CHAPTER 10

The Role of Vertical Supply Links in Boosting Growth

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EXPORT NETWORKS MATTER

The external environment is critical in the quest for growth. Strong global demand can provide the lift that amplifies the fruits of structural reforms, while global headwinds can mean a delay. As Chapter 9 highlighted, however, the reforms that will provide growth in the longer term can also be important to facilitating the medium-term external rebalancing required in many European countries.

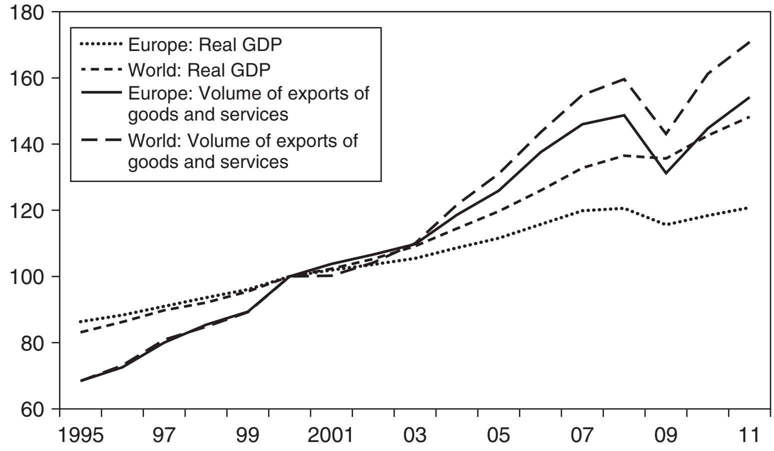
The nature of international trade has changed dramatically in the past few decades. Production processes have increasingly involved production chains stretching across many countries, with each nation specializing in one or more stages of production. As a result, intra-industry trade now dominates world merchandise trade, and because products cross borders multiple times, world trade has grown faster than both global GDP and global value added in manufacturing (Figure 10.1). In this globalized environment, reforming the domestic economy, while necessary, may not be sufficient if done in isolation. Countries need to find their place in these cross-border production chains to benefit the most from global trade and output growth.

The analysis of vertical supply links poses a data challenge. Official trade statistics are measured in gross terms that include both intermediate inputs and final products, thus double counting the value of those goods that cross international borders more than once. As cross-border production links become more important, official trade statistics are becoming less meaningful as a gauge of the value contributed by a country in a particular sector, also reducing their usefulness as a tool for measuring export competitiveness and informing policy advice. Figure 10.2 illustrates this point: suppose a German car maker ships $50,000 worth of car components to Hungary. A factory in Hungary then assembles the car and sells it to a dealership in France for $55,000.The gross or official trade statistics would record $50,000 worth of exports from Germany to Hungary as well as $55,000 worth of export from Hungary to France. But in value-added terms, Hungary's exports to France would be only $5,000.[1]

For additional technical detail, we direct the reader to Rahman and Zhao (2013).

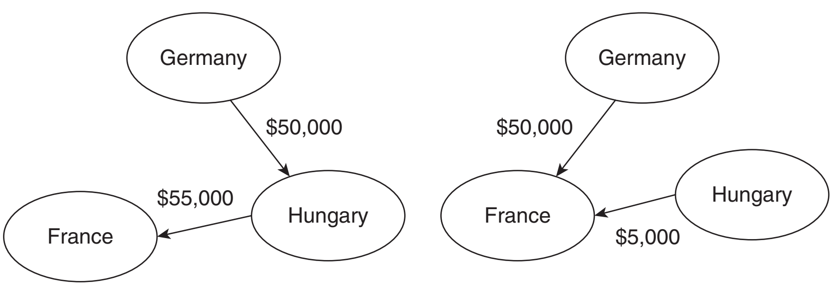
[1]In the example, Hungary's value added is identical to the value of net exports, but this is not generally the case. For example, gross and value-added exports of a country are identical only when no imported

Figure 10.1 Real GDP and Exports Growth, World and Europe *(Index, 2000 = 100)*



Source: IMF, World Economic Outlook database.

Figure 10.2 Trade Flow in Gross Terms and Value-Added Terms



Source: Authors' illustration.

A larger role for supply links in export growth implies a large and possibly increasing role of foreign value added. However, if a country's export growth is driven mostly by value crossing borders rather than domestic production, its impact on growth and employment may be smaller. These issues have particular relevance for many European countries. Since the mid-1990s, a number of Central European economies, such as the Czech Republic, Hungary, Poland, and the Slovak Republic, experienced export-led growth. As discussed in IMF (2013), these countries have strengthened their trade links to Germany considerably since the mid-1990s, with large export increases in knowledge-intensive sectors. At the

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inputs were used in the export production. Thus, when no imported inputs are used in the production of exports, gross and value-added exports are (weakly) greater than a country's net exports. Although the concept of value-added exports is different from that of net exports, both are relevant for assessing an economy's competitiveness.

same time, a number of other European countries, including some in the euro area (EA) periphery, travelled a different growth path, relying instead on domestic demand and fast credit growth. To what extent can the first group's export success be attributed to plugging into the pan-European supply chain, and what factors helped them achieve this success? For countries in the EA periphery that are desperately looking to increase exports to rebalance their external positions and bring back growth, answers to these questions can provide valuable lessons.

