Competition and product mix adjustment of multi-product exporters: Evidence from Belgium

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by Koen Breemersch

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Abstract

This paper studies the effects of competition in a destination market on the product sales distribution of Belgian multi-product firms using the framework of Mayer et al. (2014). We show that in high competition markets multi-product firms export relatively more of their core products thus skewing the sales distribution towards the best-performing varieties of the firm. A calibrated fit indicates that the general productivity effects that are associated with this skewness reaction are potentially large as firms adjust their production process to accommodate the increased demand for its core products. The skewness effect of high competition markets is only observed for products that the firm eventually drops, underlining the importance of the product extensive margin adjustment. The effect is not limited to manufacturing firms, but also extends to intermediaries in trade and is shown to depend on the type of good that is exported.

JEL classification: JEL D21, F14, F41, L11

Keywords: international trade, multi-product firms, competition, product mix

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1 Introduction

Heterogeneity has a pivotal role in international trade. While the heterogeneous nature of firms can explain why some export and others do not, differences in the efficiency with which the products of a single firm are manufactured, imply that a firm does not export equal quantities of all products to all destinations. Rather, the sales of a firm in a destination market are often highly concentrated in a few core products Arkolakis and Muendler (2010). Given that the level of competition in a destination market allows only the most productive exporters to export their top products, a natural question then arises as to how the level of competition in a destination market might affect the sales distribution of the multi-product exporters.

In this paper, we assess this question using data on Belgian multi-product exporters. We use proxies for the level of competition in the destination market to uncover the effects of competition on the sales distribution of an exporter. We find that more competitive destination markets induce increased skewness of the product sales distribution of exporters. In other words, the firm's best products sell relatively more. For instance, a ten percent increase in destination market size increases the skewness of the export sales distribution of the best performing products of Belgian multi-product exporters by 0.35 to 0.84 percent. We also assess the relevance of these effects for the domestic economy. When the best performing products of a firm are also the ones in which the firm is most productive, then any increased skewing of the product sales distribution that results from exporting to a more competitive destination market will increase the productivity of the firm. This flows naturally from the fact that a firm needs to adjust its production process to accommodate the increased demand for the most productive, core goods of the firm. It will do so by assigning relatively more production factors to the production of its most efficient products. Hence, the effects of foreign competition on the sales distribution of exporters represents a channel of transmission by which changes in foreign competition could influence the domestic economy. We show that the aggregate productivity effects for the domestic economy can be potentially sizable as a doubling in size of the destination market corresponds to a 5.6 to 16.3 percent productivity difference for the product mix exported to that destination market. We also present novel evidence that the skewness effect is a short-term result of longer term adjustment on the product extensive margin. If we control explicitly for product churning in subsequent years, we do not find proof that a skewness effect exists.

Our paper thus offers corroborating evidence to the findings of Mayer et al. (2014) for French multi-product exporters. The model presented by Mayer et al. (2014) forms the theoretical underpinning that is the backbone for our empirical approach. In the model, a firm can produce one product at a core cost, but for each product that the firm wishes to add to the product range it will incur additional costs, thereby raising the price of those products. The cost structure of the firm's products will then resemble a ladder, where each additional product is at a higher step to the one before. By introducing this heterogeneity between the products of the firm, the model puts a limit on the number of products a firm can profitably produce. As consumers in more competitive destination markets are more price sensitive, they will buy relatively more of the cheaper core goods of the firm compared to the pricier goods. Demand will thus skew the sales distribution of the firm even more towards its most efficient, low price products in its product range.

This paper also contributes to the literature by offering further detailed regression results and look at the product competence ladder of a firm over time to account for product switching (Bernard et al., 2010). We document the interaction of the selection effect along the product extensive margin and the product sales distribution of the firm and find that the rank of a product is highly correlated over time. However, firms simultaneously discontinue the exports of a product to a specific destination or drop the product altogether from their export product range. Our regression results show that this product switching plays an important role in establishing the competition effects on skewness. If we limit our sample to those products that are consistently exported to a specific destination market over multiple years, we find that there is no competition effect on skewness. Hence, the skewness result manifests itself as a consequence of product switching by the firm. We also show that the competition effect on skewness is not a phenomenon purely limited to manufacturing firms, but also occurs in the exports of intermediaries in trade. Suppliers of these goods are therefore indirectly exposed to the competition effect. The size of the competition effects and the channel through which the competition manifests itself also differ according to the type of good that is exported. For intermediate products that play an important in Global Value Chains, the free access to a market is important in causing skewing of the sales distribution whereas for consumer goods the market size is found to be more important.

The estimated productivity effects further highlight the importance of multi-product firms in international trade established earlier by other studies (Arkolakis and Muendler, 2010; Bernard et al., 2011b; Eckel and Neary, 2010; Iacovone and Javorcik, 2010). Bernard et al. (2011b) note that the addition of within-firm differences across products is quantitatively of similar importance as the traditional Melitz (2003) across-firm heterogeneity. Arkolakis and Muendler (2010) observe that only a limited number of core products of the total product scope of Brazilian multi-product firms account for the bulk of a firm's exports to a market. Moreover, those firms with the largest product scope are few in number whereas narrow-scoped firms operating at a smaller scale are much more common. This heterogeneity in product efficiency implies that potential entry costs exist that vary by product and destination, which has consequences for the product and firm extensive margins. Iacovone and Javorcik (2010) empirically investigate the behavior of Mexican exporters. The continuous changes that Mexican multi-product firms apply to their exported product scope are mostly concentrated in fringe products, while the total number of export varieties are kept stable. However, in line with the thesis on the existence of an interaction between trade freeness and within-firm heterogeneity, the core products of the firms respond in a more outspoken way than fringe products to new export opportunities. This heterogeneity has also been found by Bernard et al. (2010) for multi-product firms producing in the United States.

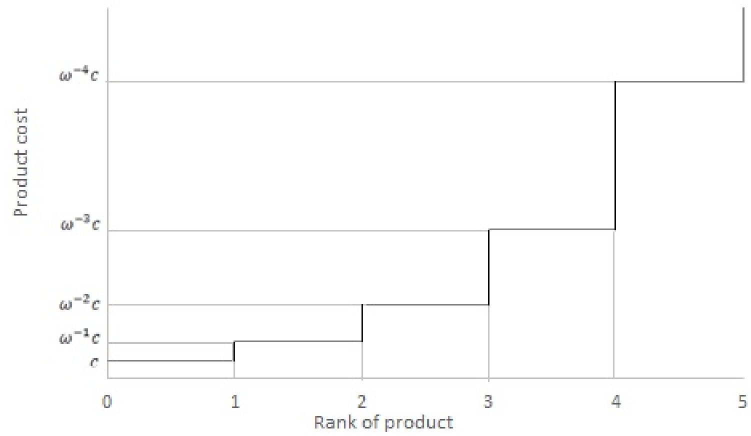
The paper proceeds as follows. Section 2 elaborates on the theoretical foundations of the Mayer et al. (2014) model that shall guide the empirical analysis of this paper. Section 3 will describe the empirical approach that will be followed and the econometric issues that need to be controlled for, while section 4 describes the data. Section 5 provides the results and offers a comparison with the findings of Mayer et al. (2014). Section 6 concludes.

2 Theoretical foundations

The model of Mayer et al. (2014) studies the interesting repercussions of introducing multi-product firms into the Melitz and Ottaviano (2008) framework. On the firm extensive margin, the general implications of the latter model remain intact. A firm is thus assumed to pay an entry cost and receive a core cost draw from a Pareto distribution[1]. If this cost is below the general cost cutoff (or equally, above the general productivity cutoff) of the domestic economy, the firm can successfully

[1]The core cost equally represents the inverse core productivity of the firm.

Figure 1: Product cost structure of multi-product firm with competence ladder



enter the market. The innovation of the model is situated in the ability of firms to bring additional products to market. However, in doing so, the firms incur an increasing customization cost with each product they add to their product range, effectively placing a limit on the number of products the firm can produce. Hence, only the most productive firms will decide to produce multiple products. The core product of the firm is that product with the lowest cost of all products within the firm's product range. By specifying the product range in this way, a competence ladder of the firm's products emerges. The competence ladder is characterized by increasing steps, each of which exhibits the increasing customization costs to the firm from producing additional products upon moving away from its core product. Hence, the existence of multi-product firms with within-firm heterogeneity across all products of its product range arises directly from the specification of the model.

The most productive firms will export to foreign markets. However, the ability to export one's product(s) to different markets is subject to certain restrictions. First of all, for each unit of the product that is shipped from one country to the other, a proportional iceberg trade cost is incurred. This raises the cost of selling a product on a foreign market compared to selling it on the domestic market. Secondly, the destination market equally has a cost cut-off, above which the product(s) of the firm cannot be profitably sold.

Within the model of Mayer et al. (2014), measures of economic geography and market size can directly be linked to the cost cutoff of a destination market. Favorable economic geography and large market size increase the productivity cutoff (or decrease the cost cutoff) and raise the level of competition in the (destination) market. On the extensive margin, a more competitive environment will push down the mark-ups a firm can charge and lead to the exit of the least efficient products. On the intensive margin, a firm's sales will become more skewed towards the best performing, core varieties. The adjustment along the intensive margin results from a mechanism operating along the demand-side of the economy. A higher productivity cutoff raises the number of varieties traded in a country and lowers average prices, thereby increasing the price elasticity of demand. Differing elasticities of demand across markets makes demand in high elasticity/high competition markets shift demand towards the product closest to the core competence of a firm through two channels. First, high levels of competition in destination markets, brought about through favorable geography (low transport costs) and a large market size, increase demand elasticities, yielding an increase in consumer demand for the (lower priced) core goods. Secondly, the markup of a variety closest to the core competence of the firm is greater than the markup of other varieties further away from the core product and thus able to react more forcefully to changes in competition. Relative prices between the core product and lower ranked products thus decrease in destination markets with higher competition. This process flattens the price distribution of the firm. The price effect leads to a further increase of the quantity sold of the good closer to a firm's core competence as compared to the good that is further away from the firm's core competence.

As skewness of the sales distribution is affected by the degree of competition in the destination market, the overall organization of the production process of the firm is adapted to meet the requirements of the skewed demand structure. When a firm is more efficient in the production of a good closer to its core competence, the increase of the skewness of a sales distribution in a destination market leads to relatively higher concentration of the production factors in the production of the higher productivity good. The within-firm reallocation effect increases the firm's overall productivity as the output per worker increases. This process has clear repercussions for productivity at the macro-level as the productivity of an economy has a direct relationship with the productivity cutoff. This link between the micro- and the macro-level ensures the existence of overall productivity gains from trade for the broader macro-economy.

