It's a Small, Small World... A Guided Tour of the Belgian Production Network

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ABSTRACT

This article presents stylized facts about the participation of Belgian firms in global and local value chains, using transaction data at the firm level to depict the Belgian production network and its integration in the world economy. These data allow the identification of the various channels through which a Belgian firm has access to the world market, either to source its inputs or to sell its output. We also discuss how the level of efficiency of individual firms is related to their position in the local and global value chains.

Production fragmentation is a pervasive phenomenon in the world economy. Firms buy inputs from other firms and sell their output for intermediate use, giving rise to a sequencing of production stages.[2] This fragmentation has been mostly viewed as an international process, with some countries specialized in early stages of production (design of the product), some in medium stages (early production stages) and others in final stages (final assembly, marketing, distribution), but this process may also occur locally. Newly available international input/output tables have enabled an analysis of international supply linkages and the extent to which value added is sequentially created along the global value chains (Timmer *et al.*, 2014; Koopman *et al.*, 2014). Sectoral linkages within countries and how they affect technological diffusion have also been studied, mostly using input/output tables (Acemoglu *et al.*, 2012).

However, little work has been done on domestic production networks at the firm level due to lack of data availability.[3] The goal of this article is to provide a description of the integration into the globalized economy of firms that are not directly involved in international trade. To do so, we provide a detailed description of the organization of a domestic production network and

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how it integrates itself into global value chains (GVC).

At the firm level, the integration into GVC has largely been addressed by analyzing the decision to export or to import. The widely used new trade models with heterogeneous firms (Melitz and Redding, 2014) show a positive relation between the level of technological efficiency of a firm and its export status (Bernard and Jensen, 1999; Ottaviano and Mayer, 2007).[4] In related literature, there are firm-level studies that stress the link between imported intermediate inputs and productivity (Antras *et al.*, 2016; Bernard *et al.*, 2009; Amiti and Konings, 2007).

Recent research, however, has questioned the exclusive focus on exporting (or importing) firms. Some empirical papers have shown that many firms are exporting indirectly through trade intermediaries or other manufacturing firms.[5] More generally, one finds evidence that many firms are indirectly connected to the rest of the world. Some firms supply parts and components that are then integrated into exports. Others buy inputs whose parts or components are imported.

Exporting and importing firms therefore act as connectors of the domestic production network to the rest of the world. Dhyne and Duprez (2015) documented that phenomenon using a sample of around 350,000 Belgian firms.[6] In their sample, the number of exporting firms is relatively small (less than 5 per cent of firms), of which almost half export less than 10 per cent of their turnover. However, almost 80 per cent of their sample supplied inputs to the rest of the world, either directly or indirectly through third companies. Overall, around 20 per cent of their sample, on average, ultimately exported at least 10 per cent of their output, and almost 10 per cent exported at least 25 per cent of their output. The situation is even more striking when it comes to imports. Almost all Belgian firms use foreign inputs, obtaining supplies directly or indirectly from importers, particularly in the case of energy and commodities.

This article provides additional evidence on indirect international trade by showing how close firms are to world markets, either as a source of inputs or a destination for output. The data used make it possible to identify potential commercial channels through which a domestic firm can source foreign inputs or serve foreign demand. Using a similar dataset, Dhyne and Rubinova (2016) found evidence of a performance premium that rises with the proximity to foreign demand. We extend this result by showing that the same applies to the import side. In the spirit of Antras *et al.* (2016), we also find a stronger impact of the distance to foreign inputs on firm performance than that normally associated with the distance to foreign demand.

Describing and understanding the organization of domestic production networks at a very disaggregated level is crucial to understanding

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3   Atalay *et al.* (2011) use transaction data to characterize the organization of the production network in the United States, but their sample only covers large firms and their main customers. Bernard *et al.* (2016b) use the collection of the main supplier/customer relations for Japanese firms, but do not observe the size of the transactions. To our knowledge, the Belgian business-to-business (B2B) transaction data is the first micro dataset available that provides an exhaustive description of the inter-firm linkages, including the magnitude of those transactions.

4   The impact of export activities on TFP growth has also been addressed to test the learning-by-exporting assumption, but empirical evidence is not as clear.

5   For instance, Bernard *et al.* (2010) have shown that wholesalers and retailers play a major role in US exports. Similarly, Bernard *et al.* (2016a) have found that a significant share of the value of products sold abroad by Belgian manufacturing exporters is not directly produced by those firms.

