tables and bilateral trade data is required. Two sources exist: the World Input-Output Database (WIOD; www.wiod.org/home) and the OECD Trade in Value-Added (TiVA) database. We use the former in this paper (see Appendix A). As noted by Timmer et al. (2015), the WIOD is based on official data using the International System of National Accounts. It is also freely available. By contrast, the OECD publishes only derived indicators and not the underlying data. WIOD data are available from 2000 until 2014. The database contains 43 countries (plus the rest of the world) and 56 sectors.

Calculations are done in R using the “decompr” package (Quast and Kummritz 2015), which generate the decomposition provided by Wang et al. (2013). Since our focus is on Greek exports by sector to all trading partners (that is, we do not focus here on bilateral-sectoral trade of Greece with each of its individual trading partners), the Wang et al. decomposition is sufficient for our analysis and there is no need to use the even more complex decomposition found in Borin and Mancini (2015, 2017).

In what follows, we focus on some of the more interesting sectoral developments based on criteria such as the importance of the sector in terms of exports as well as sectors exhibiting significant changes. There are many metrics that we could use from the literature. We begin with one of the simplest measures of integration – vertical specialisation (VS) technically defined as the sum of FVA_FIN, FVA_INT and PDC. VS shows us the extent to which different sectors depend on imported foreign value added in producing their exports. We then move on directly to look at the decomposition found in Wang et al. (2013, 2017, 2018). We do not look at back-

⁵ Bank of Greece (2014), *Annual Report 2013*, Box V.1 “The crisis favours a shift of productive activities to tradable goods and services”. Bank of Greece (2015), *Monetary Policy – Interim Report*, Special Feature IV.2 “Sectoral productivity and export activity”, December.

ward and forward linkages for the reasons noted above.

4 RESULTS

A general conclusion that emerges is that domestic value added is lowest in Greek manufacturing and more dispersed and highest in services. This is in line with the stylised fact that GVCs dominate manufacturing because of the ability to divide production in manufacturing up into various steps. There is some evidence that between 2000 and 2014, for the economy as a whole, total FVA has been rising whilst total DVA has been falling, pointing to greater integration into GVCs. The correlation coefficient between DVA and FVA is strongly negative (-0.97). With the rise in FVA, there has also been a rise in double counting (correlation coefficient 0.67) as would be expected.

Turning now to some specific sectors, Chart 3 shows “crop and animal production”, which accounts for 6.2% of gross value added (GVA) in the Greek economy (average 2000-2014) and 3.8% of exports. Exports are mainly domestic value added ($DVA = DVA_{FIN} + DVA_{INT} + DVA_{INTrex}$ was on average 86%). FVA is likely to take the form of inputs to crop production (fertilisers, seeds, etc.). Interestingly, however, DVA in exports is half in intermediate goods, which will act as inputs to intermediate/final goods in other countries, and half in final goods being exported. While the sector is clearly not that integrated, there is evidence of quite strong changes over the period 2000-2014. DVA has been falling as FVA is rising. Additionally, double counting (PDC) has been rising as has returning domestic value added (RDV). All these developments point to rising GVC integration.

Chart 4 presents the breakdown for “mining and quarrying”. The high proportion of DVA (88% on average) reflects the fact that this sector deals with natural resources. It is an upstream

activity in that the natural resources are extracted only to be exported as intermediate goods (note that $DVA_{INT} + DVA_{INTrex} = 86\%$) to be finalised elsewhere. Over time, in spite of the fall in DVA and the rise in FVA and PDC, the changes are small, as would be expected for a sector that is a natural upstream activity.

These results are consistent with IOBE (2016). A characteristic of the domestic mining industry is its openness; the share of exports of mining products in total Greek exports of goods had been rising over the period 2008-2014 and picked up to 12% in 2014. The internationalisation of the mining industry is also evidenced by the fact that some domestic enterprises are subsidiaries of multinational corporations,⁶ while others have joint ventures, mining activities and export trade networks in many foreign destinations.