In what follows, our paper will focus on providing empirical evidence of the skewness effect of the sales distribution for Belgian exporting multi-product firms. We will do so by studying the reaction of the intensive margin of the firm to changes in the competitive environment as proxied by economic geography variables over all destination markets. Our main research objective is to find proof of whether higher competition in a destination market, as captured by the economic geography measures, affect the skewness of a firm's sales. Hence, we would like to find out in what way the activity of exporters in the foreign market affects the domestic economy in which these exporters operate.

3 Econometric specification

This section discusses the empirical strategy that we will apply in section 5. One of the key challenges in testing the predictions of the Mayer et al. (2014) model is finding satisfactory empirical proxies for market size and economic geography. Although destination market size can be proxied by destination market GDP, other destination-specific geographic variables are less straightforward. Firstly, we shall discuss the chosen measures of economic geography. In a second step, we will discuss the firm-level regression specification that will make extensive use of these geographic and market size variables as proxies for competition.

3.1 Measures of economic geography

The role of geography as a proxy for competition in a particular destination market requires a series of measures capturing different dimensions of geographic diversity between markets. As can be inferred from the discussion of the theoretical model in section 2, transport costs form an important factor of the level of competition in a destination market as they embody the accessibility of the market to foreign firms. In this empirical part, we shall use the Foreign Supply Potential (FSP_h) (Head and Mayer, 2011; Redding and Venables, 2004). This measure forms a proxy of competition in the destination market. It estimates how much trade partners would export to a country h based on the estimates of the bilateral economic distance between that same country h and all its trade partners, on the one hand, and the size of the trade partners, on the other hand[2]. FSP_h can be seen as capturing the favorable nature of the geographic location of a country. If many large supply countries enjoy easy access to the market of a country h it raises overall competition in that market as the goods of all foreign suppliers compete for the consumers of the market of country h. Alternatively, FSP also serves as a proxy for the integration of the country in value chains. If a country is tightly integrated with the surrounding countries, it will automatically obtain a higher Supply Potential value.

A second measure of economic geography that we include in our main specification is an index that captures the bilateral freeness of trade between Belgium and the destination country. It can directly be derived from the gravity equation in two distinct ways[3], but to avoid unnecessary cluttering of the main text we defer this discussion to Appendix B. We simply state here that the index takes up higher values if general Belgian exports enjoy easier access to the destination market. Mayer et al. (2014) argue that the inclusion of this index will function as a control for the bilateral economic distance between the two countries. However, the high degree of correlation between the bilateral trade freeness index and the multi-lateral FSP_h variable suggests that the bilateral economic distance of Belgium to a foreign market serves as a proxy for more general ease of access to that foreign market for all supplying countries. Hence, the trade freeness index itself will capture the competition in a destination market caused purely by how easy it is for foreign exporters to enter the market. If firms enjoy easier access to a market, then more firms will compete in that market. Therefore, the bilateral distance measures proxy for wider ease of access to a certain market for exporters from all countries.

3.2 Firm-level econometric estimation

The skewness of the sales of a multi-product firm can be approximated both as a narrow and broad concept. The narrow concept refers to limiting the analysis of skewness to two products produced by a firm. As a result of asymmetric firm competencies in the production of each product, the sales of each product should react differently to changes in the competition in the destination market. This paper follows Mayer et al. (2014) in constructing the primary skewness measure by computing the rank of all the multi-product firm's products sold within the same a product category code. We opt to define the product category at the HS4 product level since the CN2 level at times contains highly diversified goods. To do so, sales of each product are collapsed at the global level and ranked accordingly. The core product is then determined as the product within a HS4 category sold the most as measured by revenues, whereas the second ranked product would be the second best sold product and so on. In a second step, narrow measures of skewness for each destination market are derived by computing the ratio of the local sales in each destination market of the global first ranked product to the global second ranked product. This ratio shall henceforth be referred to as the global ratio, rr_{lh}^{glob}. To deal with the possibility that within a given HS4 product category,

[2]The size of the trade partners is captured by the exporter fixed effect, (υ_l), of a gravity equation whereas the bilateral economic distance can be expressed in the form of the bilateral trade freeness index.

$$FSP_h = \sum_{h \neq l}^{H} \exp(\widehat{\upsilon}_l) \phi_{lh}^{EST} \tag{1}$$

[3]The structure of the gravity equation and the results are presented in Appendix A.

the ranking of sales diverges across local destination markets, we construct a local analogue to this measure. This local ratio rr_{lh}^{loc} is computed on the basis of local product ranks[4] These measures can be altered to express the skewness of the first best product to lower ranked products, such as the third best product.

We additionally compute three measures of skewness that aim to capture the general skewness of the entire product sales distribution of a firm within a given HS4 and destination. First of all, a Herfindahl ($Herfindahl_{lh}$) index captures the level of concentration of the sales of all the firm's products. Secondly, a Theil index ($Theil_{lh}$ is constructed that measures the entropy and rises with the degree of skewness. Finally, a standard deviation of the natural logarithm of sales ($sd \ln r_{lh}$ is also used[5].

The main regression specification regresses a particular skewness measure, or the logarithm thereof for the narrow skewness measures, on the proxies for competition in the destination market. It is instructive to clearly state the economic intuition behind the inclusion of these variables. GDP_h captures the market size effect that stirs competition among the firms in the market as a consumer has more varieties to choose from in the market. The core varieties of the firm with the lowest prices will then be most attractive to consumers and the skewness of the firms sales distribution will increase as a result. Whereas the trade freeness index ϕ represents the freeness of trade between the exporter and the importer nation, FSP consists both of all bilateral trade freeness measures between the importer nation and all foreign exporter nations, on the one hand, and the size of these exporters, on the other. Both variables therefore relate to the ease of access to the market. If more firms obtain easy access and face low transport costs, they are able to charge low prices in the destination market and competition will be fiercer. The firms best performing and lowest priced products will benefit as these products are most able to attract consumers with their low price. As a result, the skewness of the local sales distribution of the firm increases.

The skewness measures of a multi-product firm's exports are computed based on the ranking of the product sales within every HS4 code in which the firm exports products. Therefore, product sales within the same firm-HS4 combination contain unobserved characteristics that are common among all products. We eliminate this unobserved heterogeneity by applying the within transformation on the firm-HS4 level on all log transformed variables of the regression equation. However, directly

[4] A potential reason for the emergence of discrepancies between the local and the global ranking is the existence of taste heterogeneity stressed by Di Comité et al. (2014). This additional source of heterogeneity arising from the demand side can vary across markets and offers an explanation as to why global and local product ranks are not perfectly correlated. Nevertheless, the next section shall show that the global and local product ranks of Belgian multi-product firms are highly correlated.

[5] Formally, we define the variables as follows:

$$Herfindahl_{lh} = \sum_{m}^{M_{lh}} \left(\frac{r_{lh}(m)}{R_{lh}} \right)^2$$

$$Theil_{lh} = \frac{1}{M_{lh}} \sum_{m}^{M_{lh}} \left(\frac{r_{lh}(m)}{\frac{1}{M_{lh}} R_{lh}} \right) \ln \left(\frac{r_{lh}(m)}{\frac{1}{M_{lh}} R_{lh}} \right)$$

$$sd \ln r_{lh} = \left[\sum_{m}^{M_{lh}} \left(\ln r_{lh}(m) - \frac{1}{M_{lh}} R_{lh} \right)^2 \right]^{\frac{1}{2}}$$

where $r_{lh}(m)$ is the sales of product m in a firm-HS4 combination to country h; R_{lh} is the total sales per firm-HS4 combination; M_{lh} is the total number of products that are shipped in a firm-HS4 combination to destination market h.

regressing any of the resulting measures of skewness on the explanatory variables is problematic as it will lead to downwardly biased standard errors (Wooldridge, 2006)[6]. Therefore, we apply the Random Effects (RE) estimator at the destination country level to account for the correlated error component structure (Wooldridge, 2006).

The final regression equation is of the following form

$$\ln(y_{Bel,h,i}) = \beta_0 + \beta_1 \ln(GDP_h) + \beta_2 \ln(FSP_h) + \beta_3 \ln(\phi^{RES}_{Bel,h}) + \varepsilon_{hi} \tag{2}$$

with $y_{Bel,h,i}$ representing the narrow skewness measure of a manufacturing firm i in Belgium (Bel) exporting to country h, FSP_h is Foreign Supply Potential of country h and $\phi^{RES}_{Bel,h}$ is trade freeness between Belgium and destination market h. ε_{hi} is the idiosyncratic error term. To obtain proper estimates, the regression specification with broad skewness measures is augmented by including two polynomials of the number of local products sold by the firm within the given HS4. In this way, we account for the influence of the product extensive margin on the broad skewness measure.

4 Data

The firm-level regressions require a number of different data sets as input. The panel of firm-product level export data available from the National Bank of Belgium constitutes the main source and provides the necessary data to derive the skewness measures. The export data are reported on CN 8-digit level, where the first six digits of the CN8 code consist of the international HS6 codes, whereas the two digit suffix is specific to the European Union. Transactions that do not constitute a transfer of ownership with compensation, such as transit trade, repair of goods, etc. are excluded. In the main text, we use the data for the single cross-section year 2003. Next, the export data are matched with accounting information on the firms available through the Belgian Business Registry of the National Bank of Belgium. The information in this data set allows for the identification of the NACE sector activity code. In the model of Mayer et al. (2014) the increased skewness of the sales distribution in the more competitive destination markets, has a positive effect on the productivity of firms that produce their own products. This results from the fact that these manufacturers are forced to produce a higher quantity of their core products in which they are most efficient. In the main section of our results, we therefore limit the scope of our sample exclusively to firms whose primary activity is manufacturing. In this way the presence of intermediaries in trade is accounted for (Bernard et al., 2011a). By purposely ignoring these firms, a significant amount of trade with lower-income countries is potentially eliminated as the mode of export generally depends upon the contracting environment in the destination market. We also exclude a second group of firms that are involved in FDI transactions in our main specification. The work of Helpman et al. (2004) indicates that firms must make proximity-concentration tradeoffs and decide whether to export from the current location and incur a variable trade costs or invest in local production capacity. The inclusion of these firms in our dataset would distort our estimates as the plants located in Belgium might only serve those markets not served by other plants of the same firm. Since both multinationals and intermediaries in trade represent the majority of trade, we shall also present

[6]The reason for this bias is that different firms export to the same country and this will create an error-component correlation structure among the exports of these firms. Resolving this issue through clustering is not a possibility as the level at which we would like to cluster, i.e. the country level, is not nested withing the level of the fixed effects, i.e. the firm-HS4.

estimates where the multinational status of the firm is controlled for and estimates with a sample limited to intermediaries in trade[7].