6   While also considering Belgian data, their analysis is restricted to the sample of firms registered in the Central Balance Sheet Office of the National Bank of Belgium, which only covers around 50 per cent of the VAT affiliates considered in this article.

the evolution of total factor productivity in advanced economies (Oberfield, 2013). Over the last decades, the development of information and communication technologies and the reduction in transport costs have completely overhauled the organization of production and corporate boundaries. Efficient or cost-saving production may require fragmentation of the production process among multiple producers. Firms have more and more intensively outsourced or offshored tasks they were doing in-house and concentrated on the business activities where they are most efficient. For example, it has been commonly observed in many countries that firms have increasingly outsourced support activities like catering, cleaning and security services to specific service providers (Goldschmidt and Schmieder, 2017).

These changes have led to the organization of production in very complex networks reshaping the way technological or trade shocks propagate within an economy. Analyzing the spread of shocks through the network may provide very useful insight for understanding the global TFP slowdown observed in the last decade and why the technology gap between frontier firms and laggards has been widening. While these important questions are clearly beyond the scope of our article, we intend to contribute to this literature by providing a first description of the production network and illustrate how the integration of individual firms into the Belgian production network and the global economy affects productivity.

This article is structured as follows. The first main section presents the new database. A second section provides an initial set of network-related statistics that describe the Belgian production network and its development over the 2002-2014 period. The third section is dedicated to the analysis of the proximity of Belgian firms to foreign markets, while section the fourth section investigates the link between our measures of proximity and the firm's economic performance. The fifth and final section presents some tentative conclusions.

The Belgian Production Network

In order to document firms' involvement in the international fragmentation of production as well as the organization of the production network, we use two datasets which are available for the 2002-2014 period. The first dataset managed by the National Bank of Belgium provides firm-level information on exports and imports by product and by country.[7]

The second dataset comes from the annual declarations of deliveries by business customers to the Belgian tax administration. It records for every VAT-registered business the annual value of its deliveries to any other VAT affiliate, as long as this amount is greater than or equal to 250 euros per year. This annual value of sales from firm i to firm j is called a transaction. This transaction is not split between the potentially multiple goods and services traded between firms i and j. It only represents the total value of goods and services traded between those two firms. However, we may observe bilateral trade between those two firms. In this case, we observe both the transaction between i (as a seller) and j (as a buyer) and its reverse transaction between j (as a seller) and i (as a buyer). This

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7   The term firm refers to any legal entity registered by the tax administration under a VAT number. It is therefore a legal concept of a firm that is used. This concept covers all kinds of organisations from the Belgian affiliates of multinationals to the local corner store or the self-employed. A given firm may have more than one plant operating under the same VAT number. Transactions between those plants are not observed in our data. Alternatively, some organizations may decide to use more than one VAT number to handle specific activities (for example, on VAT number will deal with production, another with domestic business relations and a third one with exports). Trade between the different VAT affiliates is observed.

dataset therefore provides all the linkages between all Belgian firms. These data, described in Dhyne, Magerman and Rubinova (2015), enable us to fully characterize the local production network.

Merging these two datasets therefore gives a full picture of any domestic or international linkages that involve at least one Belgian firm. We will discuss in the next two sections some facts about the organization of the domestic production network and its interrelation with world markets, but first it is useful to discuss the specificities of such a dataset.

The firm-to-firm transaction data can be viewed as a kind of input-output matrix where each row and each column is a firm. In that respect, it is therefore a very suitable tool for analyzing the organization of production chains at the national level, in the same way that world input/output tables (Timmer et al., 2014) provide a description of the contribution of a given industry in a given country to global value chains. Still, this dataset departs from traditional I/O tables in a number of ways.

First, we have no information of what is traded between two firms. We are therefore not able to distinguish between intermediate inputs and investment inputs. In our data, buying an investment good is considered as an intermediate purchase. Conversely, investment expenditure is part of final demand in an input-output framework.