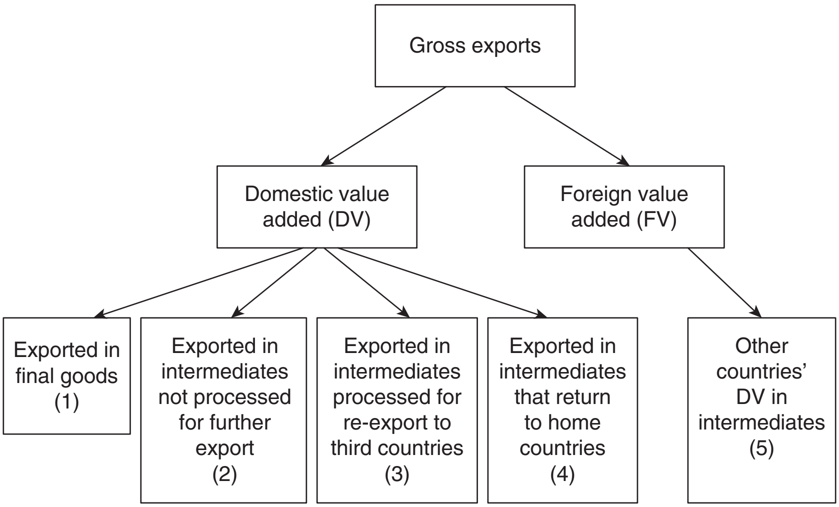
To get a true picture of a country's export growth, the foreign-value-added component needs to be stripped from total exports. By analyzing trends and developments in the decomposed flow data, this chapter aims to improve the understanding of international trade in Europe: where value is created, the role of vertical supply links in export growth, what factors contribute to the growth of supply links, and how countries' comparative advantages are affected by supply links over time. The analysis begins by dissecting gross export statistics in the next section. The subsequent section uses the decomposed trade statistics to look at the role of vertical supply chains in overall export growth and competitiveness developments. Then regression analysis is used to explore the factors that contribute to a firm's decision to locate part of its production abroad. The regression analysis is followed by a section that looks closely at a set of European countries to see which have successfully benefited from being part of the supply network. Conclusions and related policy implications are discussed in the final section.

DISSECTING GROSS EXPORTS IN EUROPE

The shortcomings of gross trade statistics have been well recognized (Hummels, Ishiib, and Yi, 2001; Ando and Kimura, 2003; Koopman, Wang, and Wei, 2008; Koopman and others, 2011; and Breda, Cappariello, and Zizza, 2008). The conceptual framework developed in Koopman and others (2011) is adopted in this chapter to decompose sources of value added in exports into five main categories depending on the location of value added and stage of production (Figure 10.3): (1) domestic value added in final goods, (2) domestic value added in intermediate goods not processed for further export, (3) domestic value added in intermediate goods processed for export to third countries, (4) domestic value added that is exported to another country but returns to the original country for export to a third country, and (5) value added imported from abroad as inputs into exports, that is, foreign value added. This enables first, a connection to be made between gross or official statistics and value added statistics in merchandise and services trade, and then allows all value added embedded in a country's exports to be distributed to its original sources at the country and product levels.

The five-category value-added decomposition for manufacturing and services exports, respectively, are made using a world input-output table. The World Input-Output Table used in this study is based on a World Input-Output Database (WIOD) by Timmer (2012), covering 27 European Union countries and 13 other major countries in the world during 1995 to 2009. The 40 countries

Figure 10.3 Decomposition of Gross Exports into Value-Added Exports



Source: Koopman and others (2011).

included in the world input-output table for this analysis cover more than 85 percent of world GDP.[2] The data are disaggregated at the industrial level, covering intermediate and final goods usage for 35 industries.

Components 1 through 4 provide the value of exports that is created domestically, and component 5 provides the value of exports created abroad. In the terminology of Figure 10.3, components 1 and 2 tell how much of a country's exports are created as stand-alone exports, that is, outside any supply chain, and components 3 through 5 capture exports generated by supply links. Supply link–related exports have two components: upstream, which include domestic value added intermediate exports that are processed for further export (components 3–4), and downstream, which include foreign value added exports (component 5). A large share of foreign value added in a country's exports signifies its position as a downstream processor or assembler.

Based on the above decomposition, some of the key developments in manufacturing and services exports observed during 1995–2008 include the following:

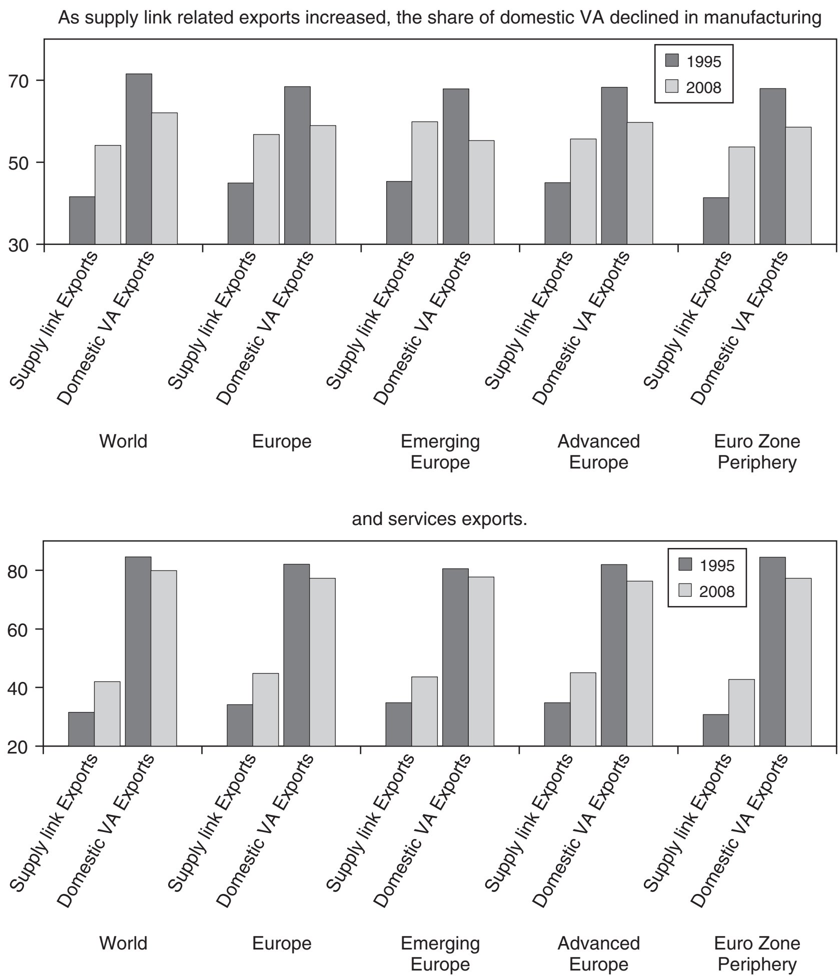
- *The share of domestic value added has declined.* During 1995–2008, the average share of domestic value added (components 1–4) in manufacturing exports in the sample countries declined to 62 percent from 72 percent (Figure 10.4). Similar declines were visible in Europe and subgroups of

