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The variation of export prices across and within firms

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Abstract This paper uses transaction-level trade data to analyze the differences in export prices across and within Spanish firms exporting manufactures in the 2010–2014 period. The transactional nature of the database uncovers sizable differences in the price that an exporter charges for the same product and destination. These differences are related with the number of goods covered within each product category, the exported quantity per transaction and the number of transactions carried out by firms.

Keywords Export prices · Firm-level transaction data · Heterogeneous firms · Quality · Spain

JEL Classification F1 · F10 · F23

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1 Introduction

The literature has documented large differences across exporters (Bernard et al. 2007, 2012). On the extensive margin, there is ample variation in the number of exported products, the portfolio of destinations and the frequency of transactions across firms. On the intensive margin, there are sizable differences in the export price of a product across firms, and within firms and across destinations (Bastos and Silva 2010; Manova and Zhang 2012; Martin 2012; Harrigan et al. 2015; Görg et al. 2017).[1] In particular, exporters set higher prices in more distant and richer markets.

This paper uses transaction-level trade data to analyze the variation of export prices across and within Spanish firms. The transactional nature of our database uncovers important differences in the export price that a firm charges for the same product in the same destination. For a representative sample of multi-transaction exporters, we find that this new margin explains 23% of the overall variation in export prices.

We test five hypotheses that might explain this new component of the variation in export prices. First, the variation of export prices might be explained by randomness or measurement errors in the prices charged by firms. We expect this randomness to increase as firms carry out a larger number of transactions. In line with this hypothesis, we find a positive relationship between the dispersion of export prices within a firm, destination, product and year, and the number of transactions carried out by firms at this level. Second, even in a highly detailed 8-digit product classification, some categories might cover different goods. We show that within a firm and a destination, product categories that cover more goods have a higher dispersion of prices. Third, firms might find easier to set different prices for differentiated than for homogeneous products. We find a positive relationship between the variation in export prices within firms, products and destinations and product differentiation. However, this coefficient is not precisely estimated. Fourth, firms might charge lower prices for customers that place larger orders. Our empirical analysis confirms this hypothesis, documenting a negative correlation between export prices and quantities for the same firm, product and destination. Finally, following Manova and Yu (2017), we argue that differences in prices can be explained because firms offer vertically-differentiated varieties of a product. This model predicts that (i) more productive firms have a larger dispersion of export prices; and, (ii) the dispersion of export prices is higher in large markets and in markets where the level of competition is lower; and the dispersion is lower in markets that are far away. We do not find support for a positive association between productivity and dispersion of export prices. The results for market size and level of competition are in line with the second prediction. However, the result for distance is not in line with the prediction.

This paper contributes to the literature showing that there are sizable differences in the export price that firms charge for the same product and destination. This new

[1] Previous studies such as Schott (2004), Hummels and Klenow (2005), Hallak (2006), Khandelwal (2010) and Baldwin and Harrigan (2011) analyzed the variation in export prices using country-product-level data.

margin, which is uncovered by the transactional nature of our data, contributes substantially to the overall differences in export prices. We show that this new component of the variation of prices is related to the number of export transactions carried out by firms, the number of goods that are covered within each product category and pricing to customer strategies. We also find partial support for the vertically-differentiated varieties' hypothesis.

The dispersion of prices within firms, products and destinations identified in this paper suggests that firms organize production across detailed product lines, vertically-differentiated varieties and customers' characteristics. These margins provide firms with further opportunities to reallocate resources to their best use in response to shocks. The large dispersion of prices also suggests that the decision to export is not only market and product specific, but also customer specific. In line with this argument, recent empirical evidence shows that export promotion agencies help regular exporters to expand the buyers portfolio in destinations where the firms are already selling (Gil-Pareja et al. 2015). Models of international trade should incorporate this new margin to the understand the differences in exports across firms (Carballo et al. 2013; Bernard et al. 2018).

This paper is related with different strands of the literature. First, it is related to previous papers, such as Bastos and Silva (2010), Manova and Zhang (2012), Martin (2012), Harrigan et al. (2015), Görg et al. (2017) and Manova and Yu (2017) that use firm-level data to explain the differences in export prices across and within exporters. We add to this literature showing that differences in prices within a firm and a destination is an important source of variation in export prices. The paper is also related to theoretical and empirical papers which argue that firms compete in quality (Verhoogen 2008; Baldwin and Harrigan 2011; Crozet et al. 2012; Johnson 2012; Kugler and Verhoogen 2012). Our empirical estimations do not show a positive association between TFP and the dispersion of export prices. Our paper also relates to Bernard et al. (2010), Eckel and Neary (2010), Nocke and Yeaple (2014) and Manova and Yu (2017), which analyze multiple-product or multiple-variety firms.