Second, the manner in which wholesale and retail trade intermediaries are recorded is fundamentally different from that of standard I/O tables. In standard I/O tables, the contribution of the wholesalers and retailers to the economy and their intermediate deliveries to other sectors is measured in terms of the value added generated by wholesalers and retailers. In our transaction data, we observe gross transactions to or from trade intermediaries. The contribution of wholesalers and retailers in the network is therefore much larger than in standard I/O tables. These firms, as shown in section 2, play a crucial role in the domestic production network. They are in fact most of the time the ultimate step between the producer and the final consumer. They are also a key player in connecting firms.

Third, there is no intra-firm trade in our dataset, which means that the diagonal of our firm-to-firm I/O matrix is 0. On the contrary, in standard I/O tables, the main action is in the diagonal. This affects measures of production fragmentation, as the Antras et al. (2012) upstreamness indicator.

Stylized Facts on Domestic Trade

Before looking at how Belgian firms are involved in GVCs, we first describe the Belgian production network. As we do not restrict our analysis by any firm characteristics such as size or productivity level, we obtain the largest coverage of the Belgian economy available for our analysis. This means we use the set of all legal entities that are registered with a VAT number both for tax declarations and in international trade data. Each year, we observe between 676,000 and 861,000 VAT declarants, which is twice the number of firms that have to report their annual financial statement to the National Bank of Belgium Central Balance Sheet Office. The difference is due to the self-employed or fiscal representatives of foreign firms that do not have to file a financial statement.

Characteristic 1: Belgian Firms Typically Have a Small Number of Domestic Customers and Domestic Suppliers

On average, we observe around 20 domestic business customers for each firm (Table 1).[8]

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8   By customers, we only refer to business customers. Firms may also serve final demand and may have many households in their client portfolio, but these transactions are not observed in our dataset.

Table 1: Firm Production Network Characteristics in Belgium

	2002	2007	2010	2014
# of firms	676,016	737,326	770,902	860,735
excluding wholesalers and retailers	*486,508*	*549,747*	*585,079*	*680,651*
# of domestic transactions	13,312,924	15,008,281	16,201,273	17,304,408
excluding wholesalers and retailers	*4,416,893*	*5,382,637*	*5,878,684*	*6,975,793*
Avg. # of domestic business customers	19.7	20.4	21.0	20.1
excluding wholesalers and retailers	9.1	9.8	10.0	10.2
Network's density	2.9E-5	2.8E-5	2.7E-5	2.3E-5
# of exporters	29,056	24,463	22,550	21,464
# of importers	32,711	35,164	42,361	46,151

Note: The decline in exporters is counter-intuitive with the idea that countries are moving towards a more globalized economy. The decline is partly due to changes in the reporting thresholds of intra-EU trade activities by Belgian firms. In 2006, firms that exported less than 1,000,000 euros per year to other EU countries on an annual basis were exempted from reporting, while the reporting threshold before 2006 was 250,000 euros.

This indicates that the density of the production network, which is equal to the ratio between the observed transactions and the potential number of transactions is very small (around 2.3E-5 in 2014).[9] If we exclude from our sample firms that are operating as wholesaler or retailer (NACE Rev 2 45 to 47), the average number of domestic business customers falls to 10. This illustrates how important the distribution sector is in connecting firms not only to final demand but also to other firms themselves, especially on the domestic market.

The distribution of the number of customers and suppliers is highly skewed. One quarter of the firms in our sample had no Belgian business customers in 2014.[10] One quarter have at most three domestic suppliers. The median firm has only two Belgian customers but nine domestic suppliers. By contrast, 1 per cent of the firms have at least 300 domestic customers and 1 per cent have at least 175 domestic suppliers.

Characteristic 2: Belgian Firms Typically Trade Locally on the Domestic Market

Geography matters on the domestic market. Even in a small country like Belgium, the organization of the production network is mostly local. One quarter of the domestic business transactions involve domestic partners located within a six kilometer range. The median domestic transaction involves two firms separated by less than 20 kilometers. Only 1 per cent of the domestic transactions are between firms 155 kilometres or more apart. This is well documented in Dhyne and Duprez (2016), who have also pointed to significant cultural trade barriers within Belgium.

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9   The potential number of transactions in a production network is given by the product of the number of firms and the number of firms minus 1.

10 The firms that have no Belgian business customers are firms that are either only serving foreign markets or domestic final demand. By construction, the average number of domestic suppliers is equal to the average number of domestic customers.