[2]The WIOD contains an additional region (Rest of the World) as a proxy for the aggregate of all other countries in the world. Annex 2 in Rahman and Zhao (2013) provides a detailed description of the WIOD.

countries in Europe, in which the share of domestic value added in total exports declined by 9 to 13 percentage points. The decline in the share of domestic value added in services trade was less pronounced, reflecting a lower degree of fragmentation in international trade in services.

- *The role of supply links has increased.* During 1995–2008, the average share of world manufacturing exports produced via supply links (components

Figure 10.4 The Role of Domestic Value Added and Supply Links in Exports Growth, 1995–2008 *(percent of total exports)*



Source: Authors' calculation using world input-output table based on Timmer (2012).
Note: Advanced Europe: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden, and the UK. Emerging Europe: Estonia, Hungary, Czech Republic, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia, and Turkey. Euro area periphery: Greece, Ireland, Spain and Portugal.

3–5) rose to 54 percent from 42 percent (Figure 10.4). Increases of similar magnitude were experienced by Europe and country subgroups in Europe. For services, the average share of supply link–related exports increased to 42 percent from 32 percent, indicating a pace of increase similar to that in manufacturing.

These observations suggest that cross-border supply chains have become increasingly important in Europe, especially in emerging Europe, with nearly half of manufacturing value added produced abroad. But what does this mean for the external environment of countries seeking growth? For example, does foreign value added boost overall export growth in the countries participating in supply chains, and to what extent are supply links beneficial for employment, growth, and competitiveness?

To shed light on these issues, the analysis starts by normalizing gross exports and its two main subcomponents, domestic and foreign value added, by GDP. An increasing exports-to-GDP ratio indicates that a country's growth is becoming more oriented toward international trade and, possibly, cross-border joint production. The percentage increase in gross exports to GDP is simply the sum of the percentage increases in the ratios of domestic and foreign value added of exports to GDP.

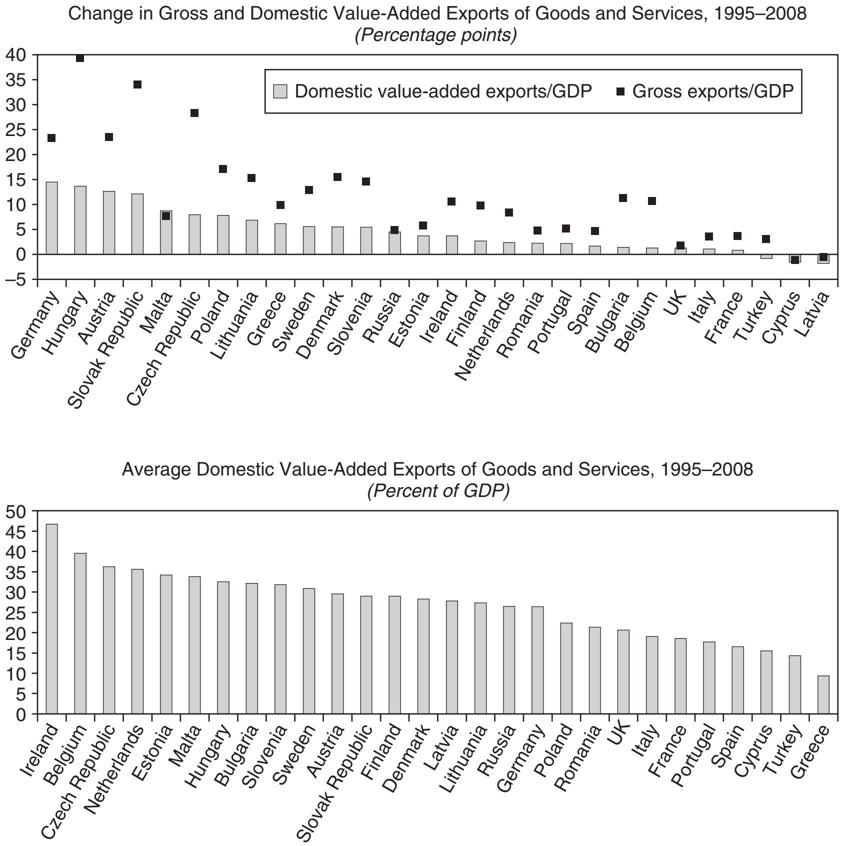
Figure 10.5 compares growth in domestic-value-added exports and gross exports during 1995–2008. Although increases in domestic-value-added exports account for much of gross export growth in many countries, for a large number of them (most notably, Belgium and Bulgaria), increases in gross exports as a share of GDP during 1995–2008 mostly reflect increasing foreign value added. The lower panel of Figure 10.5 shows the average ratio of domestic-value-added exports to GDP in European countries during 1995–2008.