The paper is organized as follows. The next section presents the theoretical models that guide our empirical analyses. Section 3 describes how we combine three different datasets to build our estimation samples. Section 4 performs the price decomposition and highlights the important contribution of the variation in prices within a firm and a destination to the overall variation in prices. Section 5 proposes five hypotheses to explain the new price variation component and tests their empirical validity. The final section concludes.

2 Theoretical explanations of the differences in export prices

To guide the interpretation of our empirical results, this sections introduces, briefly, the main theoretical arguments explaining the differences in export prices across and within firms. Our starting point is the model introduced by Baldwin and Harrigan (2011), where firms compete in quality, and more productive firms are able to produce higher quality goods. In this model, quality is positively correlated with prices.

This positive relationship might stem because high-quality products demand more labor inputs (Crozet et al. 2012), or because they use high-quality inputs (Kugler and Verhoogen 2012). Firms producing high-quality products obtain larger profits than firms producing low-quality products. Therefore, the model predicts that high-productivity firms should produce high-quality products and command higher export prices.

Firms will export if the profits obtained in the foreign market cover the fixed costs of exporting. Profits will be higher the larger the demand in the foreign market, the lower the competition in the foreign market and the lower the transport costs. Since low-productivity firms produce low-quality goods and obtain fewer profits, they will export to large markets, to markets where competition is lower (remote), and to markets that are close to their domestic market. In contrast, firms producing high-quality goods will be able to obtain profits in distant, small and high-competition markets. Hence, we should expect a negative relationship between average export prices and the size and remoteness of the foreign market; in contrast, we should expect a positive relationship between average export prices and distance.[2] Baldwin and Harrigan (2011) provide empirical evidence supporting these predictions. Other papers also show that export prices rise with the importing country's GDP per capita (Hallak 2006). This positive relationship is explained by the higher demand for quality in richer countries.

Recent studies have analyzed the differences in export prices using firm-level export data (Bastos and Silva 2010; Manova and Zhang 2012; Martin 2012; Harrigan et al. 2015; Görg et al. 2017). These studies also find that firms set higher prices in more distant markets. There are two competing explanations for this positive relationship. The first, based on Manova and Yu (2017), is that firms produce vertically-differentiated varieties of a good. In this model, profits are maximized when the firm sells its core variety, which corresponds to the superior quality-variety. Profits are lower for inferior quality varieties, because they have larger (quality-adjusted) marginal costs.[3] Since firms obtain higher profits in high-quality varieties, this model leads to predictions on export prices that are identical to the ones in Baldwin and Harrigan (2011). In particular, they predict a negative relationship between the size, and the remoteness, of the foreign market and export prices; and a positive relationship between distance and export prices. If rich countries demand higher quality goods, we will also expect a positive relationship between firm-level export prices and the GDP per capita of the importing countries (Fajgelbaum et al. 2011). The second explanation is that firms have different mark-ups across markets. Models with variable mark-ups predict that firms should have lower mark-ups in markets where competition is intense, such as large markets; and in markets where trade costs are larger, such as distant markets (Melitz and Ottaviano 2008). Therefore, the

[2] As an alternative explanation, the positive relationship between distance and export prices could stem if transport costs were unitary. This is known as the Alchian-Allen conjecture, which predicts a larger relative demand for high-quality varieties in more distant markets. This prediction has been validated empirically by Hummels and Skiba (2004).

[3] The model is similar in spirit to Eckel and Neary (2010), where firms produce a core product, but can produce other varieties with rising marginal costs.

variable mark-up model predicts a negative relationship between export prices and foreign market size, and between export prices and distance to the foreign market. Note that the first prediction is also shared by the vertically-differentiated varieties' model; in contrast, the second prediction is opposite to the one predicted by the vertically-differentiated varieties' model.