Table 2: Relationship Between Number of Customers/Suppliers and Employment and Labour Productivity in Belgium

Correlations between:	2002	2007	2010	2014
Employment and # customers	0.400***	0.405***	0.401***	0.398***
Employment and # suppliers	0.633***	0.626**	0.604***	0.615***
Labour productivity[2] and # customers	0.032**	0.057***	0.056***	0.066***
Labour productivity and # suppliers	0.038***	0.070***	0.069***	0.074***

Notes: All variables are in logs. Labour productivity is measured as value added per employee.

Characteristic 3: Larger Firms and More Productive Firms Tend to Manage a Larger Number of Domestic Customers or Domestic Suppliers

When firm-level characteristics are available, simple correlations between size or labour productivity (in level) and the number of customers and suppliers show that the ability to manage a large portfolio of customers and suppliers increases with firm size and firm efficiency, as shown in Table 2.[11]

Characteristic 4: The Network's Organisation Changes Significantly Every Year

Between 2002 and 2014, the structure of the Belgian network changed dramatically. Not only do we observe a large increase in the number of sampled firms and in the number of transactions, but we also observe a high transaction replacement rate. Every year, on average 43 per cent of the transactions between firms from the previous year are not repeated and 44 per cent are newly created. In 2014, only 13 per cent of the transactions observed in 2002 were still open.[12]

How Close are Belgian Firms to World Markets?

Because we have a full description of both international and domestic transactions, we are able to identify the various channels used by a Belgian firm to access a foreign supply of inputs or to serve foreign demand for goods and services. Importers and exporters are able to directly access some foreign markets (according to the countries they are importing from/exporting to and the products and services they trade with these countries), but they may be able to reach more foreign markets by trading with other Belgian importers or exporters.

More generally, a domestic firm that may not directly import or export may source foreign inputs or sell its products abroad indirectly by trading respectively with a Belgian importer or a Belgian exporter.

Indirect access to foreign markets is reflected in the phenomenon of the so-called carry-along trade described in Bernard *et al.* (2016a). In Dhyne and Rubinova (2016), the Belgian production network was used to identify how far a firm was from foreign demand. Here, we extend this approach to the import side and we characterize firms by the number of transactions they need to import foreign inputs or by the number

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11 Note that in Table 2 the correlation between labour productivity and the number of customers/suppliers increases over time. This may reflect the fact that the gap between productive and unproductive firms has widened over time.

12 In 2007, 28 per cent of the 2002 transactions were still observed, in 2010 20 per cent. Note that the high churn rate is partly due to new or exiting firms.

Figure 1: Closeness of Belgian Firms to Foreign Supply/Demand
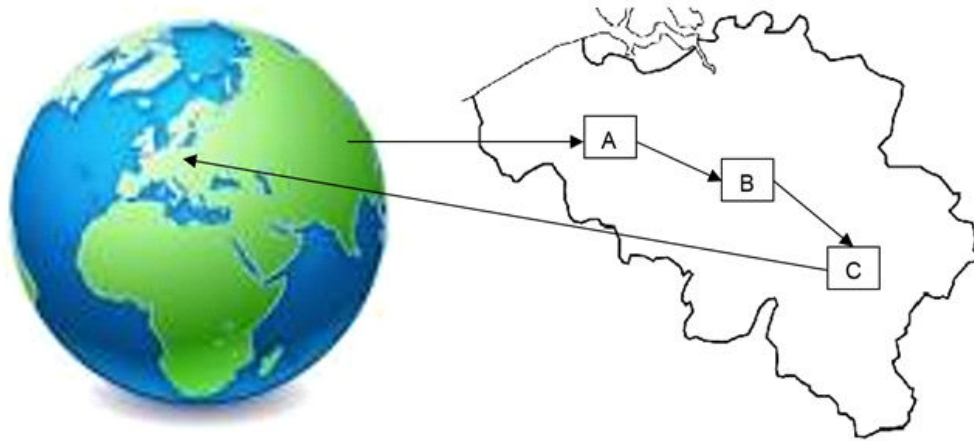
of transactions needed for their products to be exported. For instance, if firm A is an importer which sells to firm B (which is not importing), firm B is considered to be a 1st rank M-customer as it is just two transactions away from imported inputs. If firm C (which is not importing) is not a customer of firm A but of firm B, firm C is three transactions from the imported inputs and is called a 2nd rank M-customer. If firm C is an exporter, while firms A and B only serve the domestic market, B is considered to be two transactions from the foreign demand or a 1st rank X-supplier, while A is three transactions away from the foreign demand or a 2nd rank X-supplier.