A sector that is closely related to mining and quarrying is the “manufacture of basic metals” (see Chart 5). Domestic value added ($DVA = DVA_{FIN} + DVA_{INT} + DVA_{INTrex}$) accounts for 70.4% of total gross exports. This industry stems, in part, from natural reserves of basic metals which Greece has. VS averaged 29.1% over the period, suggesting downstream activities. In addition, domestic value added is overwhelmingly in intermediate goods which are then exported as inputs to production in other countries (see DVA_{INT} and DVA_{INTrex}). Toing and froing is also evident, with double counting coming in on average at almost 15%. Double counting has also been increasing since around 2005 (the large drop in 2009 is connected with the global slowdown in trade associated with the financial crisis). Thus, another important export sector appears to have been showing signs of increased integration into global production.

⁶ In 2012, Kerneos acquired a 54% stake in the Greek mining company, Elmin, the leading European exporter of monohydrate bauxite. In 2014, Imerys acquired S&B. Imerys Greece is the world's largest producer of pre-treated perlite and the world's largest exporter of bentonite, exploiting the excellent quality mineral resources and the processing plants in Milos. Almost all the company's products are exported.

Chart 3 Crop and animal production, hunting and related service activities



Chart 4 Mining and quarrying



Chart 5 Manufacture of basic metals



Looking in more detail at the products exported in this sector, aluminum and nickel take up about 20% of gross exports. Alumina comes next with about 10%, while magnesium products (refractories, dead-burned magnesia and caustic calcined magnesia) also have a significant share in exports. IOBE (2019) notes that Greece is among the largest exporting countries of aluminum as a raw material, 4th in Europe and 12th globally. Moreover, the manufacture of aluminum, which mainly involves the manufacture of raw materials and semi-final products, is among the fastest growing sectors of Greek manufacturing, having increased by 21% between 2010 and 2017.

The “manufacture of food products, beverages and tobacco products” averaged 7.1% of Greek exports between 2000 and 2014 (see Chart 6). This sector illustrates some interesting changes over time. It is a high domestic value added sector, as might be expected (Greece processes and exports its own produce). However, until the crisis the allocation between the export of intermediate goods and final goods was fairly stable (at just below 60% for final goods, just under 20% for intermediate goods and some 8% in the form of DVA_INTrex). Thereafter, there is a sharp decline in domestic value added in intermediate exports and a rise in value added in final exports. In particular, between 2000 and 2014, DVA_INT falls by 11 percentage points and DVA_FIN rises by 16 percentage points, and, as is clear from the chart, these movements occurred from the late 2000s onwards. The implication is that Greece now takes its agricultural produce right through all processing stages to ultimately export branded final goods often covered by the European scheme of protected designation of origin.

These developments are consistent with sectoral studies of the manufacturing of food products. The National Bank of Greece (2015a) notes that while the food supply chain still has a relatively small manufacturing component (adding just 40% to the agricultural

production versus 70% in Western Europe), around 25% of Greek food exports have exploited Greece’s comparative advantages and gained significant shares in the international market (e.g. olives, yogurt and honey). The common strategy of producers is to target high-income countries (such as the euro area, the UK, the US, Japan) with branded products in packaged forms.

The authors of the National Bank of Greece (2015b) provide the indicative example of Greek olive oil. Olive oil is mainly exported in bulk form to Italy, where – after being blended with olive oil of different origins – it is marketed as Italian branded olive oil, leaving most of the value added to Italian companies. As a result, only 27% of Greek olive oil production reaches the stage of labelling/branding, compared with 50% in Spain and 80% in Italy. Nevertheless, a gradual change in strategy has been observed, resulting in an increase in exports of branded olive oil in the period 2010-2014. This has brought about higher domestic value in final exports of olive oil, one of the top exporting Greek products, which is what our results show.

Kalyvitis et al. (2018) also note that since 2003 olive oil has been exported to more countries. While Italy remains the top exporting destination, it now has a lower share in total Greek exports. They interpret this diversification as signalling a gradual change in strategy of Greek exporters from exports of olive oil in intermediate form to Italy to exporting olive oil to final high-income destination countries, such as Germany and the US.