In this paper, we show that firms also set different prices in the same market and for the same product. We propose five alternative explanations for this new price margin. The first explanation relies on the vertically-differentiated varieties' model. If firms obtain larger profits in higher quality varieties, following the same arguments explained above, we expect firms to export a lower range of varieties to distant markets, and a broader range of varieties to larger and more remote markets. If we capture the range of varieties exported by a firm by the dispersion of export prices, we expect a negative relationship between export price dispersion and distance, and a positive relationship between export price dispersion and foreign market size and remoteness. We do not expect any relationship between the dispersion of prices and the GDP per capita of the foreign country. Since more productive firms are able to export a larger set of varieties, we also expect a positive relationship between productivity and the dispersion of export prices.

An alternative explanation is the existence of randomness in the price charged by a firm to a customer, or measurement errors in the export price. In this scenario, we expect a positive relationship between export price dispersion and the number of export transactions carried out by a firm.[4] Since the number of transactions is higher in larger and more remote markets, and lower in more distant markets, this random model also predicts a positive relationship between export price dispersion and market size and remoteness; and a negative relationship between export price dispersion and distance to the foreign market.

The third explanation for the dispersion of prices within a firm, product and destination is that the product category at which we are measuring export prices still covers different type of goods. If the goods included in a product category command different prices, we will observe price variation for the same firm, product and destination. This model predicts that product categories including a larger number of goods should have a larger export price dispersion than product categories including a smaller number of goods. As an additional explanation, we also expect a larger dispersion of prices when a firm exports differentiated products than homogeneous products, since the first category of products allow for a larger variation in quality than the second category (Rauch 1999). Finally, exporters might charge different prices to different customers. There could be different explanations for this behavior: (i) firms might offer discounts to customers that place large orders; (ii) exporters might offer discounts to new customers in order to attract them, or to old customers to reward fidelity; (iii) firms might also charge a lower price if they are selling the product to a subsidiary in the foreign market. In Sect. 5 we will test the empirical validity of these alternative explanations.

[4] We thank a reviewer for suggesting us this alternative explanation.

3 Data

Our database is the result of combining three different sources. The first is the universe of export transactions database, which is elaborated by the Customs and Excise Department of the Spanish Tax Agency. The second source is Bureau Van Dick SABI database, which provides detailed financial and accounting records of Spanish firms that deposited their accounts in the Business Register. Unfortunately, it is not possible to combine directly Customs and SABI because of the lack of a common firm identifier. This handicap is solved by using a third source, the Directory of Spanish Exporting and Importing firms (Directorio), which is elaborated by the Chamber of Commerce of Spain. The Directorio contains both the custom and the fiscal identifier for a sample of regular exporters.

From the Customs database, we get the universe of Spanish manufactures export transactions in the 2010–2014 period. Each export transaction captures an invoice-based exchange between an exporter and importer. If the invoice includes more than a product, it is disaggregated into product-specific transactions. Hence, the Customs database does not capture shipments, but transactions. For each transaction, we know the firm's custom identification code, the product at the 8-digit Combined Nomenclature (CN) classification,[5] the destination of the transaction, the free-on-board (FOB) value in euros of the transaction and the exported quantity (in weight metric and/or units).

Export prices (or unit values) are calculated as the ratio of value over quantity. All transactions report the value in euros and quantity in a weight metric. A third of transactions also provide the number of physical units as an additional measure of quantity. The fact that some products report units suggests that export prices can be better expressed in terms of euros per physical units (i.e. pairs of shoes, number of aircrafts, ...) rather than euros per kilogram (or equivalent). In those cases, we use units instead of kilograms to calculate unit values.

The use of transaction data brings us closer to the actual export price charged by a firm to a customer in a given destination, for a given product in a given year. However, the use of high frequency data also introduces some problems. In particular, as explained by Manova and Zhang (2012), when high-frequency data for export prices are combined with yearly data on destinations, standard errors can be biased downwards. Nevertheless, collapsing the transaction data at annual frequency avoids that problem at the cost of eliminating the richness of price variation within any product-destination for multi-transaction firms, which constitutes the main analysis of this investigation.

Unit value data are prone to outliers, which might bias the empirical analyses. Since outliers are more likely to arise in small transactions, we remove all transactions with a value below 1500 euros.[6] Next, following Méjean and Schwellnus (2009) and Martin (2012), we drop observations for which the unit value is 5 times

[5] An example of an 8-digit product is CN 87120030 Bicycles with ball bearings.

[6] Firms with monthly exports to EU countries below this threshold for a given product are not obliged to report their transactions to the Spanish Tax Revenue Agency.