We define the distance between a given firm and foreign demand as the smallest number of transactions that are needed for that firm's products to cross the border. Similarly, we define the distance between a given firm and foreign inputs by the smallest number of transactions that are needed for that firm to consume foreign inputs. These two measures characterize the Belgian economy's degree of participation in GVCs and its exposure to foreign demand or supply.

Characteristic 5: A Large Fraction of Belgian Firms are at Most Three Transactions From Foreign Markets

Results obtained applying this approach to all domestic transactions and international transactions observed in 2014 are presented in Table 3 (Panel A).

Our first measure of the integration of Belgian firms into GVCs is based on the (smallest) number of transactions involved in the X and M trajectories, disregarding the size of those transactions. As the reporting threshold of a domestic transaction is very low (250 euros in a given year), any firm that is able to sell at least 250 euros in goods and services to an exporter is, according to the analysis conducted in Panel A, a 1st rank X-supplier even if this transaction is not important for both the buyer and the seller. Similarly, a firm that buys at least 250 euros in goods and services from an importer is a 1st rank M-customer.

To restrict our analysis to relevant or economically meaningful transactions, we follow Dhyne and Rubinova (2016) and only consider transactions that represent a minimum fraction of the supplier's total sales or of the customer's total input consumption. We consider that a transaction between two firms is relevant if it represents at least 1 per cent of either the total sales of the supplier or the total input consumption of the customer. Concerning international trade rela-

Table 3: Distribution of Number of Transactions for Belgium Businesses Needed to Sell or Buy from the Rest of the World, 2014 (in %)

Panel A – All transactions							
	# of transactions to sell to RoW						
# of transactions to buy from RoW		1	2	3	4	≥5	∞ [1]	Total
	1	1.7	2.3	0.7	0.1	0.0	0.7	5.4
	2	0.8	25.8	24.2	3.3	0.3	22.1	76.4
	3	0.0	1.3	3.6	0.8	0.1	10.0	15.8
	4	0.0	0.0	0.0	0.0	0.0	0.1	0.1
	≥ 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	∞ [1]	0.0	0.4	1.2	0.4	0.0	0.2	2.3
	Total	2.5	29.8	29.7	4.5	0.4	33.1	100.0
Panel B – Relevant transactions							
	# of transactions to sell to RoW						
# of transactions to buy from RoW		1	2	3	4	≥5	∞ [1]	Total
	1	1.3	1.3	0.6	0.1	0.0	0.5	3.9
	2	0.8	20.1	25.0	5.4	0.6	19.5	71.3
	3	0.1	2.2	5.2	1.7	0.2	12.2	21.6
	4	0.0	0.0	0.1	0.1	0.0	0.7	1.0
	≥ 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	∞ [1]	0.0	0.3	1.1	0.5	0.1	0.2	2.3
	Total	2.1	23.9	32.1	7.8	0.9	33.1	100.0
Panel C – Essential transactions							
	# of transactions to sell to RoW						
# of transactions to buy from RoW		1	2	3	4	≥5	∞ [1]	Total
	1	0.9	0.5	0.6	0.3	0.1	0.4	2.8
	2	0.4	5.7	10.1	9.5	4.3	13.9	43.8
	3	0.3	4.4	8.4	7.8	3.6	12.2	36.7
	4	0.1	0.9	1.9	2.0	1.1	7.2	13.2
	≥ 5	0.0	0.1	0.1	0.1	0.1	0.7	1.1
	∞ [1]	0.0	0.2	0.5	0.8	0.5	0.3	2.4
	Total	1.7	11.8	21.6	20.6	9.7	34.6	100.0

Note: [1] An infinite number of (relevant/essential) transactions means that there are no (relevant/essential) X-trajectory or (relevant/essential) M-trajectory that connect the firms to the foreign markets.

tions and according to this definition of a relevant transaction, a firm is an exporter (resp. importer) if at least 1 per cent of its total sales (resp. total expenses) are made abroad.