The final dataset of manufacturing firms neither receiving or performing FDI consists of 4,796 Belgian firms exporting to 198 countries a total set of more than 6,000 different products.

Table 1 reports the distribution of the number of exporting firms according to the number of products that the firm exports and the number of countries whereto the firm exports. Multi-product firms are ubiquitous and constitute 74.2 percent of all manufacturing exporting firms. In general, the product range of these firms is not spread over a great amount of products, as 71.3 percent of all multi-product firms export at most 10 products. Belgian multi-product exporters also export to a wider range of countries than do single-product exporters, witness to this phenomenon is the increasing range of countries to which any firm exports as it simultaneously exports an increasing range of products.

Table 1: Percentage of exporting firms in 2003 according to number of exported products and number of destination markets

	Number of countries exported to						
Number of products	1	2 to 5	6 to 10	11 to 20	21 to 50	50+	Total
1	16.6%	7.0%	1.6%	0.5%	0.1%	0%	25.8%
2 to 5	6.4%	17.7%	6.7%	3.5%	1.0%	0%	35.4%
6 to 10	0.8%	4.9%	5.7%	4.1%	1.8%	0.2%	17.5%
11 to 20	0.5%	2.7%	3.2%	3.5%	2.8%	0.2%	12.8%
21 to 50	0.1%	1.2%	1.5%	1.8%	2.0%	0.3%	6.9%
More than 50	0.0%	0.4%	0.2%	0.5%	0.5%	0.1%	1.6%
Total	24.4%	33.9%	19.0%	13.8%	8.2%	0.7%	100%

Table 2 bears evidence of further heterogeneity among the group of manufacturing exporters. It shows the importance of each group in total aggregate exports. Although single-product exporters constitute 25.8 percent of all exporters, the value of their exports represents a mere 5.6 percent of the total value of all Belgian manufacturing exports. This underlines the importance of multi-product exporters as the value of exports is highly concentrated among such exporters. Furthermore, a small fraction of firms is responsible for a high fraction of the total relative exported value in line with evidence on exporters in other countries. Firms exporting to more than ten countries represent 22.7 percent of all exporting manufacturers, but make up 61.5 percent of the total exported value by that same group of firms.

The link between the global rank and the local rank offers a measure of persistency of the general ranking across markets. It also serves to ease worries that the theoretical concept of the competence ladder has no clear empirical counterpart at the destination market level. The overall spearman rank-correlation between these two rankings is 0.75 and suggests that there is a consistent ranking of the firm's products across destination markets that is generally in line with the ranking based on overall global sales. This therefore lends credibility to the concept of a firm's competence

[7] The number of outliers in our sample in terms of the skewness pattern is generally limited. Nevertheless, we tested the sensitivity of our results to different cutoffs for the skewness measure. In the current analysis, we exclude those skewness measure with a value higher than 10,000. However, lowering this to 1,000 or increasing this to 100,000 does not affect the overall results.

Table 2: Percentage of total value of exports in 2003 by manufacturers according to number of products and number of destination markets served

	Number of countries exported to						
Number of products	1	2 to 5	6 to 10	11 to 20	21 to 50	50+	Total
1	1.4%	2.1%	1.2%	0.5%	0.4%	0%	5.6%
2 to 5	0.8%	6.1%	6.7%	4.8%	2.6%	0%	21.0%
6 to 10	0.2%	2.4%	6.0%	7.2%	6.1%	1.3%	23.3%
11 to 20	0.5%	2.7%	4.9%	7.4%	10.0%	1.1%	26.6%
21 to 50	0.0%	0.9%	1.8%	5.2%	8.7%	2.5%	19.2%
More than 50	0.0%	0.4%	0.3%	0.8%	2.3%	0.7%	4.3%
Total	3.1%	14.6%	20.9%	25.9%	30.0%	5.6%	100%

ladder. Nonetheless, this result could be driven by single-product exporters or narrow-scoped multi-product firms. Bearing this caveat in mind, table 3 imposes further restrictions on this correlation by gradually increasing the minimal number of export market destinations and products exported by the firm. Even as the computation of the correlation is limited to those firms exporting 20 products within a HS4 category to 50 countries or more, the correlation remains highly positive (0.64)[8].

Table 3: Rank correlation reported for Belgian firms exporting at least a certain amount of products to a certain amount of destination markets

	Minimum number of products exported				
Minimum number of countries exported to	1	2	5	10	50
1	0.75	0.70	0.68	0.66	0.64
2	0.74	0.69	0.68	0.66	0.64
5	0.74	0.70	0.68	0.65	0.64
10	0.74	0.70	0.68	0.65	0.64
20	0.74	0.71	0.67	0.64	0.64

It has been documented in the literature that firms simultaneously drop products from and add products to their products range over time (Bernard et al., 2010). A static framework that focuses on the product sales distribution in a single year will neglect this product churning. To evaluate the consistency of the product ranking over time and obtain an indication of both the consistency of the firm product competence ladder and of the degree of adjustment along the extensive margin, we therefore compute the Spearman rank correlation of a product over time. We use the concordance procedure of Bernard et al. (2012) between 1998 and 2003 to obtain consistent

[8]The correlation is higher when one exclusively focuses on the top quintile of high income destination markets compared to the other four quintiles. For the top quintile the correlations shown in table 3 lie within the interval [0.649,0.777]. For the remaining quintiles, the corresponding interval is [0.389,0.607]. As most Belgian manufacturing firms export to high-income countries, the overall correlation structure is for the most part determined by the rank correlations observed in the high income destination markets.

product codes for the entire time frame. Next, we compute the Spearman rank correlation for the product rank in year 2003 and each of the preceding years. Table 4 reports these correlations for the Belgian multi-product exporters and equally shows the fraction of observations that are present both in 2003 and the relevant preceding year. The latter forms an indicator of adjustment along the extensive margin that is taking place in the firm's exported product range. The number of observations shared between 2003 and the relevant preceding year diminishes as the firm, product or country extensive margin changed over time[9]. Overall, it is clear from table 4 that the correlation of the product ranking over time is high, only slightly diminishing over time, lending credibility to the consistency of the product competence ladder. However, the number of shared firm-product observations decreases over time. A more detailed analysis (not reported here) shows that this is mostly due to the fringe varieties of the firm that have high overall churn rates, revealing a potential interaction between skewness and product churning. We shall return to this issue during our econometric analysis.

Table 4: Rank correlation reported for Belgian firms over time

		Preceding year to which ranking 2003 is compared				
		2002	2001	2000	1999	1998
Global rank	Correlation	0.87	0.84	0.82	0.79	0.77
	Shared number of observations	0.60	0.45	0.36	0.30	0.24
Local Rank	Correlation	0.81	0.78	0.75	0.73	0.71
	Shared number of observations	0.59	0.41	0.32	0.25	0.20

Table 5 presents summary statistics on the different skewness measures that form the main variables of interest throughout the empirical analysis[10]. Row 1 and 2 focus on the logarithmically transformed global and local ratio computed at the firm-HS4 level, respectively, of sales of the product identified as the firm's core product relative to the second best performing product. The overall mean of the global ratio is positive, confirming the result from Table 3 that the global ranking corresponds highly to the local ranking. Yet, the breakdown of this perfect rank correlation is also apparent as the minimal value is negative implying that the local sales of the globally best sold product are at times lower than the local sales of the globally second best sold product. The wide interval in which both the local and global ratios vary shows the significant variation among these narrow skewness measures. Rows three to five report summary statistics on the constructed broad skewness measures where $\sigma_{\ln(exp.values)}$ reflects the standard deviation of the log transformed export values of every firm-HS4 combination.

Before proceeding with the presentation of the empirical results, we first consider evidence of the relation between the geographic variables and measures of skewness. The model presented in section 2 has established a firm theoretical relationship between the skewness of a firm's exports and geographic variables that are drivers of the level of competition within a destination market through their link with the general productivity cutoff. This theoretical relationship should manifest

[9] The change in the country margin either implies that the firm has ceased all export activities to the country or has discontinued exports of that specific product to the country

[10] As the computation of skewness requires that the firm's product range consists of at least two products, observations where a firm exports a single product to a destination shall be excluded in the remainder of this paper.

Table 5: Summary statistics for five measures of skewness

	Mean	σ	Minimum	Maximum
$\ln(rr_{lh}^{glob})$	0.779	2.12	-8.994	9.199
$\ln(rr_{lh}^{loc})$	1.341	1.452	0.000	9.199
Theil index	0.241	0.251	0.000	1.845
Herfindahl index	0.608	0.203	0.077	0.999
$\sigma_{\ln(exp.values)}$	1.103	1.034	0.000	6.505

itself empirically as more favorable geography and higher destination market size leads to higher average skewness of product sales for Belgian multi-product exporters. At the country level this entails that the average skewness computed over all firms exporting to that country should be higher than in a country with less competition. Figure 2 conveys the message that a positive relationship indeed holds empirically[11]. This finding does not constitute as such that an individual firm skews its exports depending on the level of competition in the destination market. There is a close relationship between the number of firms exporting to a specific country (the firm extensive margin) and the geographic variables, implying that more Belgian multi-product firms export to these markets. Averaging over all firms at the destination market level thus hides a significant degree of variation along both intensive and extensive margins, hampering the ability to draw conclusions and motivating the use of a micro-econometric analysis.