Further to this point, the European countries are divided into four groups based on the increase in the ratio of domestic-value-added exports of goods and services to GDP during 1995–2008 (Table 10.1), with a view also to investigating the implications of increasing supply links on competitiveness. An increase in this share indicates that a country increased its export orientation in growth during this period, which can be interpreted as an improvement in competitiveness.

The results show that most European countries in the sample increased their domestic value-added-exports-to-GDP ratio, that is, they increased the export orientation of their economies. However, this outcome needs to be viewed in the context of a country's level of export orientation. Table 10.1 shows the average domestic-value-added-exports-to-GDP ratio in European countries during 1995–2008 along with the respective increases during the same period. A position in the upper-left corner in Table 10.1 indicates high and increasing export orientation of domestic production, whereas a position in the lower-right corner shows low and declining export orientation during 1995–2008.

Table 10.1 suggests a positive correlation between initial levels of export orientation and future increases. That is, on average, countries with higher levels of export orientation strongly increased their export orientation, whereas those with lower levels of domestic value added in GDP had much lower increases or actually declines. This absence of convergence could be driven simply by standard economies

Figure 10.5 Domestic VA Exports in Europe, 1995–2008



Source: Authors' calculation using world input-output tables.

of scale or network externalities, but in the present context, the question that arises is whether and to what extent increasing cross-border supply linkages may have played a role. Figure 10.6 (left panel) exhibits a strong positive relationship between the change in a country's foreign value added—which has been a strong engine of export growth in much of Europe—and domestic-value-added exports expressed as a percentage of GDP.

More formally, the correlation between foreign-value-added growth and domestic value added up to five years later is tested by regressing the growth in domestic value added on growth in foreign value added (and year dummies) for various lags using the following equation:

$$\log\frac{DV_t}{DV_{t-1}} = \beta_0 + \beta_1 \log\frac{FV_{t-m}}{FV_{t-m-1}} + \sum \delta_i Year_i \quad \text{for } m = \{1,\ldots,5\}, \tag{10.1}$$

in which m denotes the lag length.

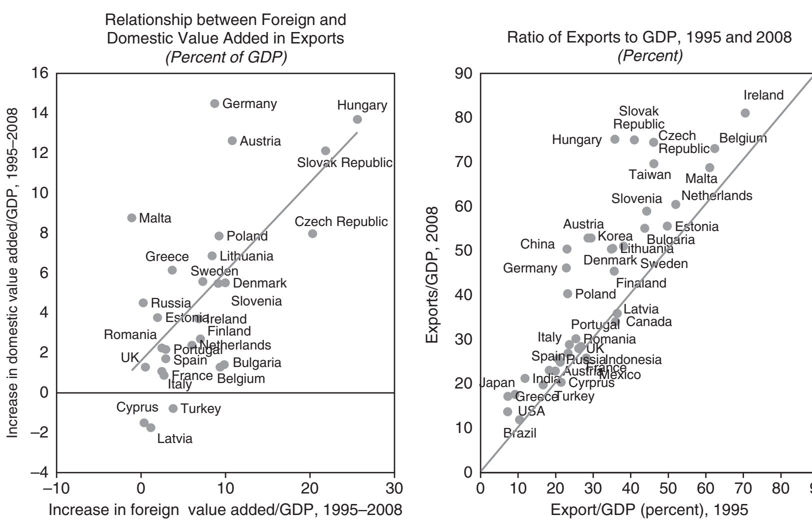
TABLE 10.1

Domestic-Value-Added Export Performance in Europe, 1995–2008

		Growth of Domestic-Value-Added Exports/GDP during Period			
		Domestic-Value-Added Exports/GDP Increased More Than 10 Percentage Points	**Domestic-Value-Added Exports/GDP Increased 5–10 Percentage Points**	**Domestic-Value-Added Exports/GDP Increased Less Than 5 Percentage Points**	**Domestic-Value-Added Exports/GDP Declined**
Annual Average Domestic-Value-Added Exports/GDP during Period	**Average domestic-value-added exports/ GDP greater than 30 percent**	Austria and Hungary	Czech Republic, Malta, Slovenia, Sweden	Belgium, Bulgaria, Estonia, Ireland, the Netherlands	
	Average domestic-value-added exports/ GDP of 20–30 percent	Germany, Slovak Republic	Denmark, Lithuania, Malta Poland	Finland, Romania, Russia, the United Kingdom	Latvia
	Average domestic-value-added exports/ GDP less than 20 percent		Greece	France, Portugal, Spain, Italy	Cyprus, Turkey

Source: Authors' calculation using world input-output table based on Timmer (2012).

Figure 10.6 Exports during 1995–2008



Source: Authors' calculations using world input-output table based on Timmer (2012).

Foreign value added and future growth in domestic-value-added exports are positively and statistically significantly related for all lag specifications (Table 10.2). These results do not establish causality, but a plausible interpretation is that increasing foreign-value-added exports during 1995–2008 helped

TABLE 10.2

Impact of Foreign-Value-Added Growth on Domestic-Value-Added Growth

	1-year lag	2-year lag	3-year lag	4-year lag	5-year lag
Foreign value added growth in period *t*–1	0.0151				
	(0.47)				
Foreign value added growth in period *t*–2		0.1014*			
		(3.26)			
Foreign value added growth in period *t*–3			0.0947*		
			(3.09)		
Foreign value added growth in period *t*–4				0.0934*	
				(3.05)	
Foreign value added growth in period *t*–5					0.0789*
					(2.57)
R^2	0.5901	0.6522	0.6167	0.6179	0.616

Note: Standard errors are reported in the parentheses.
* denotes significance at the 1 percent level.

downstream assembly producers to expand and create jobs and growth, subsequently resulting in increasing domestic-value-added exports. Because world GDP growth was driven by growth in world trade, and world trade growth was driven by supply links, foreign and domestic value added were complementary to each other, creating a virtuous circle for countries able to plug into regional or global vertical supply chains. Convergence did not appear to play a role: countries that had higher export-to-GDP ratios in 1995, such as China, the Czech Republic, Hungary, the Slovak Republic, and Taiwan Province of China, maintained or further strengthened their positions over time (Figure 10.6, right panel).