The “apparel and textile” industry is one of the most important manufacturing industries in Greece, accounting for 11% of total exports in manufacturing over the period 2000-2014. This industry has undergone significant changes over the past decade caused by systemic changes on the international stage, through globalisation, the liberalisation of textile trade and the resulting increase in competition. The liberalisation of textile trade, i.e. the abolition

Chart 6 Manufacture of food products, beverages and tobacco products



of import restrictions in Europe in 2005, led to a rapid restructuring process in all southern European countries. Restructuring was exacerbated by the financial crisis of 2008-09 and was visible in the reduction in the number of companies, a downsizing of surviving firms and their consolidation through a change in their business model. The Greek apparel sector has focused on products with higher value added offering design services in addition to quality manufacturing and has delocalised production activities to neighbouring Southeast European countries. In particular, Northern Greece has the advantage of geographical proximity to possible delocalisation areas in South Bulgaria, the Republic of North Macedonia and Albania. Vertical integration has been a successful strategy in the textile industry, as vertically integrated textile companies have been more resistant in the financial crisis than single-stage firms (EC 2012).

Chart 7 looks at the “manufacture of textiles, wearing apparel and leather products”. The results again suggest rising GVC integration – Greece appears to be making more cloth from its cotton/wool which it exports directly as an input to textile firms downstream, which then turn it into clothes and other products. This is reflected in a rising DVA_INT and a falling DVA_FIN, along with a rise in PDC and a rise in FVA_INT. Double counting now stands at 6% of gross exports. This rise in double counting suggests increased toing and froing of products. To put that number into perspective, PDC is around 5-7% in the US automobile industry, which involves a lot of cross-border transactions that double count value added (Wang et al. 2013).

Charts 8 and 9 look at the manufacturing of products which are often inputs to other activities – wood and cork products, and paper and paper products. In the early 2000s, domestic value added was rising while that of foreign origin was falling. Similarly, double counting fell and then rose again. In the case of wood and its products, the turning point occurred at the crisis and by 2014 double counting was

above 7%, up from its trough of just over 3%. VS, which indicates some downstream activity, reached 25% in 2014. Finally, most domestic value added is in intermediate goods, indicating some upstream activity as well. The story for paper and paper products is similar; this time, the turning points occur earlier (around 2005), but double counting is higher on average (6.4%) and there is more downstream activity (VS is 24% on average and, in the post-crisis period, fluctuates between 25% and 30%).

The petroleum refining industry is a vital link in the supply chain of petroleum products. It imports and processes crude oil, producing intermediate and finished petroleum products. The products are then directed for final consumption (domestic demand and exports), mainly through the network and infrastructure of oil trading (marketing) companies.⁷ With continuous investment in modernisation and upgrading, the Greek refineries have achieved a high Nelson complexity factor.⁸ For comparison, the average capacity of European refineries is about 144,000 barrels per day, while the average Nelson complexity factor is 7.63 (IHS 2013). In Greece, the average capacity is slightly smaller, 131,000 barrels per day, but the average complexity factor is well above the European average (9.57). It is worth noting that the most complex refineries have the capability of producing petroleum products with high market value and can process most types of crude oil and thus exploit variations in price and availability. Moreover, they can adapt more easily to changing market and geopolitical conditions and local fuel specifications. These factors contribute to better profitability, but the greater complexity requires significant investments and implies an increased need for inputs and energy use.

⁷ Two groups of companies (Hellenic Petroleum SA and Motor Oil Hellas SA) operate four refineries with a total refining capacity of 526,000 barrels per day, or 26.3 million tons per year.

⁸ The Nelson Complexity Index (NCI) is a measure of the sophistication of an oil refinery, where more complex refineries are able to produce lighter, more heavily refined and valuable products from a barrel of oil.