5 Results

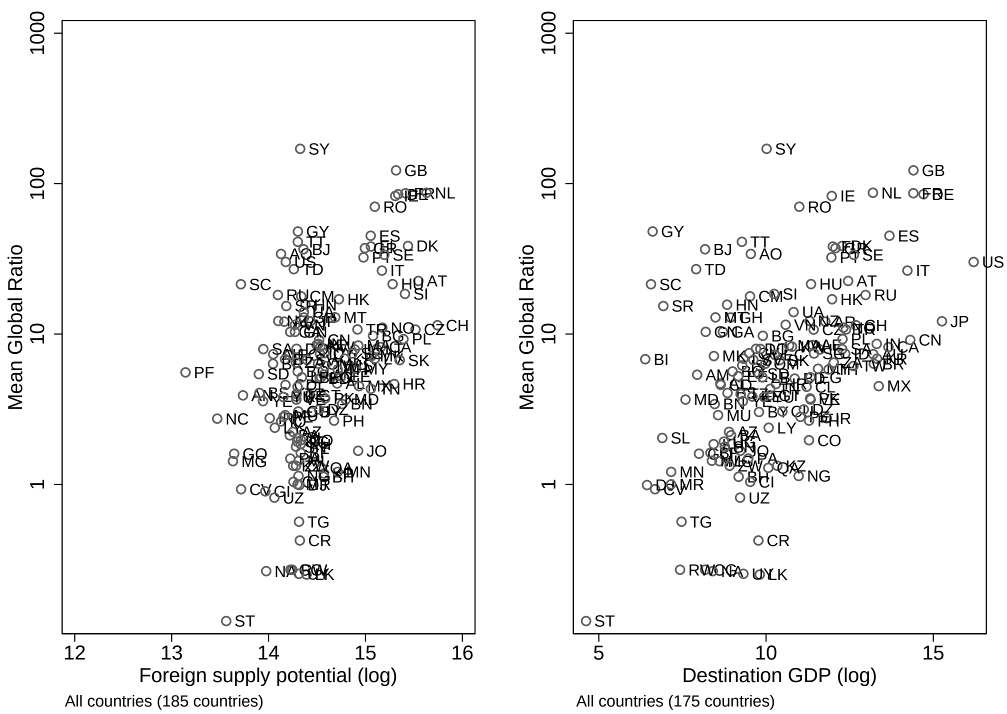
In this section we first discuss the results of the different firm-level regressions. Next, we present the evidence from a calibration exercise to obtain an indication of what these estimates imply in terms of productivity effects. Next we will account explicitly for potential product switching that occurs over time. Finally, we present extensions to the general econometric specification.

5.1 General results from the firm-level regressions

Table 6 presents estimation results of the basic econometric specification expressed in equation (2) where the dependent variables are the two narrow skewness measures that have undergone a logarithmic transformation. The first two columns report results where the dependent variable is defined as the ratio of the local sales of the global best sold product to sales of the global second best sold product (henceforth, global ratio rr_{lh}^{glob}), whereas the last two columns use a similar ratio but now based on local ranking in the destination market (henceforth local ratio, rr_{lh}^{loc}). In column (1) and (3), we abstain from using the trade freeness index $\ln(\phi_{Bel,h})$ directly and instead revert to the inclusion of all bilateral economic distance variables applied in the gravity equation. In column (2) and (4) the regression specification is significantly simplified by using the trade freeness index computed via the residual approach. The results of the Hausman test are presented and show that in every regression there are no systematic differences between the estimates of the fixed effects and random effects regressions. The random effects estimator is thus not only the most efficient

[11] The positive relation persists among different measures of skewness

Figure 2: Relation of GDP and FSP to mean global ratio of all Belgian multi-product exporters



estimator but also equally consistent as the fixed effects estimator[12].

All regression specifications show a significant effect of destination market GDP_h on the increased lopsidedness in the firm's sales of the two core products. Given that both GDP and the dependent variable are in logs, the coefficient of GDP can be interpreted as an elasticity. An increase in destination market size by 10 percent leads to an increased skewing of the firm sales towards the global core product (global ratio) by 0.69 to 0.84 percent compared to its second-ranked product while for the local core product (local ratio) this effect is estimated at 0.29 to 0.35 percent.

Several remarks are in order concerning the results on our geographic variables. The inclusion of the entire set of bilateral economic distance measures is far from parsimonious, motivating the use of a more simplified measure of trade freeness. Moreover, in contrast to the extended set of economic distance variables, the reported coefficient can directly be interpreted as an elasticity of the overall effects of trade freeness. A 10 percent improvement in the bilateral trade freeness index of Belgium and the destination country increases the skewing of a firm's sales by 0.72 percent to 1.44 percent. The independent identification of Foreign Supply Potential is impeded by a high degree of co-linearity in the regressions caused by both the inclusion of the FSP_h variable and the bilateral

[12]Estimates are of similar magnitude if demeaning is performed at the firm-CN2 level rather than the firm-HS4 level.

Table 6: Effects of geography and market size on narrow skewness measures

	$\ln(rr_{lh}^{glob})$		$\ln(rr_{lh}^{loc})^{dm}$	
	(1)	(2)	(3)	(4)
$\ln(GDP_h)$	0.069***	0.084***	0.029***	0.035***
	(0.018)	(0.016)	(0.010)	(0.017)
$\ln(FSP_h)$	-0.247*	-0.168*	-0.159*	-0.105
	(0.144)	(0.097)	(0.093)	(0.069)
WTO	0.264*		-0.008	
	(0.151)		(0.083)	
RTA	-0.006		0.013	
	(0.109)		(0.071)	
col	0.266		0.298**	
	(0.654)		(0.147)	
contig	-0.051		-0.065	
	(0.130)		(0.081)	
comlang	-0.036		-0.167***	
	(0.096)		(0.053)	
comcur	0.241***		0.143**	
	(0.090)		(0.063)	
$\ln(dist)$	-0.120**		-0.115***	
	(0.056)		(0.034)	
$\ln(\phi_{Bel,h})$		0.144***		0.072***
		(0.043)		(0.031)
Constant	-0.008	-0.008	-0.000	-0.000
	(0.023)	(0.021)	(0.010)	(0.014)
Observations	11,961	11.961	14,580	14,580
Within R^2	0.006	0.006	0.004	0.003
p-value Hausman test	0.993	0.280	0.767	0.358

Estimates based on data of the year 2003 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-transformed ratio of the sales of the firm's global core product to the global second-to-core product in country h, rr_{lh}^{loc} is a similar skewness ratio but local sales in market h, rather than global sales, are used to determine core and second-to-core product. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; WTO = both part of WTO; RTA = part of same regional trade agreement; *col* = existence (historical) colonial relationship; *contig* =contiguity; *comlang* = common language among trade partners; *comcur* = common currency; $\phi_{Bel,h}$ = trade freeness index. H_0 Hausman test : The coefficients of the Random-Effects estimator and the fixed-effects estimator are equally consistent.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Robust standard errors in parentheses.

trade freeness index[13]. As stated before, we see the high degree of correlation between the bilateral

[13] Although trade freeness and Supply Potential are two separate concepts, they both derive from the same gravity

distance measure (the trade freeness index) and a multilateral geography measure (FSP_h) as proof that the bilateral economic distance between Belgium and a foreign destination market often reveals the more general multi-lateral openness of a destination market. Given that the general openness of a market nurtures competition, the bilateral trade freeness index can in this sense be seen as a proxy for the level of competition in the destination market. The overall insignificance of FSP in explaining skewness therefore does not undermine the main finding that firms experience increased skewness as a result of strong competition in the destination market.

The results reported in table 6 are in line with the results of Mayer et al. (2014) for French exporters. However, the estimated coefficients differ in size as Mayer et al. (2014) report a coefficient for French multi-product firms of 0.107 for GDP and 0.096 for ϕ when using the same specification as the one reported in column (2) of table 6. Hence, differences in the freeness of access to foreign markets force a stronger reaction of the skewness of the product sales distribution for Belgian exporters. Additionally, for French exporters it is possible to identify the FSP coefficient implying that the mere location of a destination market in economic geography terms influences the skewness of firm sales[14]. In Appendix C, we show that the overall conclusions reached with data for the year 2003 carry over directly to all other cross-sections in the 1998 to 2005 time frame.

Although our analysis of the narrow skewness measure has for now been limited to an analysis of the sales of the two best performing products within a firm's product range ($m = 0, m' = 1$), a similar relationship between the skewness measure and geographic variables is recorded when comparing a firm's third best product to the first best product ($m = 0, m' = 2$). Column (1) of table 7 represents the basic estimates obtained in column (2) of table 6 for the standard definition of the global ratio ($m = 0, m' = 1$), whereas column (2) of table 7 computes a different skewness measure with a firm's core product compared to its third best product ($m = 0, m' = 2$). The comparison between the estimates shows that the coefficient on GDP increases whereas the effect of trade freeness turns insignificant[15].

In columns (3) and (4), the destination markets included in the regression are limited to those countries with GDP per capita higher than the median and the 80^{th} percentile, respectively. Remarkably, we obtain a significant estimate for FSP_h but with an opposite sign to the one we would anticipate. More detailed analysis indicates that this result is highly sensitive to the inclusion of far away markets such as New Zealand and the United States. No satisfactory explanation is at hand to explain this result, but given the strong significance of the bilateral trade freeness measure and the correlation between the trade freeness and the FSP, the FSP variable is most likely picking up something unintended.

In column (5) we control for GDP per capita of the destination market. Bastos and Silva

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equation and there might thus be insufficient variation independent from one another to successfully estimate the two parameters in our main firm-level specification. The estimates of Mayer et al. (2014) are subject to lower correlation between trade freeness and FSP. In an attempt to offer a possible explanation for this apparent discrepancy between our results and those for French firms, we have repeated the estimation of the gravity equation applying log-linearized OLS and obtained a significant reduction in the correlation between trade freeness and FSP (0.47). This finding highlights the sensitivity of the derived geographic variables to the chosen specification.

[14] Belgium, as highest FSP destination market in the dataset of Mayer et al. (2014) and important French trade partner, might play an important role in obtaining overall significance in the results of Mayer et al. (2014) for FSP.

[15] Theoretically, one would ex-ante expect that the effects would be more outspoken when comparing the skewness of the first to the third best sold product in comparison to the first to the second best sold product, given that the assumed productivity differences are larger for the third to the first best sold product. However, a substantial amount of multi-product firms export no more than two products to any given destination, therefore causing a drop in the number of observations when one compares the sales of the first to the sales of the third ranked product. It can be shown that once we control for this difference in the sample, we obtain the theoretically anticipated result.

(2010) find that unit values increase for shipments to higher income per capita countries while the quantity shipped does not significantly vary with destination market income level, indicating higher quality of goods shipped to that market. Hence, the narrow skewness measure may partially pick up differentiation of quality by the firm within its product range depending on the destination market. However, GDP per capita is insignificant and has little impact on the size of the estimated elasticities.