As can be seen from Panel B of Table 3, this new definition of the X and M trajectories has a relatively limited impact on our results. Considering only relevant transactions in 2014, 58 per cent of Belgian firms were still at most three transactions from foreign demand. Similarly, still 97 per cent of Belgian firms were at most three relevant transactions from foreign supply. Globally, 57 per cent of Belgian firms were at most three relevant transactions from both foreign demand and foreign supply, compared to 60

per cent when considering any transaction. This confirms the strong integration of a majority of Belgian firms into the GVCs.

Restricting even further the number of transactions to essential transactions accounting for at least 10 per cent of total sales or total input consumption of a firm naturally increases the (smallest) number of transactions needed to reach the foreign market but does not affect the share of firms connected to either world supply or world demand, as shown in Panel C.

At a macro level, the results presented in Table 3 can be summarized by the distance to the foreign market averaged across firms as proxied by the number of transactions required to engage

Chart 1: Average Number of Transactions Needed to Source Foreign Inuts and Serve Foreign Demand, by Markets
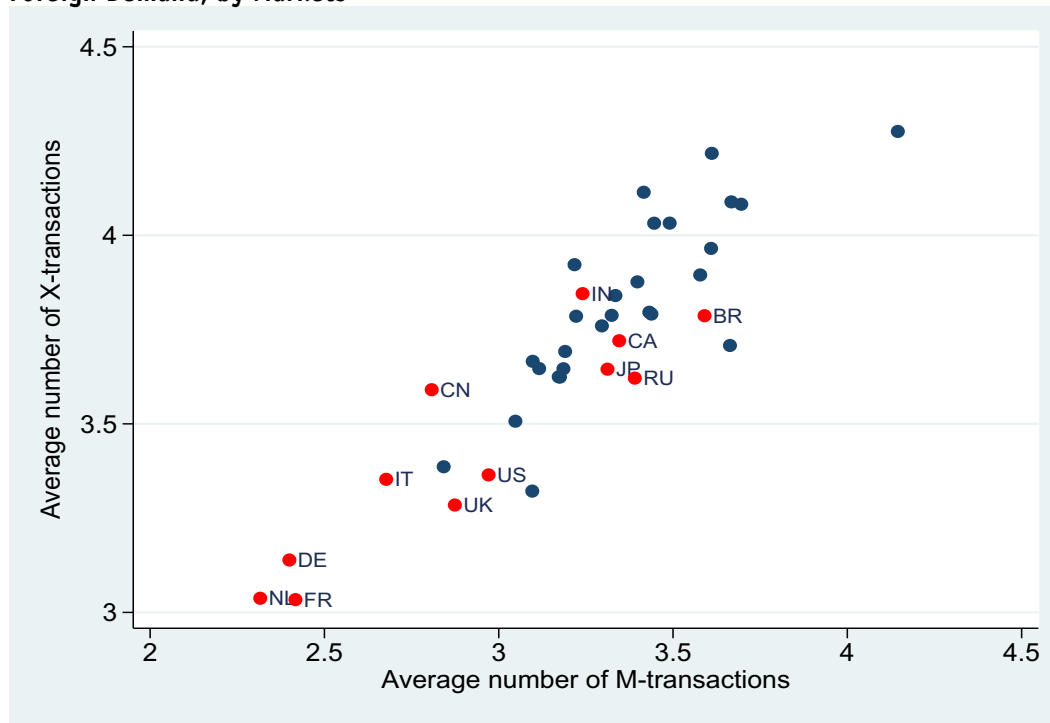
in international trade. In 2014, considering only those firms connected to export markets, the average number of transactions needed ranged between 2.6 (any transactions) and 3.4 (only essential transactions). On the import side and considering only the firms connected to import markets, the average number of transactions is smaller, ranging respectively between 2.1 and 2.6.

Characteristic 6: Belgian Firms Need More Transactions to Source From / Serve More Geographically Remote or Smaller Markets

It is well documented that the gravity variables affect the probability of a firm exporting to or importing from a given country. As a result, the number of firms directly exporting or importing varies considerably across countries of origin or of destination. Indeed, as more remote/smaller markets are more costly to serve or to source from, fewer firms will be able to establish a direct link with those markets. As

expected, this is naturally reflected in the average number of transactions required to reach those countries. The probability that a non-exporting firm will trade with either an exporter to or an importer from these markets declines with the remoteness or the smallness of the markets. Chart 1 shows that Belgian firms need on average more transactions to reach more distant markets or less important markets, for both the export and import side.