Chart 7 Manufacture of textiles, wearing apparel and leather products

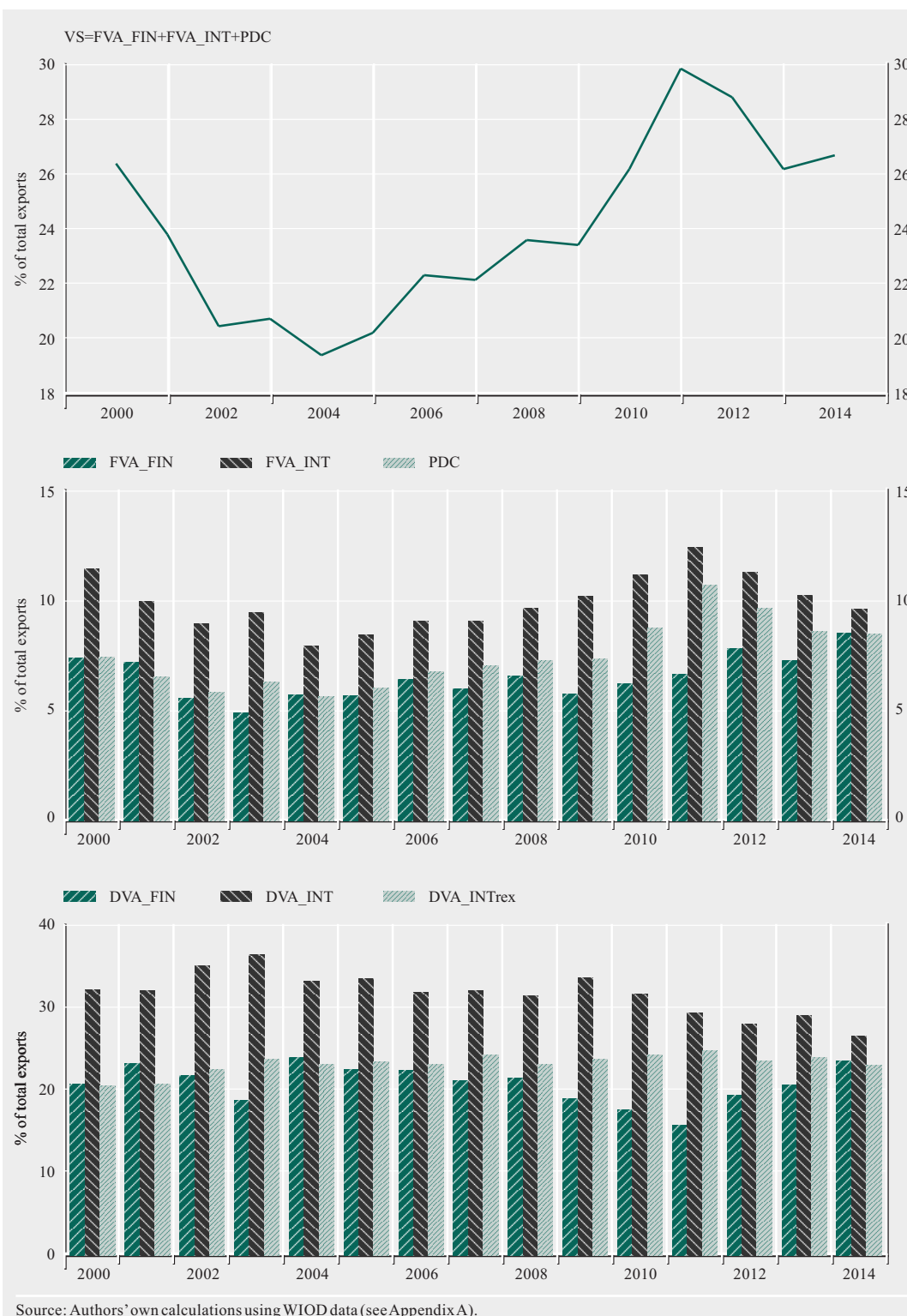


Source: Authors' own calculations using WIOD data (see Appendix A).

Chart 8 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials



Chart 9 Manufacture of paper and paper products



The crisis of the Greek economy, together with the recession in Europe, has had catalytic effects on the refining sector in Greece, significantly changing the environment in which the Greek refineries operate. The turn to exports provided an outlet for the Greek refineries, which following the contraction in the domestic market faced the risks of low capacity utilisation and of falling below the minimum efficient scale of production threshold that would have worsened further their financial results. Thus, after a period of significant investments to modernise and upgrade their capacity and under the pressure from low domestic demand and its weak outlook, the Greek refineries have sought new markets and have expanded in existing markets abroad, mainly in countries outside the EU.

The activity of the Greek refineries contributed to the reduction of the trade deficit. With the exports of petroleum products reaching EUR 10.3 billion in 2012, most of which (86%) goes to non-EU countries, the Greek refineries contributed 37.5% to the total exports of the country, up from 8.4% a decade earlier. Meanwhile, imports remained relatively stable. As a result, according to Bank of Greece data, the import coverage ratio of crude oil and petroleum products with exports increased from 25% in 2005 to 42% in 2012.