All results that were obtained here do not differ in any discernible sense from those obtained for the local ratio, reported in appendix C.

Table 7: Further analysis of effects geography and market size on global ratio of core product (m=0) to product m' based on alternative specifications

	(1)	(2)	(3)	(4)	(5)
$\ln(GDP_h)$	0.084***	0.132***	0.071***	0.052***	0.083***
	(0.016)	(0.027)	(0.014)	(0.020)	(0.018)
$\ln(FSP_h)$	-0.168*	0.137	-0.263***	-0.322**	-0.171*
	(0.097)	(0.193)	(0.069)	(0.135)	(0.094)
$\ln(GDP/Capita)_h$					0.002
					(0.024)
$\ln(\phi_{Bel,h})$	0.144***	0.078	0.179***	0.186***	0.144***
	(0.043)	(0.068)	(0.039)	(0.048)	(0.043)
Constant	-0.008	0.000	-0.000	0.000	-0.008
	(0.021)	(0.022)	(0.011)	(0.011)	(0.021)
Observations	11,961	3,784	11,544	9,993	11,961
countries	all	all	top 50%	top 20%	all
$\ln(rr_{lh}^{glob})$ $m/m\prime$	$m' = 1$	$m' = 2$	$m' = 1$	$m' = 1$	$m' = 1$
Within R^2	0.006	0.008	0.006	0.003	0.006

Estimates based on data for the year 2003 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-tranformed ratio of the sales of the firm's global core product to either the global second-to-core ($m' = 1$) or third-to-core product ($m' = 2$)product in country h. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $GDP/Capita$ = GDP per capita; $\phi_{Bel,h}$ = trade freeness index. In columns (3) and (4) the included countries are limited to those with GDP per capita higher than the median and the 80^{th} percentile, respectively. Non-reported regressors include polynomials of the number of products exported by the firm.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
Robust standard errors in parentheses.

We now alter the dependent variable to account for the skewness across the entire product sales distribution of the firm rather than the relation between two individual products. In this way, we can see whether the interaction of the competitive environment in the destination market and skewness applies to the entire sales distribution of the firm. Table 8 shows that geography and market size effects equally apply to skewness measures covering the entire product range of a firm[16].

[16]The results in table 8 do not report the polynomials included in the regression to account for potential effects

The coefficient on the effects of the market size confirm the earlier findings that skewness increases when the destination market is larger in size. The geographic remoteness of a destination market generally reduces the skewness measure as competition is less fierce in these markets. This result confirms our main hypothesis that an increase in competition in the destination market increases the skewness of the firm's sales. We will now use the model of Mayer et al. (2014) to obtain estimates of what the implications might be for aggregate productivity in the domestic economy.

Table 8: Broad skewness measures and the effect of destination market and geography

	(1)	(2)	(3)
$\ln(GDP_h)$	0.071***	0.009***	0.016***
	(0.008)	(0.001)	(0.002)
$\ln(FSP_h)$	-0.095	-0.008	-0.016
	(0.062)	(0.009)	(0.014)
$\ln(\phi_{Bel,h})$	0.135***	0.013***	0.022***
	(0.026)	(0.004)	(0.006)
Constant	0.000	-0.001	-0.001
	(0.010)	(0.002)	(0.003)
Observations	14,604	14,604	14,604
dependent variable	$sd \ln r_{lh}$	$Herfindahl_{lh}$	$Theil_{lh}$
Within R^2	0.060	0.158	0.226

Estimates based on data for the year 2003 using the Random Effects-estimator. Dependent variable in column 1 is sd $\ln x$, the standard deviation of the log of sales of all the products in the firm-HS4 pair; in column 2 it is the Herfindahl index of the product sales; in column 3 the Theil index of the product sales of the firm-HS4 pair. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $\phi_{Bel,h}$ = trade freeness index.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
Robust standard errors in parentheses.

5.2 Within-firm reallocation effects on aggregate productivity

In section 2 we discussed the theoretical link between the productivity cutoff of a market and skewness on the basis of the Mayer et al. (2014) model. From an empirical point of view, it is not feasible to estimate the size of this relationship directly as the productivity cutoff has no clear empirical counterpart. The link between the two aforementioned variables therefore has rested on the link between the determinants of the productivity cutoff, the geographic variables and market size included in the regressions, and the skewness measure. The empirical results have thus far confirmed that both trade freeness and destination market size induce changes in skewness in the

of the extensive product margin on the different skewness measures. These covariates are nonetheless always highly significant.

expected manner. Hence, both from the model and the empirical proof, we expect that a shift in the productivity cutoff c_{hh}^{-1}, and therefore the level of competition, of a destination market shifts the sales distribution of an exporter. Assuming that the underlying ranking of products reveals productivity differences, the change in skewness in response to the change in the level of competition will raise overall productivity in the exported product mix of the manufacturing firm. This follows from the reallocation of production factors that the firm must execute in order to accommodate the relatively increased demand for its core products. By using relatively more production factors in the production of core goods in which the firm is most productive, it increases the overall productivity of its operations. As stated earlier, the coefficient of $\ln(GDP_h)$ in table 6 is to be interpreted as an average elasticity that reports the percent change in skewness as a result of a one percent change in destination market size, $\overline{\frac{d\ln(rr_{lh})}{d\ln(GDP_h)}}$.

In appendix D we calibrate the average elasticity of the skewness ratio with respect to the cost cutoff of a market, $\overline{\frac{d\ln(rr_{lh})}{d\ln(c_{hh})}}$. To perform this calibration, we rely on the model of Mayer et al. (2014). By dividing this elasticity by $\overline{\frac{d\ln(rr_{lh})}{d\ln(GDP_h)}}$ we now know by how much the productivity cutoff of a market needs to change in order to get an equivalent change in the skewness of the product sales distribution as a doubling of destination market GDP. To express this in a more succinct way, we have first looked empirically at how the sales distribution of a firm responds on average to changes in the market size and have now found, through calibration, how the same sales distribution responds on average to a change in the productivity cutoff. From these responses, we derive how a change in the market size of an economy translates into a change in the productivity cutoff of that same economy. The added value of this approach is that the theoretical model of Mayer et al. (2014) shows that there is a direct proportional relationship between the change in the productivity cutoff of a destination market and the aggregate productivity of the goods exported to that market. We are therefore able to translate the change in the productivity cutoff of a destination market directly into a change in the aggregate productivity of the product mix exported to that market. In this manner, a doubling of destination market size is found to imply changes in the exported product mix of Belgian firms to that destination market corresponding to a productivity differential of 5.6 percent to 16.3 percent[17]. Hence, the estimated productivity effects that emerge as a result of the increased skewness of export sales distribution of the firms can be substantial[18]. These estimates for Belgian exporters are within the range found by Mayer et al. (2014) for French exporters of 2.56% to 17.3%.

5.3 The effects of product switching

We showed in table 4 that the rank correlation of a product over time remains consistently highly correlated. However, we also found that there were frequent changes over the years in the product range that the firms export. Our empirical setting thus far has not accounted for the existence of

[17]Note that the productivity changes associated with the change in the product sales distribution are specific to the exports to the destination market undergoing the increase in GDP. For the productivity effects to apply to the general economy, GDP of each destination market (including the home market) would need to increase by 100%.

[18]As a word of caution, we note that the results of the calibration exercise depend on assumptions incorporated in the model. If any additional product features, aside from the cost efficiency of the product, determine the initial ranking of the products or the skewness reaction, it is less clear how productivity will react. In such instance, the ranking of the product sales within the firm would not reveal underlying efficiency of the firm in producing the product.

product switching of the firm. It might, however, imply that the observed skewness effect is the result of comparing the sales of a core product to a fringe product undergoing strong declines in sales in high competition markets and dropped by the firm the year thereafter. Hence, we have only looked at our results from a static competition point of view, neglecting the more dynamic feature of product switching. A remaining worry in our approach is that if we were to focus on those observations that are present over the years and that are not subject to product switching, the static skewness effect could disappear. Such a result would mean that the relation between skewness and destination market competition measures that we have established so far, potentially represents the stronger relative decline in sales of the fringe variety in highly competitive destination markets. These fringe varieties are subsequently dropped from the product range. In other words, the observed static effect would actually result from underlying dynamic product switching.

To account for these dynamics, we repeat our earlier analysis but we only keep those observations for 2003 where both the top ranked and the second-best ranked product are sold in both 2003 and 2004, or in both 2003 and 2005 in an alternative specification. If the decrease in the sales of a fringe variety in 2003 is a precursor to the product being dropped in the near future and is entirely driving the competition effect on the skewness of the sales distribution, then dropping those observations should cause the static competition effect to disappear. As before, product codes were made consistent over time through the application of a concordance procedure. Column (1) and (2) of table 9 report the estimates of the competition effect on skewness in 2003 when the two top products of the firm that make up the skewness measure are sold in both 2003 and the following year[19]. Our estimates confirm that product switching is shown to be of importance as the competition effects on the local ratio disappear when only considering the local ratio of products exported to a destination market in both 2003 and 2004. We can interpret the result as a sign that the skewness effect that we pick up in 2003 is an indication of the stronger decline in sales of the fringe variety in highly competitive markets, leading to its eventual dropping from the product range in the following year. The same holds true if we focus on the time frame of 2003 to 2005. A product consistently present in the product portfolio of the firm during this time frame shows no competition effects on skewness for the local ratio in 2003. The results alter when considering the global ratio as this ratio fails to account for product switching at the country level over the years. The results stress the importance of considering a dynamic rather than a static framework in the current context. Assuming the underlying ranking reveals efficiency differences among the products, the continuous product switching still entails productivity gains at the firm level as the lesser efficient product is dropped from the product range.

5.4 Econometric extensions

We have for now not made any clear distinctions between the reaction of the sales distribution to the competitive environment and the type of good that is exported. Although an intermediate product

[19]The distinction between the global and the local ratio is greater importance in this instance. For the global ratio it is sufficient to be exported to any random market in 2004 in order for the product to appear among the global rank of the firm in both 2003 and 2004. Hence, only if the product is dropped entirely from the export product range in 2004, will we exclude the observation from our regression. For the local ratio, which is computed at the destination market level, the product must be exported to the specific destination market in both 2003 and 2004. As the degree of product switching is higher at the individual destination market level than at the aggregate global level, more observations in the regressions of the local ratio are dropped. The local ratio is thus more capable in capturing the product switching effect occurring at the individual destination market level.