Table 1 Description of the database, 2010–2014 period

Database variable	Customs All	Customs Multi	Customs + Directorio + SABI multi
Number of transactions	19,464,463	16,542,424	12,499,754
Number of firms	160,714	37,060	13,101
Number of products	8803	7785	7197
Number of countries	183	177	174
Exports (million euros)	817,176	732,418	579,653

higher or lower than the product and firm-specific median unit value in all destinations. We take additional steps to clean the database. Due to their special characteristics, we exclude transactions of petroleum, tobacco and printing products from the database. Since they have a particular status relative to Spain, we also remove export transactions with Andorra and Gibraltar. We also drop transactions with countries for which we cannot obtain some of the data demanded by the econometric analyses.[7] Finally, due to their special geographical situation and fiscal status in Spain, we remove all export transactions from the Canary Islands, Ceuta and Melilla.[8]

Table 1 provides some descriptives of the databases for the whole 2010–2014 period. It reports the number of transactions, that are defined at the firm + product + destination + year level, the number of exporters, the number of different exported products, the number of different destinations and the total export value. The first database, Customs All, includes all the transactions covered in the Customs database after the cleaning process: 19,464,463. These transactions are carried out by 160,714 firms, which export 8,803 products to 183 countries, with a total value of 817,176 million euros.

The second database is denoted Customs Multi. We will use this database to calculate the dispersion of prices within a firm, product, destination and year. To ensure a minimum number of observations at this finely defined dimension, the Multi database only includes transactions that are repeated, at least, 4 times.[9] When we move from the all transactions set (All) to the multi-transaction set (Multi), the number of exporters drops from 160,714 to 37,060. However, the relative reduction in the number of transactions is much lower (from 19.5 to 16.5 million). The Multi sample still represents 90% of all manufacturing exports. This is our main estimation sample.

We link the Customs-Multi sample with SABI, using Directorio as link. The sample is reduced to 13,101 firms, which represent 35% of firms included in Multi. These firms export 7197 different products to 174 different countries, and account for 79% of all manufacturing exports in Multi. We use this sample for estimations incorporating firm-level characteristics.

[7] The required country level data are real GDP, population and bilateral distance. For example, we remove all export transactions with Syria, because we cannot obtain GDP data for this country.

[8] The value of exports lost due to the cleaning process amounts to 9.1% of the initial value of exports.

[9] That is, a firm should have, at least, 4 transactions in the same product, to the same destination, and in the same year.

Table 2 Summary statistics for the median firm, 2014

Trade data in 2014	All	Multi	CDS
Exports (thousand euros)	36	552	769
Products	1	1	2
Countries	1	2	3
Number of transactions	3	24	37
Number of product–destination specific transactions	2	8	9

Table 2 provides some summary statistics of the three samples in 2014, the final year of our period of analysis. We will use 2014 to perform the baseline price decompositions in the next section. The median firm in our main estimating sample, Multi, exports 552,000 euros, one product and serves two destinations. The median firm performs 24 transactions per year, and eight of them belong to the same product and destination. The median firm in Multi exports more, sells the same amount of goods abroad, serves more countries and performs more transactions than the median exporter in the All database. These differences are widened when we compare the CDS sample with the All database.

4 The decomposition of export price differences

This section shows that differences in prices for a given product within a firm and a destination contribute substantially to the overall differences in export prices. To measure the contribution of this margin, we decompose the variance in prices of a product in three components: differences across firms, differences across destinations within firms, and differences across transactions within firms and destinations. Algebraically:

$$\sum_{fdr}(p_{fdr}-\bar{p})^2=\sum_{fdr}(\bar{p_f}-\bar{p})^2+\sum_{fdr}(\bar{p_{fd}}-\bar{p_f})^2+\sum_{fdr}(p_{fdr}-\bar{p_{fd}})^2$$
$$+2\sum_{fdr}(\bar{p_f}-\bar{p})(\bar{p_{fd}}-\bar{p_f})+2\sum_{fdr}(\bar{p_f}-\bar{p})(p_{fdr}-\bar{p_{fd}})+2\sum_{fdr}(\bar{p_{fd}}-\bar{p_f})(p_{fdr}-\bar{p_{fd}}) \quad (1)$$

where p_{fdr} is the price of firm f at destination d in transaction r, $\bar{p}$ is the average price of all transactions, $\bar{p_f}$ is the average price of all transactions by firm f, and $\bar{p_{fd}}$ is the average price of all transactions by firm f at destination d. The first term on the right-hand side captures the variance across firms, the second term the variance across destinations within firms, and the third term the variance across transactions within firms and destinations. The remaining three components are interaction, or covariance, terms.