Chart 10 depicts the results of our analysis for this sector (“manufacture of coke and refined petroleum products”). It has the lowest domestic value added of any sector in Greece and the highest foreign value added (averaging 41% and 45%, respectively, over the period). Double counting also averaged 14% and VS 59%. This indicates a very high degree of downstream activity, associated with the importing of crude oil and its refining into various products which are then re-exported. However, the fact that the majority of these exports are intermediate goods and not final consumption goods, because refined oil and

other products are usually used as inputs into other activities, suggests that along with increased downstream activity, there has also been increased upstream activity.

A similar picture is found in the “manufacture of chemicals and chemical products” (see Chart 11), albeit to a lesser extent. Both upstream and downstream linkages are present. VS averages 23.1%, indicating downstream activity. Value added in intermediate goods –whether domestic or foreign– is higher than that in final goods, indicating integration into GVCs. Double counting is also high at 7.6% and has been increasing. IOBE (2018) notes that the sector’s production is focused on special chemicals and consumer chemicals and is highly dependent on imported chemical raw materials. The most important exports are polymers and consumer chemicals, representing 32% and 25% of total exports of chemicals, respectively. About a quarter of exports of chemicals are special chemicals, followed by basic inorganic compounds (mainly fertilisers) and petrochemicals, which are intermediate inputs into other sectors.

The “manufacture of basic pharmaceuticals and pharmaceutical preparations” (see Chart 12) has likewise been growing in importance as an export industry over the past years. The exporting performance of the sector, as defined by the share of exports in gross output, rose from 31% in 1995-2007 to 68% in 2008-2014. The sector is characterised by high domestic value added (84.9%), which is overwhelmingly domestic value added in final products (79%). In other words, products are made almost from start to finish.

Greek pharmaceutical companies have the expertise and produce branded pharmaceuticals, mainly generics. Over the last decade, pharmaceutical companies in Greece have invested in high-tech equipment and quality control systems; as a result, they have increased their competitiveness, both in domestic and

Chart 10 Manufacture of coke and refined petroleum products



Chart II Manufacture of chemicals and chemical products



Chart 12 Manufacture of basic pharmaceutical products and pharmaceutical preparations



international markets.⁹ Multinational pharmaceutical companies have also been investing in research programmes in Greece. According to a report of the Panhellenic Exporters Association (March 2015), six modern units of production were created over the period 2011-2014, while participation in 85 research programmes was recorded. At the same time, investment in R&D led to the registration of 90 patents. As a result, the pharmaceutical industry has been considered a driver of the restructuring of the Greek economy towards tradable and competitive sectors.¹⁰

Turning now to utilities: unsurprisingly, utilities industries are dominated by domestic value added (Chart 13 provides the example of “electricity, gas, steam and air conditioning supply”). In the case of “water” and “sewage, waste, etc.”, domestic value added is over 90% of gross exports. Exports are almost in their entirety intermediate goods. With respect to “electricity, etc.”, foreign value added is slightly higher than for the other two, probably reflecting the import of primary materials to make electricity. Moreover, as would be expected, domestic value added in intermediate utilities (DVA_INT) and value added of intermediate utilities for re-export (DVA_INTrex) are high, reflecting the upstreamness of this industry.

The largest exporting sector in the Greek economy is “water transport” (see Chart 14). A share of 78% of gross exports (including both intermediate and final goods) represents domestic value added. VS is 21.8% of gross exports, indicating that foreign value added in the sector is important and double counting accounts for 5.5%. These results suggest some degree of GVC integration.