Table 9: Skewness effects of destination market competition: Controlling for product switching

Time frame of sale both top products	2003-2004		2003-2005	
	(1)	(2)	(3)	(4)
$\ln(GDP_h)$	0.039***	-0.000	0.038***	-0.008
	(0.013)	(0.012)	(0.013)	(0.016)
$\ln(FSP_h)$	-0.137	-0.085	-0.147	0.039
	(0.098)	(0.068)	(0.104)	(0.093)
$\ln(\phi_{Bel,h})$	0.161***	0.029	0.157***	-0.011
	(0.040)	(0.030)	(0.040)	(0.040)
Constant	0.000	-0.000	0.000	0.000
	(0.015)	(0.015)	(0.016)	(0.020)
Observations	9,899	9,189	8,488	6,468
Dependent var	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$
Within R^2	0.003	0.000	0.003	0.000

Estimates based on data for the year 2003 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-tranformed ratio of the sales of the firm's global core product to the global second-to-core ($m' = 1$) product in country h. Dependent variable $\ln rr_{lh}^{loc}$ is the log-tranformed ratio of the sales of the firm's local core product to the local second-to-core ($m' = 1$) product in country h. Column (1) and (2) refer to the skewness effect of destination market competition in 2003 when the product is also sold in 2004; column (3) and (4) only contains observations where top products are sold in 2003, 2004 and 2005. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $\phi_{Bel,h}$ = trade freeness index. column (1) and (2) presents the estimates for firms partaking in FDI. Columns (3) and (4) present the estimates for intermediaries in trade.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
Robust standard errors in parentheses.

used in the production process of another firm might be exported to the same market as a consumer good, the former might be more sensitive to the trade freeness between two countries as free trade allows the construction of cross-border value chains. It is therefore economically interesting to see whether certain categories of goods experience different reactions to the level of competition in the destination market. We divide our sample into three types of goods, i.e. intermediate goods, capital goods and consumer goods, using the Broad Economic Category (BEC) code that corresponds to the HS6 code of the product. We report the estimates in table 10. The results show that the product sales distribution of capital goods responds the least to destination market characteristics, although observations drop strongly while solely focusing on this type of goods. The sales distribution of consumer goods is strongly affected by the size of the destination market, but whether or not the goods achieve freer access to the market is not as important[20]. In contrast to consumer goods, the skewness of the product sales of intermediate goods reacts strongly to the degree of freeness of trade between two countries, possibly indicating the role of cross-border value chains. Under the theoretical framework of the Mayer et al. (2014) model, this would imply that a firm exporting intermediates to a firm in another country, with whom trade linkages are beneficial, will enter in

[20]By further dividing the consumer goods into a category of durable and non-durable consumer goods, it becomes apparent that the market size effect is especially prevalent among durable consumer goods.

competition with many other suppliers of the same intermediate. As the core varieties of the firm prosper, the fringe varieties will suffer under the strain of competition with better alternatives provided by other firms. Of course, the validity of this explanation is contingent on the existence of substitutability of the inputs by the importing firm.

Table 10: Skewness effects by type of good

type of good	Intermediate		Capital		Consumer	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(GDP_h)$	0.101***	0.020	0.109*	0.052	0.060***	0.048***
	(0.016)	(0.016)	(0.063)	(0.034)	(0.023)	(0.013)
$\ln(FSP_h)$	-0.284*	-0.136	-0.323	-0.126	-0.092	-0.073
	(0.126)	(0.147)	(0.350)	(0.169)	(0.148)	(0.071)
$\ln(\phi_{Bel,h})$	0.222***	0.126***	0.207	0.173**	0.113*	0.038
	(0.052)	(0.046)	(0.150)	(0.075)	(0.063)	(0.027)
Constant	-0.000	-0.000	-0.008	0.006	-0.022	0.000
	(0.013)	(0.017)	(0.061)	(0.035)	(0.045)	(0.015)
Observations	6,119	7,356	748	906	4,152	5,148
Dependent var	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$
Within R^2	0.010	0.004	0.02	0.02	0.004	0.002

Estimates based on data for the year 2003 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-transformed ratio of the sales of the firm's global core product to the global second-to-core ($m' = 1$) product in country h. Dependent variable $\ln rr_{lh}^{loc}$ is the log-transformed ratio of the sales of the firm's local core product to the local second-to-core ($m' = 1$) product in country h. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $\phi_{Bel,h}$ = trade freeness index.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
Robust standard errors in parentheses.

We have thus far imposed substantial restrictions on our data by excluding firms partaking in some form of FDI and by exclusively focusing on manufacturing firms. Given the importance of both sets of firms in overall Belgian trade, it is informative as a stepping stone towards future research to establish if these types of firms equally experience a reaction of their product sales distribution depending on destination market competition levels. Therefore, we first examine the skewness reactions for firms involved in some form of FDI activity. A potential bias in these estimates is possible as horizontal FDI activities would imply that only a limited set of markets is served by the Belgian firm, whereas the remaining set of countries is served by other subsidiaries of the firm in other countries. This would mostly affect the trade freeness measure as firms located in Belgium would choose to serve those locations to which it enjoys the easiest access. We report the estimates in column (1) and (2) of table 11. A comparison with the base specification in table 6 confirms that the trade freeness is lower when only FDI firms are considered.

In column (3) and (4) we examine the skewness results for intermediaries in trade, which we define narrowly by including only retailers and wholesalers not active in the sale and repair of motor vehicles. We find that even for these non-manufacturers there is a clear effect of the product market competition on the sales distribution. The implications of the interactions between the product sales distribution of an intermediary firm and the competitiveness of the destination market reverberate to the suppliers of those products. If the ranking of products effectively reveals underlying productivity differentials between the products, evidence of increased skewness in intermediaries in trade as a result of destination market competition could benefit the productivity of those firms who supply core products to the intermediary in trade. The distribution of the product sales of the original producers to the intermediary will skew in tandem with the sales distribution of the intermediary. Considering the underlying dynamics that we uncovered that seem to drive the static result, the interaction effect of destination market competition with the production sales distribution of intermediaries might also have stronger implications for the firms providing the products to the intermediary. Those firms mostly providing the fringe products of the intermediaries might come to feel the strain of foreign competition strongly through its sales to the intermediary. However, our data lack further detailed information on the provision of goods by different firms to the intermediary in trade to look at this channel in greater detail.

Table 11: Skewness effects in FDI firms and intermediaries in trade

	FDI		Intermediaries	
	(1)	(2)	(3)	(4)
$\ln(GDP_h)$	0.088***	0.039***	0.068***	0.050***
	(0.008)	(0.008)	(0.017)	(0.012)
$\ln(FSP_h)$	0.095	0.065	0.033	0.043
	(0.073)	(0.049)	(0.102)	(0.075)
$\ln(\phi_{Bel,h})$	0.064***	-0.003	0.115***	0.033
	(0.024)	(0.018)	(0.033)	(0.038)
Constant	-0.000	-0.000	0.008	-0.014
	(0.010)	(0.010)	(0.017)	(0.016)
Observations	15,921	19,980	25,425	30,174
Dependent var	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$	$\ln rr_{lh}^{glob}$	$\ln rr_{lh}^{loc}$
Within R^2	0.005	0.001	0.005	0.003

Estimates based on data for the year 2003 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-tranformed ratio of the sales of the firm's global core product to the global second-to-core ($m' = 1$) product in country h. Dependent variable $\ln rr_{lh}^{loc}$ is the log-tranformed ratio of the sales of the firm's local core product to the local second-to-core ($m' = 1$) product in country h. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $\phi_{Bel,h}$ = trade freeness index. column (1) and (2) presents the estimates for firms partaking in FDI. Columns (3) and (4) present the estimates for intermediaries in trade.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Robust standard errors in parentheses.

6 Conclusion

This paper examines the within-firm heterogeneity in Belgian multi-product exporters and finds that the skewness of the sales distribution depends on the level of competition in the destination market. More specifically, multi-product firms exporting to big destination markets whereto Belgian firms in general enjoy easier access, experience a sales distribution which becomes more skewed towards the best performing products of the product range of a firm. Through its exporters, the Belgian domestic economy is exposed to the level of competition in the foreign markets as the production process in the Belgian economy is altered to cope with relatively higher demand for the core goods of the firm in high competition markets. The potential productivity effects of these exposures are shown to be potentially sizable. Based on the results of a calibration exercise, a doubling of destination market size entails a productivity differential within the product range exported by firms to that destination market on the order of 5.6 and 16.3 percent. On the firm-level, we have shown that the phenomenon should be understood from a dynamic rather than the fully static framework of the Mayer et al. (2014) model. The competition effects on the product sales distribution emerge as a result of products in its portfolio that underperform in the high competition markets and are dropped in the following years. Once we only focus on those firms that consistently trade all the products and where no change on the product extensive margin occurs, no static skewness result was found at the destination market level. We have also shown that different types of goods react differently to proxies for the competitive environment. Whereas for consumption goods the market size is the most important competitive factor, for intermediate products it is the freeness of access to the market. Finally, it is shown that the competition effect is not unique to manufacturing firms, but is also witnessed in intermediaries in trade.

Though this paper offers additional empirical proof that within-firm reallocation effects brought about through destination market competition are not limited to one specific country, future research will have to establish the exact drivers that govern the within-firm reallocation effects in multi-product firms. In this regard, this paper has shown that a dynamic framework is needed to account for the effects of product churning and potential changes in the ranking among the firm's top products, thereby invalidating the product ladder as a static concept. Moreover, intermediaries in trade experience a similar competition effect on skewness. The suppliers of these intermediaries will therefore be affected indirectly through these intermediaries in trade. The competitive nature of foreign markets might thus equally affect non-exporting Belgian firms through the goods they deliver to intermediaries in trade.