These two findings, that foreign-value-added exports contribute positively to domestic-value-added exports and that countries have retained or strengthened their competitive positions in exports, are related. To the extent that world trade is increasingly characterized by supply links and that these links take time to establish, it is not surprising that countries that were already well linked in 1995 are the ones that benefited disproportionately from growth in exports. This finding suggests that a successful strategy of export-led growth depends on, among other factors, finding an appropriate position in the value-added chain and nurturing this vertical relationship.

Countries that are not already well linked in the European supply chains thus have an additional difficulty in increasing the role of exports in growth. The extent of integration with supply links, measured both by the number of links and the volume of trade flowing through these links, is low in some EA periphery countries, such as Greece and Portugal. The following section investigates what factors help establish these supply links, including the role that policy can play.

WHAT FACTORS HELP COUNTRIES ESTABLISH SUPPLY LINKS?

The analysis so far shows that several European countries have increased their export-to-GDP ratios during 1995–2008 through integration with supply links. These countries linked with hubs, such as Austria, Germany, or Sweden, and managed to attract a part of the downstream production. Over time, that created a virtuous circle whereby foreign and domestic value added increased hand in hand, enhancing the role of exports in growth. Because success in export-led growth depends on plugging into this virtuous circle, it is important to investigate what factors contribute to a country's decision to send a part of its production abroad.

This analysis uses an augmented gravity model to explore this question empirically. Following McCallum (1995), the following specification is considered:

$$\begin{aligned}\ln(FV_{ijt}) = \beta_0 + \beta_1 \ln(Y_{it} \times Y_{jt}) + \beta_2 \ln(G_{it} \times G_{jt}) + \beta_3 \ln Dist_{ij} \\ + \sum\lambda_k CX_k + \sum\alpha_n S_n + \sum\mu_t T_t + \varepsilon_{ijt}\end{aligned} \tag{10.2}$$

in which i and j denote countries, and the variables are defined as follows (described in more detail below; see also Rahman and Zhao, 2013):

- FV_{ij} is the foreign value added from country i embodied in country j's exports;
- Y is nominal GDP;
- G is GDP per capita;
- $Dist_{ij}$ is the distance between countries i and j;
- CX_k is the set of gravity control variables (see below);
- S_n is the set of structural variables;
- T is the set of time controls;
- ε_{ij} is the error term.

In the baseline, the equation is estimated using ordinary least squares (OLS) with time dummies. To check for the robustness of the estimated results, OLS with no control and two-way fixed effects with both time and country-pair dummies is used. In the robustness tests, fixed effects are chosen over random effects as indicated by the Hausman test. The fixed-effects model is not used in the baseline because it does not allow distinguishing between the free trade agreement (FTA) dummy and the country-pair effects, given that the former incorporates the latter. All time and country-pair dummy variables are statistically significant.

Augmented Gravity Variables

A broad set of explanatory variables is included. In addition to the standard variables in the original gravity equation (including GDP, per capita GDP, and the distance between each country pair), dummy variables are also included for common language, common border, FTA, and whether the country is a resource exporter, as well as the tariff rate of the downstream outsourced country j.[3] The purpose is to control for as many variables as possible that may explain the value-added flows between two countries. The term $\sum\lambda_k CX_k$ in equation (10.2) can therefore be expressed as

$$\sum\lambda_k CX_k = \lambda_1\, ComLang_{ij} + \lambda_2\, ComBorder_{ij} + \lambda_3\, FTA_{ij} + \lambda_4 ResourceExporter_i + \lambda_5\, Tariff_j. \tag{10.3}$$

The estimation results show all gravity variables to be statistically significant with the expected signs (Table 10.3). For example, reducing the distance between countries by 1 percent increases the value of foreign-value-added exports by 0.5 percent. Similarly, increasing the host country's market size (i.e., GDP) by 1 percent increases foreign-value-added exports by 0.6 percent. A higher level of GDP, a shorter distance between two countries, the presence of a common border and common language, and the existence of an FTA all positively affect a country's decision to locate a part of its export production in another country.

Structural Variables

In addition, a list of structural variables are included that are commonly thought to drive fragmentation of export production. These include the labor cost differential, the initial level of similarities in industrial structure, and exchange rate volatility:[4]

$$\sum \alpha_n S_n = \alpha_1\,(ULC_{it} - ULC_{jt}) + \alpha_2\, Sim_{ijt} + \alpha_3 VolatilityEX_{ijt}. \tag{10.4}$$

The estimation results show a statistically significant positive coefficient for the unit labor cost differential, which is equal to the unit labor cost in country i minus the unit labor cost in country j. One interpretation is that countries with higher unit labor costs would have larger incentives to start outsourcing some of their downstream production processes to countries with lower unit labor costs (Table 10.3), resulting in increased foreign value added in the

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[3]The common language dummy variable is set to 1 if two countries with bilateral trade activities speak the same language; the common border dummy variable is set to 1 if two countries with a bilateral trade relationship share the same border. Both the common language and the common border variables serve as proxies for travel costs. The FTA dummy variable is set to 1 if two countries have an FTA. The resource exporter dummy variable is set to 1 if the source country is a major natural resources exporter (e.g., Australia, Brazil, Canada, Russia). The downstream tariff variable is the weighted mean of the tariff applied to manufactured products by the downstream country.