The sector of “accommodation and food services” (see Chart 15), clearly associated with the tourism industry, also has high domestic value added, 87.8% of gross exports. Integration appears low, with VS at 12% and double counting at 2.2%. Interestingly, the bulk of domestic value added in gross exports represents

intermediate services rather than final services ($DVA_INT + DVA_INTrex = 56.3\%$). The high share of exports in intermediate services is attributed to the presence of GVCs in tourism. Tourism is a highly fragmented industry, with many small firms located at tourist destinations that are geographically dispersed (Tejada and Liñán 2009; Nowak et al. 2010; Daly and Gereffi 2017). Therefore, mediation has had a crucial role in tourism. Travel agents, tour operators and the introduction of Information and Communications Technology have been the “intermediary” responsible for joining, building and advertising the tourism product and making it available to consumers. According to Bank of Greece data, the share of travel receipts attributed to “package tours”¹¹ has been on average 34% in the period 2010-2018. Independent travellers also extensively use electronic platforms to book their holidays.

Finally, we can look at “wholesale and retail trade” (see Chart 16). DVA_INT and DVA_INTrex are high, at around 81%, reflecting upstreamness. Domestic value added in these trade services is exported as inputs into other activities. This perhaps reflects the fact that Greece is a Balkan hub exporting utility services to countries in the region.

Policy implications

Our results show that several sectors in Greece have seen a dynamic integration into GVCs since the global financial crisis of 2008-09, exploiting cyclical and conjunctural

⁹ See the speech by the Governor of the Bank of Greece, Yannis Stournaras, at the Hellenic Association of Pharmaceutical Companies (SFEE): “Macroeconomic developments and the contribution of investment, research and innovation in the pharmaceutical sector to the new growth model” (15.3.2017, in Greek).

¹⁰ According to estimates by Kalyvitis et al. (2018), the share of total domestic value added in exports of Greek pharmaceutical products came to 86.6% for the year 2010. The value of “parallel exports” from Greece has also been declining since 2007, according to National Organisation for Medicines (EOF) data, and this provides additional evidence in favour of the high domestic value added in Greek exports of pharmaceuticals.

¹¹ The category of “package tours” comprises any combination of travel services for tickets, accommodation and other services, provided by travel agencies. Cruise packages are also included.

Chart 13 Electricity, gas, steam and air conditioning supply



Chart I4 Water transport



Chart 15 Accommodation and food service activities



Source: Authors' own calculations using WIOD data (see Appendix A).

Chart I6 Wholesale and retail trade and repair of motor vehicles and motorcycles



developments as well as some structural changes. Yet, both theory and experience suggest that there are a number of policies and institutional factors that, if developed, could further promote the participation of a country in GVCs. Such policies would enhance and propagate the net gains in terms of economic growth, exports, competitiveness, productivity and employment.

The quality of institutions, including the business environment, the rule of law and contract enforcement, and the quality of infrastructure and connectivity are important determinants of GVC participation. Trade and investment policy reforms as well as improvements in logistics networks and customs' administration also play a key role. This is particularly important for the Greek economy as a whole and for a number of its more extrovert sectors operating both upstream and downstream.

Domestic policies targeting knowledge creation and diffusion as well as capital investment, such as strengthening protection of intellectual property rights and investor rights, could enhance a country's GVC integration and its repositioning towards the upstream.

Adopting policies that facilitate innovation and reduce protectionist barriers may also help to improve the economy's competitiveness and narrow current account imbalances by fostering its GVC participation (ECB 2017). Similarly, multilateral initiatives aimed at trade and financial liberalisation may foster greater GVC participation and help reduce an economy's external imbalances.

Upstream sectors and services are more sensitive to trade barriers. Thus, given the gradual rise of services in GVC trade, it is also important to better understand barriers to services trade and the type of reforms and trade agreements that could potentially facilitate it (Ignatenko et al. 2019). Emerging evidence also reveals how the liberalisation of service markets, particularly the entry of new foreign service providers, can lead to substan-

tial productivity gains in downstream manufacturing firms (Arnold et al. 2011, 2016).

Meanwhile, Greek governments need to develop a comprehensive and long-term digital strategy. Economies increasingly require a digital foundation, one that generates high-speed growth and navigates through disruptive change. The employment and investment of tomorrow will be data-intensive, and value in a knowledge economy is increasingly created by innovative ideas and data. Embracing digital technologies is not only good for the economy but for society as well. The digitally-powered, knowledge-intensive GVCs that are emerging and are likely to dominate in the coming years have a strong potential for inclusion.

Finally, the participation in GVCs might entail a trade-off between economic efficiency and income (or job opportunity) distribution, calling for proper domestic labour market adjustment policies and wider social safety nets.