We calculate Eq. (1) for each CN8 product using 2014 data. We perform the price decomposition without weighting and weighting transactions by quantity. To determine the contribution of each component, we divide each right-hand side term by the left-hand side term.

We present the contribution of each variance component for the median product. First, we perform the analysis for our main estimation sample: Multi. In the unweighted calculation, the across firms component is the main contributor to the differences in export prices: 59%. The second contributor is the across transactions component, explaining 30% of the overall differences in export prices. This result points out that the new component uncovered by the transactional nature of our database contributes notably to the overall differences in prices. The across destinations component only explains 2% of the differences in prices. In the next column, we calculate the contribution of each component weighting transactions by quantity. The across transaction component drops from 30 to 23%. Nevertheless, it still contributes substantially to the overall differences in export prices.

In the CDS sample, our second estimation sample, there is an increase in the contribution of the across transaction component to the overall differences in prices. In the quantity-weighted calculation, differences in export prices within firms, products and destinations explain 29% of the overall differences in prices. In the CDS sample the across firms component contributes less to the variation in prices than in the Multi sample. This is explained by the lower number of firms included in the CDS than in the Multi sample in 2014 (23,426 vs. 8900). Due to the lower number of firms, in the CDS sample there are 1305 products, out of 5714, which are exported by one firm only. In these products the across firm component is zero. In contrast, in the Multi sample, there are 1074 products, out of 6459, exported by one firm only. Therefore, in the CDS sample the contribution of the across firm component in the median product is lower than in the Multi sample.

As mentioned above, the Multi and CDS samples only include firm, product, destination and year combinations that have, at least, four transactions. This selection might lead to a positive bias in the contribution of the across transactions component. To measure this bias, in the first two columns of Table 3, we perform the decomposition of export prices for all the firms included in the Customs database. In the All sample, the across firms component becomes the most important contributor to the variation of export prices, explaining 82% of the quantity-weighted variation. In this sample there are 544 products, out of 7550, exported by one firm only, a lower number than in the CDS and Multi samples. The across destinations component explains 4% of the differences, and the across transactions component 9% of the differences. This lower contribution is explained by the fact that, as shown in

Table 3 Decomposition of the variance in prices

	All		Multi		CDS	
	Unweighted	Weighted quantity	Unweighted	Weighted quantity	Unweighted	Weighted quantity
Across firms	85.1	82.0	59.2	64.7	47.6	51.7
Across destinations	2.0	4.3	1.5	2.7	2.8	4.3
Across transactions	6.2	9.3	30.4	23.2	35.3	29.3

Results for the median product (%), 2014

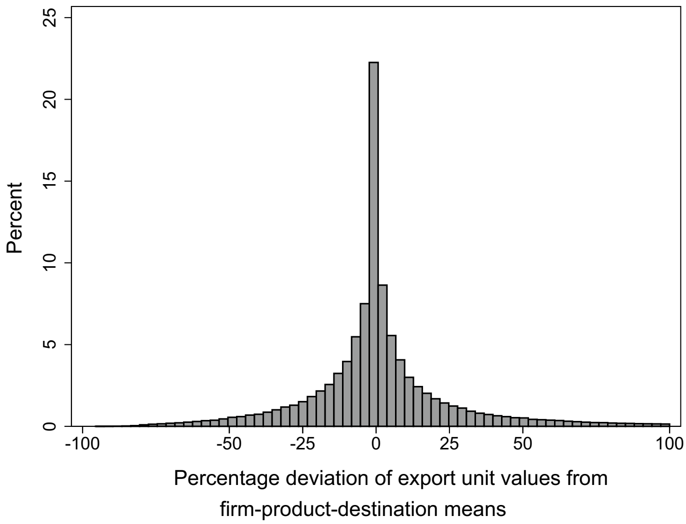

Fig. 1 Distribution of the percentage deviations of export unit values from firm–product–destination means, 2014 (Multi sample)

Table 2, almost half of firms in the All sample perform two transactions per product, destination and year only, so their across transactions component is lower. Although the contribution of the across transaction component is lower in the All sample than in the estimation samples (Multi and CDS), it is still remarkable, given that half of firms only perform two transactions per product, destination and year. Table 7 in "Appendix" performs the price decomposition analysis for the years 2010, 2011, 2012 and 2013. Although there are some small changes in the percentages, the main conclusions are not altered.