[4]We also experimented with including a variable capturing the statutory corporate tax differential between source and recipient country in the regression. The variable showed a positive relationship with foreign-value-added exports, meaning higher taxes in the source country cause exporters to locate abroad. However, because the coefficient was very small and statistically significant at 10 percent in two of the estimation methods, we excluded the variable from the final version of the regression.

TABLE 10.3

Regression Results of Determinants of Foreign Value Added

Variable	OLS with no Control	OLS with Time Control (Baseline)	Two-Way Fixed Effects
	(1)	(2)	(3)
Log of GDP_1	0.8255**	0.8272**	0.6695**
	(0.0057)	(0.0057)	(0.0957)
Log of GDP_2	0.6127**	0.6100**	-0.8357**
	(0.0057)	(0.0058)	(0.0986)
Log of GDP per capita_1	−0.1052**	−0.1018**	−0.0127
	(0.0102)	(0.0104)	(0.0910)
Log of GDP per capita_2	0.1656**	0.1807**	1.2998**
	(0.0120)	(0.0121)	(0.0934)
Log of distance	−0.5378**	−0.5370**	
	(0.0111)	(0.0112)	
Common language dummy	0.6847**	0.6731**	
	(0.0399)	(0.0398)	
Common border dummy	0.7629**	0.7618**	
	(0.0370)	(0.0368)	
Resource-rich dummy	0.3089**	0.3088**	
	(0.0262)	(0.0261)	
FTA dummy	0.3350**	0.3507**	0.0731**
	(0.0245)	(0.0261)	(0.0115)
Downstream tariff	−0.0179**	−0.0112**	−0.0359**
	(0.0035)	(0.0037)	(0.0020)
Exchange rate volatility	−1.5051**	−1.6656**	0.9182**
	(0.3819)	(0.3851)	(0.1423)
Difference in unit labor	0.8801**	0.8872**	0.5983**
costs	(0.0908)	(0.0903)	(0.0801)
Industry similarity	−1.7370**	−1.8217**	
	(0.2458)	(0.2450)	

Note: In the first four variables, 1 denotes source country and 2 denotes recipient country. Standard errors in parentheses. Number of observations is 17,640.
** denotes significance at the 1 percent level.
* denotes significance at the 10 percent level.

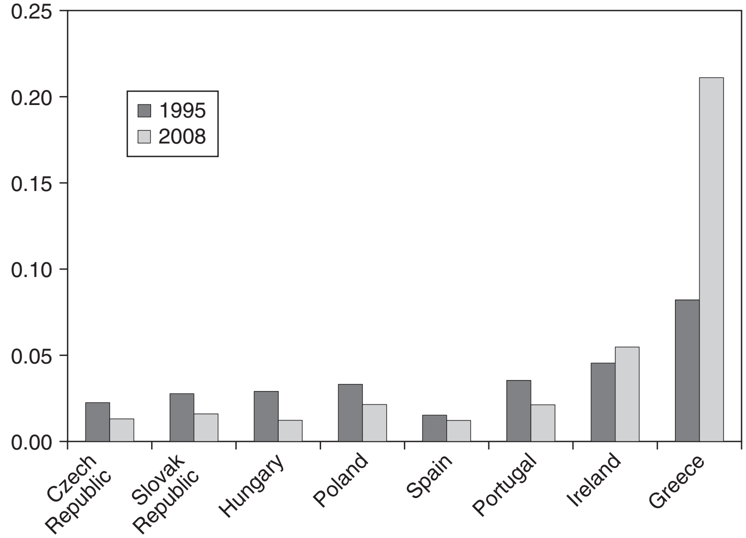
downstream country.[5] This result is consistent with Sinn (2004, 2006) who argues that Germany's high wages and rigid labor market stimulated a wave of international relocation of production to seek lower costs, especially in the automotive sector, in neighboring Eastern European countries in the early 1990s.

The impact of industrial similarity on foreign-value-added exports from country i and j is also estimated.[6] Because fragmentation within product or intra-industry trade is an important driver of supply links, two countries with similar

[5]We note that for *existing* cross-border production chains, one would expect the sign to be negative: an increased cost differential would provide incentive to reduce the value created in the higher-cost (upstream) country and reduce its share in the production process (i.e., reducing the relative importance of foreign value added). Thus, the positive sign we find suggests that the *initial* outsourcing decision (which leads to a positive sign) dominates the adjustment of *ongoing* outsourcing arrangements in the sample; however, we leave a closer examination of this issue for future research.

[6]For a given country pair (i,j), this index is constructed using the sum of the squares of the differences between the sectoral composition of country i's exports and the sectoral composition of country j's exports. See Rahman and Zhao (2013) for details. A low value indicates high similarity.

Figure 10.7 Emerging Europe and Euro Area Periphery: Similarity Index of Exports with Germany



Source: Authors' calculation using world input-output table based on Timmer (2012).
Note: A higher value indicates lower export similarity.

initial export structures are more likely to link. In manufacturing trade, this likelihood to link may also be driven by the probable availability of skilled labor if two countries have similar export or industrial structures.

To give an example, Figure 10.7 shows the similarity index between Germany and a set of countries; a lower value implies higher export similarity with Germany. This index shows a strong similarity between the export structure of Germany and four highly export-oriented Central European countries in 1995, which grew stronger by 2008. For EA periphery countries, whereas Spain and Portugal increased their similarities with Germany's export structure during 1995–2008, Ireland and Greece decreased theirs (Figure 10.7).[7] The estimation shows a strong negative coefficient for the initial industrial similarity index: although causality cannot be inferred, vertical integration is likely to occur between countries with similar industrial structures (Table 10.3). This result is statistically robust across estimation methods.