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A Gravity equation

A.1 Gravity specification

The gravity equation is estimated by using importer and exporter fixed-effects to control for the multilateral resistance terms Feenstra (2004). The fixed effects also eliminate the issue brought on by relatively high trade to GDP ratios, as quasi-transit trade passes through some countries excessively without being produced there (Head and Mayer, 2013). The application of the general log linearized OLS estimation procedure for the estimation of the gravity equation is problematic on several fronts (Silva and Tenreyro, 2006). First, the impossibility to logarithmically transform zero trade flows will lead to a sample selection bias. The addition of a fixed constant to every trade flow to do away with zero flow observations will generally lead to inconsistency of the estimators and is therefore not a valid solution. Second, the variance of the error term ξ of the gravity equation depends on the regressors and will thus be heteroskedastic. This will not only affect the efficiency of the estimator, as is generally the case, but also its consistencySilva and Tenreyro (2006) therefore propose the use of the Poisson Pseudo Maximum Likelihood Estimator (Poisson PMLE). This estimation procedure assigns a similar weight to all observations but must be combined with a robust variance covariance matrix estimator to account for the possibility that the conditional mean is not proportional to the conditional variance. In contrast to the log linearized OLS estimation procedure, the Poisson PMLE permits zero trade flows. In order to ensure that the Poisson PMLE is efficient, it is necessary to analyze the error term and test how the variance of the trade flow relates to its expected value. Specifically,

$$var\left[Y_{hl}|x_{hl}\right] = hE\left[Y_{hl}|x_{hl}\right]^{\lambda} \tag{3}$$

where Y_{ni} represents the trade flow from country n to country i, x reflects the included regressors and λ is the parameter of the Poisson distribution. The MuMa test of Head and Mayer (2013) tests whether λ is significantly smaller than 2, which they find to be a near perfect predictor of a DGP in accordance with the Poisson PMLE specification. Furthermore, a Ramsey RESET test is necessary to detect potential misspecification issues[21].

A wide set of bilateral trade variables are included to embody the economic distance between two trading countries. This set consists of the log of the great-circle distance (*dist*) between the two largest agglomerations of each of the trading partners. Moreover, a significant amount of dummies known to be of importance in establishing the strength of bilateral trade links is included to capture the effects of fixed bilateral distance measures such as common legal origin (*comleg*), common official language (*comlang*), contiguity (*contig*) and historical colonial links (*col*) between the two trading partners. Finally, two variable economic distance measures are included that measure the effects of two trading partners simultaneously being part of the WTO (*wto*) or of a random regional trade agreement (*rta*) (Mayer and Zignago, 2011) . The final gravity equation is of the following form

$$\begin{aligned} X_{lh} &= \exp(\delta_1 dist_{lh} + \delta_2 comleg_{lh} + \delta_3 comlang_{lh} + \delta_4 contig_{lh} + \delta_5 col_{lh} + \\ &\quad \delta_6 wto_{lh} + \delta_7 rta_{lh} + \upsilon_l + \upsilon_h + \varepsilon_{lh}) \end{aligned} \tag{4}$$

[21] Hence, the MuMa test indicates whether the use of Poisson PMLE is warranted. The corresponding null hypothesis states that Poisson PMLE is not the optimal estimation technique. The Ramsey RESET test provides formal evidence of whether the inclusion of non-linear combinations of the regressors have any additional predictive value. The null hypothesis states that the model is correctly specified.

where X_{lh} is the exported value from country l to country h and v_l and v_h represent the exporter fixed effect and the importer fixed effect, respectively.

A.2 Data

The extensive gravity data set of Head et al. (2010) that is constructed on the basis of the IMF's *Direction of Trade Statistics (DOTS).* provides all necessary information to estimate the gravity equation.It covers aggregate bilateral merchandise trade between countries for the 1948 - 2006 time frame and also offers an extensive array of economic distance indicators between any two countries. Head et al. (2010) deal with several issues during the construction of this data set of which the problem of foremost nature is the treatment of zeros and small observations for the trade flows between any two countries. These flows are reported in millions of US Dollars. The IMF reports that accuracy can only be ensured up to one or two decimal places, hence data are rounded to the nearest $10,000. A potential worry is the impossibility to distinguish between 'structural' and 'accidental' zeros, where the former represents the fact that no bilateral trade has taken place whereas the latter is the result of the misrecording of positive bilateral trade flows. Head et al. (2010) provide several examples of such accidental zeros which could lead to biased estimates. Though it cannot be excluded that such misrecording persists even in more recent years, it seems to be a problem of more significant nature in the earlier years of the data set and should therefore offer less constraints for the estimation of gravity equations for the time-frame from 1998 to 2005. GDP expressed in current US dollars is directly available in the Head et al. (2010) data set.

A.3 Results

Table A1 presents the results of the gravity equation for the year 2003 estimated by Poisson PML, where the base specification is reported in column (1). As is noted in the literature concerning Poisson PML estimation of the gravity equation, the coefficient on distance is lower than the one found with standard log linearized OLS estimations. All variables carry the ex ante expected sign, except for common currency[22]. The results of the MuMa test of Head and Mayer indicates that the DGP underlying the data is indeed closest to a Poisson PML. Standard log linearized OLS gravity estimation generally suffers from severe misspecification. The level of misspecification, as tested for by the Ramsey RESET test, is much more subdued for the reported base estimation. Nevertheless, the value is close to the 0.05 threshold, portraying that some caution is warranted. To gauge the implications of this result, two additional specifications were estimated. In column (2) the Poisson PMLE is estimated without contiguity. The elimination of contiguity from the regression specification nullifies the fear of misspecification but this comes at a non-negligible price since an omitted variable bias is affecting the estimates. Such results are therefore problematic and make them an unreliable basis from which to depart in computing the geographic variables. In column (3) the issue is resolved by including only the positive flows which again eliminates all traces of misspecification. Despite the fact that this undoes part of the benefits resulting from the use of Poisson PML as an estimation procedure, it provides a frame of reference for the comparison with the results in column (1). If the presence of misspecification severely influences the

[22]Estimations that go back further in time reveal that the negative effect is more conspicuous in the time frame prior to the implementation of the common currency in the Eurozone, revealing that weak trade between developing countries sharing a common currency is the main culprit of the counterintuitive sign.

estimates, the derivation of the geographic variables Foreign Supply Potential and trade freeness shall be problematic. Upon comparing the coefficients in column (1) and (3), it becomes evident that the majority of the estimates are not affected by this regression specification. Although our main Poisson PMLE estimation in column (1) is only just correctly specified, the robustness of the estimates in a regression specification completely free from misspecification indicates that the estimates can be safely utilized in the computation of FSP_h and ϕ_{lh}. These results provide the basis for estimating the relevant geography variables as discussed in section 3.

Table A1: Results gravity equation

	Poisson PMLE		
	(1)	(2)	(3)
	with contiguity	without contiguity	only positive flows
ldist	-0.731***	-0.809***	-0.730***
	(0.0326)	(0.0339)	(0.0325)
wto	0.558***	0.560***	0.622***
	(0.178)	(0.189)	(0.180)
comlang	0.152**	0.241***	0.150**
	(0.0700)	(0.0732)	(0.0701)
comleg	0.173***	0.187***	0.172***
	(0.0463)	(0.0487)	(0.0463)
rta	0.674***	0.725***	0.670***
	(0.0649)	(0.0646)	(0.0647)
comcur	-0.126*	-0.04	-0.119*
	(0.0694)	(0.0629)	(0.0695)
col	0.0694	0.0966	0.0650
	(0.0883)	(0.0944)	(0.0876)
contig	0.414***		0.418***
	(0.0694)		(0.0693)
Observations	30,578	30,578	20,850
p-value MuMa test	0.00	0.00	0.00
Ramsey RESET	0.053	0.821	0.317

Gravity equation for the year 2003. Dependent variable is export value X_{lh} from country l to country h. *ldist* = linear log of distance between countries; *wto* = both part of WTO; *comlang* = common language among trade partners; *comleg* = common legal framework; *rta* = part of same regional trade agreement; *comcur* = common currency; *col* = existence (historical) colonial relationship; *contig* =contiguity.

H_0 MuMa test : The underlying DGP is not Poisson PML.

H_0 Ramsey RESET test : The regression specification is correctly specified.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Robust standard errors in parentheses.

B Freeness of trade and Foreign Supply Potential

B.1 Technical aspects of freeness of trade computation

Based on our gravity estimates, the computation of the trade freeness variable $\phi_{Bel,h}$ can be performed in one of two ways. One can directly use the estimates of the gravity equation to obtain a log transformed estimated trade freeness index $\phi^{EST}_{Bel,h}$, with subscript Bel reflecting the fact that Belgium is the exporting country and h the destination country. Alternatively, one can reason that trade between any two countries not explained by the fixed effects of importer and exporter, must necessarily be due to the freedom of trade between these two countries. In the latter case, the resulting log transformed trade freeness index $\phi^{RES}_{Bel,h}$ effectively consists of the estimated bilateral economic distance variables and a residual from the gravity equation. The two alternatives are expressed by equations (5) and (6), respectively.

$$\begin{aligned}\ln(\phi^{EST}_{Bel,h}) \quad = \quad & \widehat{\delta_1} dist_{Bel,h} + \widehat{\delta_2} comleg_{Bel,h} + \widehat{\delta_3} comlang_{Bel,h} + \widehat{\delta_4} contig_{Bel,h} + \\ & \widehat{\delta_5} col_{Bel,h} + \widehat{\delta_6} wto_{Bel,h} + \widehat{\delta_7} rta_{Bel,h}\end{aligned} \tag{5}$$

$$\ln(\phi^{RES}_{Bel,h}) = \ln(X_{Bel,h}) - \widehat{\upsilon_{Bel}} - \widehat{\upsilon_h} \tag{6}$$

For inclusion in our main estimation specification, we shall rely on the residual trade freeness, $\phi^{RES}_{Bel,h}$. By effectively using the prediction error of the gravity equation, it is more suited for capturing the idiosyncratic character of a specific bilateral trade relationship. The Foreign Supply Potential measure, FSP_h, is computed on the basis of the estimated trade freeness index, $\phi^{EST}_{Bel,h}$, in compliance with the work of Head and Mayer (2011)

B.2 Empirical results and discussion of the trade freeness index

The trade freeness measures vary according to the chosen method of computation. The residual approach can be seen as more pragmatic in nature since it quantifies the actual state of the bilateral relationship, whereas the estimated approach assumes that bilateral trade relations follow the general gravity equation. This in turn implies that the estimated approach to trade freeness has a much higher correlation to distance (-0.89) compared to the residual approach (-0.62), illustrating that the residual approach assigns more weight to factors other than distance such as historic colonial ties in the case of Belgium. The significant level of correlation (0.80) between the FSP measure and the trade freeness computed with the estimated approach show why identification issues merit the choice for the residual approach to trade freeness for our trade freeness measure in the main regression specification.