5 CONCLUSIONS

This paper investigated Greece's involvement in GVCs using the decomposition suggested by Wang et al. (2013, 2018) and applied to WIOD data. In general, we find that domestic value added is high in service sectors and much lower in manufacturing, in line with the results from the literature.

However, we find evidence of both upstream and downstream activity in different sectors. In particular, upstreamness is found in crop and animal production, mining and quarrying, the manufacture of basic metals, and wholesale and retail trade. Downstreamness is common in accommodation and food services. Two sectors – manufacture of food products and manufacture of pharmaceuticals – have seen a rise in the importance of domestic value added in exports. That is, the products are increasingly being made from start to finish, providing high levels of domestic value added in exports. Finally, there are sectors which display the characteris-

tics of both upstreamness and downstreamness. These include the manufacture of textiles, wood and wood products, paper and paper products and, most importantly, petroleum and chemicals, which exhibit the greatest degree of GVC integration of any sector in Greece.

The consolidation of these trends towards greater integration — either in manufacturing or in services and distribution — is likely to be of benefit for the Greek economy, allowing it to improve the quality of its exports as well as lowering their price.

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APPENDIX A

GROSS EXPORTS DECOMPOSITION

Source: Own calculations using the World Input-Output Database (WIOD) 2016 Release.

The 2016 release of the WIOD covers 43 countries (and the rest of the world) for the period 2000-14. Data are produced for 56 sectors (roughly at the two-digit level with some service sectors being combined). A user guide to the database is provided by:

Timmer, M.P., E. Dietzenbacher, B. Los, R. Stehrer and G.J. de Vries (2015), “An illustrated user guide to the World Input-Output Database: the case of global automotive production”, *Review of International Economics*, 23, 575-605.

The results are derived from R, after modifying programmes originally written by:

Quast, B. and V. Kummritz (2015), “DECOMPR: global value chain decomposition in R”, *CTEI Working Papers*, 2015-01.

Sectors by NACE Rev. 2

NACE code	
01	Crop and animal production, hunting and related service activities
05-09	Mining and quarrying
24	Manufacture of basic metals
10-12	Manufacture of food products, beverages and tobacco products
13-15	Manufacture of textiles, wearing apparel and leather products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
35	Electricity, gas, steam and air conditioning supply
50	Water transport
55-56	Accommodation and food service activities
45	Wholesale and retail trade and repair of motor vehicles and motorcycles

APPENDIX B

SOME DEFINITIONS

Value added is the value added by industries in producing goods and services for exports (OECD).

Global value chain (GVC) is the fragmentation and dispersion of the different stages of production and distribution of goods and services across countries.

GVC integration or GVC participation is defined as the use of foreign intermediates and integration into international production networks (OECD).

Vertical specialisation (VS) is defined as the sum of foreign value added in final goods, foreign value added in intermediate goods and pure double counting ($FVA_FIN + FVA_INT + PDC$). Vertical specialisation shows the extent to which different sectors depend on imported foreign value added in producing their exports.

Upstreamness reflects the starting stages of global production. Industries that are located at the most upstream end provide natural resource-based intermediate inputs and more manufactured intermediate inputs. Upstream industries are more integrated into GVCs. Indication of the industries' position at the head of GVCs is high and increasing FVA_INT , DVA_INT , PDC and RDV .

Downstreamness reflects the ending stages of global production. Industries that are located at the most downstream end specialise in assembling and processing activities, as they are placed at the final stage of the production chain. Downstream industries are less integrated into GVCs. Indication of the industries' position at the tail of GVCs is high and increasing FVA_FIN and DVA_FIN , and low and decreasing PDC and RDV .

Foreign value added (FVA) is the sum of foreign value added in final goods and foreign value added in intermediate goods ($FVA_FIN + FVA_INT$).

Domestic value added (DVA) is the sum of domestic value added in final goods, domestic value added in intermediate goods and domestic value added re-exported to third countries ($DVA_FIN + DVA_INT + DVA_INT_{rex}$).

Gross exports are the sum of domestic value added, foreign value added, domestic value added returned home and pure double counting ($DVA + FVA + RDV + PDC$).