Last, the exchange rate could be a potentially important determinant of bilateral trade and vertical integration outcomes—producers presumably would prefer building production links with countries whose exchange rates are more stable. The

[7]Note that the disaggregation divides total exports of goods and services into only 35 sectors and therefore cannot capture quality differences or levels of refinement within a particular product. An index with more disaggregated product-level data may better capture the degree of industrial similarity between a hub and a host.

large literature on exchange rate volatility and trade does not offer a consensus on the appropriate method for measuring such volatility. The most widely used measure is the standard deviation of the first difference of the log of the exchange rate. This measure has the property that it will equal zero if the exchange rate follows a constant trend, which presumably could be anticipated and therefore would not be a source of uncertainty. Clark and others (2004) argue that real rates are preferable on theoretical grounds. Here, exchange rate volatility is measured by the standard deviation of the first difference of the log of the real bilateral exchange rate.

The role played by the bilateral exchange rate is unclear. The results show a negative and statistically significant relationship between foreign-value-added exports and volatility of the bilateral exchange rate in the two OLS specifications, but an equally significant positive coefficient in the two-way fixed effects specification. Even though it would seem intuitive for a higher degree of exchange rate uncertainty to adversely affect cross-border joint production decisions, the switch in signs suggests that more work is needed to assess this relationship more conclusively.

To evaluate and compare the contribution of each variable in the above regression (which are measured in different units) on foreign-value-added trade, the standardized coefficient is computed for the baseline model (OLS with time control) by transforming all independent variables to ones with zero mean and unitary standard deviations. These standardized coefficients indicate by how many standard deviations a dependent variable will change per standard deviation increase in the independent variable (Table 10.4).

The traditional gravity variables are dominant in explaining supply links as captured by foreign value added: large economic size and close distance to supply hubs have much larger impacts than the structural variables that are, to some extent, under the control of policymakers, such as FTAs, tariffs, exchange rate volatility, and ULCs. But it is important that the impact of such variables is not zero, and significant reforms will also have substantial impacts, either directly, as measured here, or indirectly. For example, structural reforms could raise economic growth and, by implication, future economic size. Thus, economic reform measures have an important role to play in countries' efforts to increase their supply-chain linkages.

SUPPLY LINKS AND REVEALED COMPARATIVE ADVANTAGE

The value-added decomposition sheds some light on the supply-chain linkages across countries, but it can also help provide a better understanding of where countries stand with regard to their comparative advantage. Balassa (1965) proposed the concept of revealed comparative advantage (RCA), which compares the sectoral composition of exports in one country with that of world exports, but Koopman and others (2011) have shown that the problem of multiple counting in official trade statistics makes the computation of RCA misleading. An RCA based on the value-added decomposition of exports eliminates the distortion of

TABLE 10.4

The Standardized (Beta) Coefficients

Variable	Standardized Coefficient
Log of GDP_1	0.672
Log of GDP_2	0.496[1]
Log of GDP per capita_1	–0.048
Log of GDP per capita_2	0.085
Log of distance	–0.266
Common language dummy	0.066
Common border dummy	0.089
Resource-rich dummy	0.052
FTA dummy	0.071
Downstream tariff	–0.015
Exchange rate volatility	–0.018[1]
Unit labor costs differentials	0.044
Industry similarity index	–0.029

[1]Results not robust across all three specifications.

multiple counting by focusing on domestic value added and can thus provide a more accurate assessment of a country's RCA.

This analysis looks at four successful central European countries that achieved export-led growth through greater integration with supply links to see how their tradables sectors evolved during 1995–2008 with regard to comparative advantage. The RCA is calculated as the share of a sector in a country's total exports divided by the world average share of the same sector in world exports. An RCA value of greater than 1 indicates a sector in which the country has an RCA. Domestic-value-added exports are disaggregated into manufacturing and services, and further divided into labor-, capital-, and knowledge-intensive sectors.[8] Based on this calculation, some key observations follow (Table 10.5):

- *Central European countries enhanced their comparative advantage in manufacturing over time.* In 1995, none of the four countries had a comparative advantage in knowledge-based manufacturing. By 2008, they had all acquired such advantage in addition to retaining and improving their RCA in labor- and capital-intensive manufacturing. Strong and growing supply links with European hubs enabled these countries to move up the value ladder.
- *The evolution of RCA is in line with the supply links.* For example, the Czech Republic and the Slovak Republic started with RCAs in all three services category in 1995 but moved to recreate RCA in manufacturing. Over time, the Czech Republic's and the Slovak Republic's RCAs became closer to that of Germany. The harmonization of RCA reflects the dominance of supply links between each of these two countries and Germany. In contrast, the role of manufacturing decreased in some EA periphery countries.

[8]The RCA index is based on a total of six sectors: labor-, capital-, and knowledge-intensive manufacturing and labor-, capital-, and knowledge-intensive services, respectively. Thus, a country could have an RCA in a maximum of five sectors.

TABLE 10.5

Evolution of Revealed Comparative Advantage in Manufacturing and Services: Emerging Europe and Euro Area Periphery, 1995–2008

	Manufacturing, 1995			Manufacturing, 2008		
	Labor-intensive	Capital-intenstive	Knowledge-Intensive	Labor-intensive	Capital-intenstive	Knowledge-Intensive
Portugal	3.42	0.94	0.57	2.40	1.25	0.72
Spain	0.93	1.21	1.04	1.04	1.40	1.07
Ireland	0.34	1.79	1.01	0.13	0.83	0.87
Greece	1.6	1.3	0.0	0.4	0.7	0.2
Czech Republic	1.29	1.30	0.56	1.10	1.28	1.28
Hungary	0.68	1.06	0.50	0.42	0.85	1.26
Poland	1.95	1.39	0.59	1.72	1.41	1.01
Slovakia	1.05	1.61	0.60	1.09	1.41	1.14
China	3.55	1.03	0.64	2.61	0.70	1.28
Germany	0.64	1.07	1.48	0.69	1.16	1.61