Characteristic 7: The Global Connectedness of Belgian Firms to Foreign Markets Does Not Vary by Country

Strikingly, if we apply our measure of GVC participation by country of origin or destination, we find that the share of firms that are not connected to a given export or import market do not vary strongly across countries. Considering the 40 main partner countries and relevant transactions only, we find that on average 33 per cent of Belgian firms cannot sell to a particular foreign market and that 2.3 per cent of Belgian

firms cannot source inputs from a particular foreign market. For both imports and exports, we do not observe any significant difference of that share across countries as it varies between 33.3 per cent and 33.4 per cent for the export side and between 2.10 per cent and 2.12 per cent for the import side. This means that Belgian firms that are able to connect with an exporter or with an importer can reach any of the 40 main markets. Given Characteristic 6, markets only differ according to the number of transactions needed to reach them.

As the share of firms not X-connected to any particular foreign market is almost constant and equal to the share of firms not X-connected at all, this finding suggests that the Belgian production network can be viewed as the sum of two components: the first one, covering 66 per cent of the firms, is to some extent exposed to both world demand and supply fluctuations, the second is only exposed to import shocks.

Productivity and Closeness to World Markets

Finally, we have undertaken an econometric analysis of the relationship between total factor productivity (TFP) in level and the distance to foreign markets. This exercise is limited to the 195,412 firms for which we observe their financial statement and for which the information required to estimate TFP using the Wooldridge-Levinhson-Petrin estimator (employment, material inputs, value added, capital stock) is available.[13] Estimated TFP is available for the 2002-2014 period.

As mentioned above, the empirical literature provides considerable evidence of a positive correlation between firm-level productivity and the international trade status of firms (for Belgian firms, see Muûls and Pisu, 2009). Dhyne and Rubinova (2016) also document a clear produc-

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13   See Wooldridge (2009) for more details on this estimator.

Table 4: Total Factor Productivity and GVC Participation in Belgium

Explanatory variables	(1)	(2)
Employment (in log)	0.132***	0.112***
	(0.009)	(0.009)
International trade status		
Only exporting	0.343***	0.261***
	(0.034)	(0.030)
Only importing	0.512***	0.442***
	(0.068)	(0.067)
Two-way trader	0.872***	0.660***
	(0.078)	(0.078)
X-suppliers		
1st rank	0.230***	0.223***
	(0.028)	(0.028)
2nd rank	0.142***	0.139***
	(0.033)	(0.033)
3rd rank	0.109**	0.111**
	(0.049)	(0.050)
M-customers		
1st rank	0.311***	0.291***
	(0.067)	(0.066)
2nd rank	0.295***	0.289***
	(0.066)	(0.065)
3rd rank	0.175**	0.179**
	(0.075)*	(0.075)*
Number of …		
destination markets	-	0.042***
		(0.005)
destination markets squared	-	-0.002***
		(0.000)
sourcing markets	-	0.025***
		(0.009)
sourcing markets squared	-	-0.002**
		(0.000)
domestic customers	-	6.1E-05***
		(2.1E-05)
domestic customers squared	-	-5.9E-10***
		(1.8E-10)
domestic supplier	-	0.002**
		(0.000)*
domestic supplier squared	-	-3.8E-07***
		(1.0E-07)
Financial participations		
Member of a Belgian group	0.194***	0.184***
	(0.018)	(0.017)
Belgian multinational	0.132	-0.012
	(0.031)	(0.028)
Belgian affiliate of a foreign multinational	0.553***	0.471***
	(0.037)	(0.044)
Time dummies	YES	YES
Sector dummies	YES	YES
R²	0.302	0.311
N	1,181,027	1,181,027

Note: Explained variable: TFP (in logs), estimated using the Wooldridge LP estimator.

Standard errors are clustered at the sector level (NACE Rev 2 classification at two digits). ***, ** and * coefficients are respectively significant at the 1 per cent, 5 per cent and 10 per cent level. The sample covers the 2002-2014 period.

tivity ranking according to the distance to export markets. Here we extend this type of analysis by also controlling for distance to import markets and other firm characteristics (firm size, number of customers, number of suppliers, number of destination markets, number of sourcing markets, etc.). Distance to foreign markets is computed considering the number of relevant transactions. The numbers of customers/suppliers/destination markets/sourcing markets are also evaluated considering only the relevant transactions.