C Firm-level regressions over time frame 1998 to 2005

Table C1: Effects of competition in the destination market on narrow skewness measures over the time frame 1998-2005 with geography measurues derived from gravity estimated by PPML

	$\ln(rr_{lh}^{glob})$							
	1998	1999	2000	2001	2002	2003	2004	2005
$\ln(GDP_h)$	0.056***	0.088***	0.082***	0.101***	0.100***	0.084***	0.072***	0.056***
$\ln(FSP_h)$	0.192*	0.118	-0.018	0.016	0.089	-0.168*	0.055	0.143
$\ln(\phi_{Bel,h})$	0.095*	0.134***	0.181***	0.152***	0.110**	0.144***	0.122***	0.137***
Constant	0.000	-0.001	-0.000	-0.000	0.000	-0.008	-0.000	-0.003
Observations	11,208	11,455	11,742	11,863	11,897	11,961	13,119	13,085
Within R^2	0.006	0.008	0.008	0.008	0.006	0.006	0.006	0.007

	$\ln(rr_{lh}^{loc})$							
	1998	1999	2000	2001	2002	2003	2004	2005
$\ln(GDP_h)$	0.037**	0.053***	0.063***	0.047***	0.050***	0.035***	0.033**	0.029**
$\ln(FSP_h)$	0.027	0.038	0.019	-0.039	0.050	-0.105	0.110	0.210***
$\ln(\phi_{Bel,h})$	0.080*	0.080*	0.087***	0.081**	0.072**	0.088***	0.052	0.028
Constant	-0.000	0.000	-0.000	0.000	-0.000	-0.000	0.000	-0.000
Observations	13,763	14,079	14,418	14,461	14,490	14,580	16,090	15,898
Within R^2	0.005	0.006	0.007	0.004	0.004	0.003	0.004	0.004

Estimates based on data for the years 1998-2005 using the Random Effects-estimator. Dependent variable $\ln rr_{lh}^{glob}$ is the log-transformed ratio of the sales of the firm's global core product to the global second-to-core product in country h, rr_{lh}^{loc} is a similar skewness ratio but local sales in market h, rather than global sales, are used to determine core and second-to-core product. GDP_h = destination market size GDP expressed in dollars; FSP_h = Foreign Supply Potential; $\phi_{Bel,h}$ = trade freeness index.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
Robust standard errors in parentheses.

Table C2: Further analysis of effects competition on local ratio based on a different definition of the skewness measure, subgroups of destination countries and including GDP per capita

	(1)	(2)	(3)	(4)	(5)
$\ln(GDP_h)$	0.035***	0.081***	0.024***	0.016	0.028**
	(0.017)	(0.020)	(0.012)	(0.017)	(0.012)
$\ln(FSP_h)$	-0.105*	0.045	-0.177**	-0.149	-0.131*
	(0.069)	(0.142)	(0.076)	(0.103)	(0.069)
$\ln(GDP/Capita)_h$					0.020
					(0.019)
$\ln(\phi^{RES}_{Bel,h})$	0.072***	0.057	0.096***	0.077*	0.074**
	(0.031)	(0.052)	(0.034)	(0.043)	(0.031)
Constant	-0.000	0.000	-0.000	-0.014	-0.000
	(0.014)	(0.027)	(0.014)	(0.027)	(0.013)
Observations	14,580	5,158	13,920	11,814	14,580
countries	all	all	top 50%	top 20%	all
$\ln(LocalRatio)$ $m/m\prime$	$m = 0/m' = 1$	$m = 0/m' = 2$	$m = 0/m' = 1$	$m = 0/m' = 1$	$m = 0/m' = 1$
Within R ^{2}	0.003	0.006	0.002	0.001	0.003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D Evidence on the product competence ladder

The theoretical assumption of the existence of a competence ladder with increasing step size has been imperative in establishing the theoretical background supporting the empirical findings. Varieties closer to the core should be expected to serve more destination markets compared to varieties at a further distance from the core competence. Since the cost of the core variety is further away from the choke price p_h^{max} in a destination market h than a product incurring adjustment costs $(\omega^{-m} - 1)c$[23], the core product is more likely to be sold in a specific destination market. Figure D1 establishes this fact empirically by mapping the global rank of the product, up to the 10^{th} ranked product, to the number of export market destinations for Belgian firms. The latter variable is demeaned to create comparability across different firms. Two distinct curves are shown. One presents all Belgian multi-product firms, whereas the other curve only focuses on multi-product firms exporting at least ten products within a certain HS4. Since some firms export less than ten products within a given HS4 product category, the graph focusing on all multi-product firms will not account for firm selection. The graph of firms exporting at least ten products corrects for this problem as only the ten top ranked products are reported.

Mayer et al. (2014) show that by regressing the total exports of all firms at a certain rank (or step on the competence ladder) to a certain destination h on the rank m of the product, the obtained coefficient, ϑ theoretically consists of the stepsize ω[24]. To control for destination market characteristics that are inevitably present in the regression specification, the fixed effect estimator is applied. The estimated coefficient ϑ captures the percentage change in sales at the aggregated level($= 100\% * \vartheta$) as one moves one step further away from the core product along the domestic country competence ladder. Computing the rank at firm-HS4 level leads to an estimate for ϑ of -0.490[25]. The decrease can partially be assigned to firm selection issues, where a significant number of firm-HS4 combinations consist of only a minor number of products[26].

We can now use these estimates as a basis for the assessment of the productivity effects in the main text. Mayer et al. (2014) show that the average elasticity of the narrow skewness ratio, rr_{lh}, with respect to the cost cutoff c_{hh}, $\overline{\frac{d\ln(rr_{lh})}{d\ln(c_{hh})}}$, is a function of the factor ω, which determines the adjustment costs for an extra product, and the factor k, the shape parameter of the Pareto function. By making use of empirical estimates in the literature for values of k and deriving an estimate for ω, the expression for $\overline{\frac{d\ln(rr_{lh})}{d\ln(c_{hh})}}$ offers the possibility to compute a calibrated fit of the elasticity of skewness with respect to the productivity cutoff. Corcos et al. (2012) have obtained an average estimate of $\widehat{k} = 1.79$ for European firms across different sectors. We have just shown that the percentage change in the aggregate Belgian export sales as we move one step down the

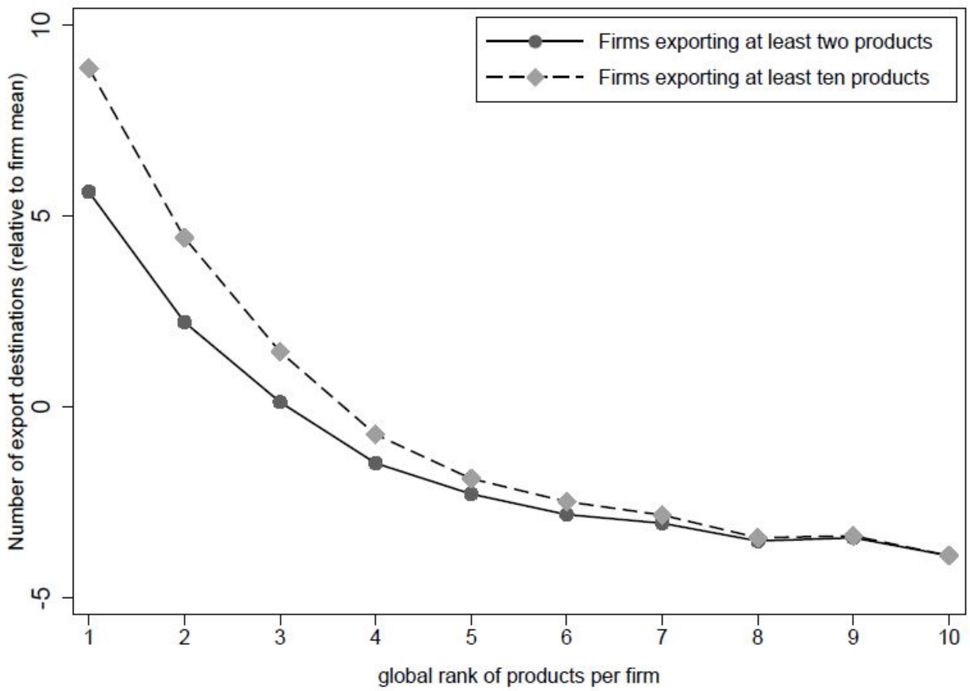
[23] Notation follows the model of Mayer et al. (2014). ω^{-m} is the geometrically increasing adjustment cost, with m reflecting the the distance of a product to the core variety ($m = 0$). ω is the stepsize on the competence ladder or, put differently, the multiplicative adjustment cost a firm needs to incur in order to produce a product. c reflects the core cost of the firm.

[24] More concretely, the slope is equal to $k \ln \omega$ with k representing the shape parameter of the Pareto function. We use the same variables as Mayer et al. (2014) so that the interested reader can directly retrace any unclear steps to the model in that paper.

[25] When the sample is limited to firms exporting at least 15 products within a given HS4, the coefficient decreases from -0.490 to -0.246. Moving a step further away from the core competence within the firm-HS4 combination therefore decreases sales by 24.6 percent for firms with 15 products within the same HS4.

[26] From a theoretical viewpoint, the decrease in the coefficient could also partially exhibit an increased degree of flexibility of multi-product firms in adding products to its product range with larger product ranges. It is nevertheless empirically not possible in the current framework to adequately separate the firm selection issues from the variability of adjustment cost factor, ω.

Figure D1: Number of destination markets for product (demeaned at firm level) depends on rank of product within same HS4 product category



product competence ladder equals −49.0%. Within the framework of the Mayer et al. (2014) model this estimate equals $\widehat{\vartheta}(= k \ln \omega)$. Using the value for $\widehat{k}$, we can therefore recover an estimate for $\widehat{\omega}$ which equals 0.760. By using these values for $\widehat{k}$ and $\widehat{\omega}$, we find that for Belgian firms the absolute value of the elasticity equals 0.514, which is near the lower bound of the 0.635 and 2.34 interval Mayer et al. (2014) obtained for France[27]. Hence a one percent change in the productivity cutoff of a destination market raises the skewness ratio in that market by 0.514 percent on average.

[27] Mayer et al. (2014) dispose of a wider range of values for $\widehat{k}$ estimated for France in the literature.

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