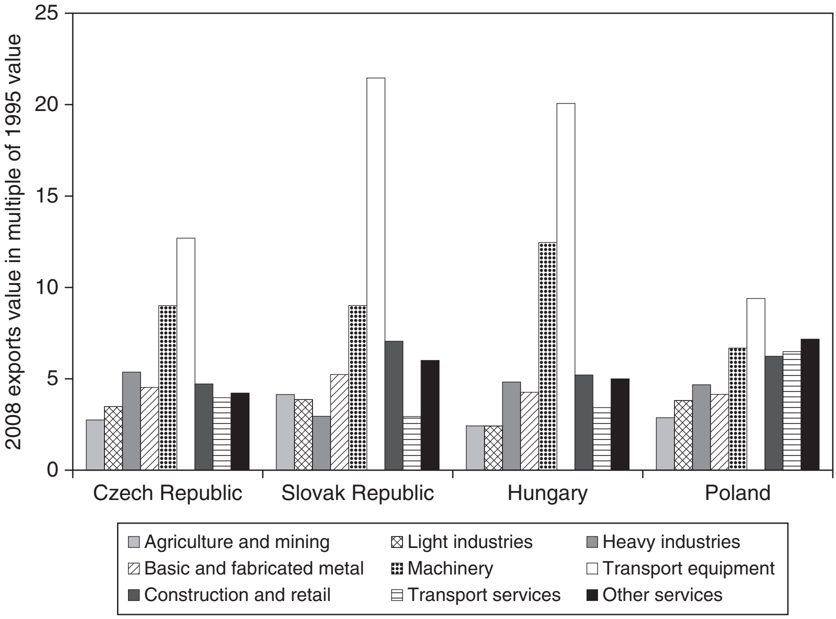
	Services, 1995			Services, 2008		
	Labor-intensive	Capital-intensive	Knowledge-Intensive	Labor-intensive	Capital-intensive	Knowledge-Intensive
Portugal	0.67	2.09	0.86	1.26	2.45	0.89
Spain	0.54	1.09	0.81	0.55	1.26	1.59
Ireland	0.39	0.23	1.82	1.69	0.54	3.90
Greece	2.9	3.0	0.5	2.0	9.0	0.6
Czech Republic	1.89	1.53	1.09	0.79	1.11	0.55
Hungary	2.50	2.39	1.62	2.27	1.07	0.82
Poland	1.32	0.90	0.58	1.08	1.16	0.48
Slovakia	1.88	1.32	1.05	1.14	0.88	0.62
China	0.86	0.74	0.12	1.34	1.10	0.54
Germany	0.55	0.63	0.51	0.55	0.84	0.71

Legend (shading): RCA < 0.5; 0.5 < RCA < 1; 1 < RCA < 2; 2 < RCA < 3; RCA > 3

Source: Authors' calculation using world input-output table.

The analysis zooms in further on product-level export data to see whether performance was driven by particular products (Figure 10.8). The importance of the transport equipment and machinery industries is seen in the export success stories of these countries. During 1995–2008, exports of all major categories more than doubled in these four countries, but exports of machinery and transport equipment increased by 7–22 times. The dominance of machinery and transport equipment exports is overwhelming. The share of these products in total exports of goods and services increased from about 10 percent to more than

Figure 10.8 Sectoral Export Performance in Selected Central European Countries, 1995–2008



Source: Authors' calculation using world input-output table based on Timmer (2012).

20 percent during this period in Hungary, the Czech Republic, and the Slovak Republic. This attests to the role of finding a few niche sectors to secure success in a supply link–driven trade environment.

What lessons can be learned from the analysis of countries' RCAs? Supply links are more dominant in manufacturing, and successful linking often involves finding niche manufacturing sectors, although Ireland's experience shows that successful linking can also occur through services. Most EA periphery countries have an RCA in services. Improving their export performance would require leveraging this RCA in the services sector.

CONCLUSION

In Europe and elsewhere, finding ways to raise living standards through strong and sustainable growth is the key policy imperative. This chapter suggests an increasingly important strategy for raising growth: plugging into and taking advantage of production patterns that increasingly involve several countries along the supply chain. Taking advantage of new data and an innovative methodology, this chapter highlights that reforms can improve countries' external environment in a sustainable fashion by helping them plug into cross-border production chains. Thus, structural reforms will not only help growth (Chapters 7 and 8) and external adjustment (Chapter 9) in the medium term, but will also provide a crucial link to global demand in the longer term.

The analysis in this chapter shows that the strongest export performances globally and in Europe during 1995–2008 were the result of successful integration with supply links. This integration often relied on a few niche sectors rather than the entire spectrum of tradable products. These findings reflect firms' increasing incentives in a globalized world to unbundle the production process across borders to take advantage of low-cost foreign factors of production. The success of emerging Europe relative to the EA periphery also serves as a cautionary tale for what can happen when higher-cost and distant producers get superseded by closer and lower-cost ones in a supply chain. For countries in the EA, especially those in the periphery with a particular need for improving their external trade positions, key lessons are that future success in export growth will, to a significant degree, depend on successfully linking to supply chains. For example, based on the analysis, Spain would be well served by integrating more strongly into supply links given its larger size, sizable existing links, geographical proximity to Germany, as well as an export structure that is similar to Germany's. For large countries such as Spain, future research should look into how they could benefit most, thatv is, whether to increase their links with a larger export hub like Germany or strengthen their own positions as export hubs. Greece, by contrast, would face more of a challenge given its small size, services-heavy export structure, and geographic location; however, further liberalization of services trade in Europe, in addition to finding niche sectors and developing a competitive wage structure, could deliver stronger export-led growth. Greater links with upstream export hubs in Europe would greatly help many of these countries improve their export prospects, and further structural reforms could help them move up the value chain.

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