While we cannot interpret the results presented in Table 4 as causal relations because of endogeneity issues between TFP (in level) and some of our explanatory variables, we still observe significant correlations between efficiency and our control variables.

As commonly observed, within NACE 2-digit sectors, the most productive firms tend to be the largest ones. They also tend to be more deeply integrated into the global economy. Two-way traders are the most efficient firms in the Belgian economy, followed by firms that only import and then firms that only export.

Firms that are active on international markets are followed in the productivity ranking by 1st rank M-customer and 1st rank X-supplier. We observe a clear productivity ranking based on the two distances to foreign markets. M-customers that are closer to foreign inputs are more efficient, reflecting their potentially greater ability to source better inputs (Dhyne and Duprez, 2017). Similarly X-suppliers that are closer to foreign demand are more efficient. As the productivity premium is higher for importers than for exporters, we find the distance to imports has a greater influence than the distance to exports.

The less efficient firms are those which are more than four transactions away from the foreign markets. These firms suffer a productivity handicap of 67 per cent in comparison to the most efficient ones.

Total factor productivity also seems to be related to the number of transactions a firm is able to engage in. Among the exporting firms, serving more markets increases efficiency. Similarly, sourcing inputs from more markets is related to higher efficiency. The marginal effect of the number of destination or sourcing markets declines but remains positive in the observation range in our sample.

A positive (non-linear) relation is also observed between efficiency and the number of domestic customers and domestic suppliers but the impact of these local transactions on efficiency is much more limited than the impact of international transactions.

Finally, as expected, firms that are members of a Belgian or a foreign group tend to also be more productive. Foreign affiliates of multinationals have the largest productivity premium.

Concluding Remarks

The purpose of this article has been to provide some facts about the degree of integration of the Belgian economy into global value chains and to describe the organization of the domestic production network.

Using a unique dataset that makes it possible to observe domestic or international transactions involving at least one Belgian firm, we find that most Belgian firms have a limited number of domestic suppliers or domestic business customers; most of their domestic transactions are local; and larger and more efficient firms are able to manage larger customer or supplier portfolios.

In terms of GVC participation, we find that, even if the share of directly exporting or importing firms is small in the Belgian production network (between 2 and 5 per cent of Belgian VAT affiliates), Belgian firms require on average between 2.6 and 3.4 transactions to serve foreign

demand and between 2.1 and 2.6 transactions to source foreign inputs. Only one-third of Belgian firms are totally disconnected from demand from the rest of the world. This share does not vary by destination countries, but firms that can export indirectly need more transactions to reach more remote and less important foreign markets. We also find a clear productivity ranking of Belgian firms according to their closeness to foreign markets.

These results have a number of important policy implications. First, they illustrate the potential damage associated with rising protectionism. Our findings suggest that restraining imports would not only hamper direct importers but almost the entire production network as well.

Second, the results could also affect the way policy-makers should address the competitiveness issue. Because exporters or importers are essential for the integration of an economy into global value chains, the economic debate on the competitiveness of a country has mostly focused on changes in its exporters' competitive position.[14] However, focusing only on the competitiveness of the exporting/importing firms does not seem to be sufficient in itself to assess the competitiveness of an economy.

Third, it is also important to look at the firms that are indirectly connected to international markets. These firms tend to lag behind in terms of technological efficiency. As described in Andrews *et al.* (2016), their technological gap has tended to widen during the recent period, jeopardizing their ability to survive and flourish in the global value chains. Evidence based on the CompNet Database (Compnet, 2014) also suggests that, when Belgian firms are compared to their German or French counterparts, it was the less efficient Belgian firms that suffered a sharp

deterioration in their competitiveness over the 1998-2011 period, being unable to offset the increase in labour costs with productivity gains (National Bank of Belgium, 2013). This may push more firms out of the internationally integrated value chains and have a negative long-run impact on the growth potential of the Belgian economy, as trade and especially international trade can serve as a vector of technological spillover.

This article also points out the potential for new information from the analysis of production networks. This type of data allows a better understanding of the exposure of an economy to external shocks and how shocks propagate throughout the economy. It also challenges the way we measure productivity, raising the issue of production boundaries and how they affect our measures of performance.

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14 In the public debate, imports are mostly considered as harmful for domestic producers. However, imports as a source of better quality inputs for domestic producers is also a key determinant of the competitiveness of an economy.

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