Figure 1 shows the distribution of the percentage deviations of export unit values from firm-product-destination averages for the Multi sample in 2014. The figure shows that around 22% of transactions have a deviation close to zero. In particular, 56% of transactions lie in the [− 10, 10%] range; this figure rises to 76% when we widen the margin to [− 25, 25%]; and it rises further to 90 and 97% when the range is enlarged to [− 50, 50%] and [− 100, 100%], respectively.

To sum up, the transactional nature of our database uncovers a new source of price variation, which contributes substantially to the overall difference in export prices, and was hidden in previous analyses. The next section analyzes the reasons that might explain this new price variation component.

5 Explaining the variation in prices within firms, products and destinations

The previous section uncovered that 23% of the variation in prices happens within the same firm, product and destination in the sample of multi-transaction firms. As explained in Sect. 2, an explanation of the variation in prices within a firm, destination and product, is that exporters might charge different prices to different customers. For example, firms might offer discounts to customers that place large orders. Exporters may also offer discounts to new customers in order to attract them, or they can offer discounts to old customers to reward fidelity. Finally, firms might also charge a lower price if they are selling the product to a subsidiary in the foreign market. Our database does not identify the importing firm, so we cannot test most of the hypotheses mentioned above. We can only perform a test for the first explanation, which predicts a negative relationship between unit prices and transaction volumes. To test the validity of this prediction, we estimate the following regression:

$$\ln p_{fdkrt} = \beta \ln q_{fdkrt} + \gamma_{fdkt} + \epsilon_{fdkrt} \tag{2}$$

where p_{fdkrt} is the export price of firm f, in destination d, product k, transaction r in year t, and q_{fdkrt} is the quantity of the export transaction. Equation (2) includes a product, destination, firm and year fixed effect. Hence, the regression analyzes whether larger volume transactions within a firm, product, destination and year have a lower export price. We expect a negative value for the β coefficient.

Table 4, column 1, presents the results of the estimation. As expected, the coefficient for export volume is negative and statistically significant. This result suggests that firms might offer price discounts to customers that place larger orders, contributing to the differences in export prices within firms, products and destinations. However, we should be cautious with this conclusion, since there might be an endogeneity problem when regressing prices on quantities.

A second explanation for the differences in prices within firms, products and destinations is the existence of randomness in the price charged by a firm to a customer, or measurement errors in the export price. If this hypothesis was correct, we would expect a positive correlation between the number of transactions carried out by a firm and the dispersion of export prices. To test this hypothesis we estimate the following equation

$$sdp_{fdkt} = \beta \ln t_{fdkt} + \gamma_{fdt} + \epsilon_{fdkt} \tag{3}$$

where sdp_{fdkt} is the standard deviation of the (log) export prices of firm f in destination d, product k at year t. Note that Eq. (3) includes a firm + destination + year fixed effect. Hence, once we control for firm, destination and year, we analyze whether products with a larger number of transactions have a higher dispersion of prices. We expect the β coefficient to be positive. Table 4, column 2, reports the results of the estimation. As expected, the number of transactions is positively correlated with the dispersion of prices. This result suggests that a share of the dispersion we observe in export prices within firms, products and destinations could be related to randomness or measurement errors.

A third explanation for the dispersion of export prices is that a CN 8-digit product category might still cover different types of goods. If these products have different prices, the new price variation component will capture the mix of products that are sold within each CN 8-digit category. For example, the CN8 code 95051090, Articles for Christmas festivities, not of glass, covers different products, such as artificial Christmas trees, wood ornaments or nativity scenes and figures, that probably command different unitary prices. Since our product categories are those included in the

Table 4 Price dispersion and export quantity, number of transactions, number of products and differentiation

	(1)	(2)	(3)	(4)	(5)	(6)
Volume (ln)	− 0.127***					
	(0.000)					
Number of transactions (ln)		0.023***			0.023***	0.025***
		(0.002)			(0.002)	(0.003)
Ratio of product lines (ln)			0.010***		0.008***	0.014***
			(0.002)		(0.002)	(0.003)
Differentiated product				0.003	0.001	0.003
				(0.005)	(0.005)	(0.007)
Dep.var.	(ln)price	sd (ln)price	sd (ln)price	sd (ln)price	sd (ln)price	(ln)price75-(ln)price25
N.observ	16,542,424	612,411	607,617	612,411	607,617	607,617
Fixed effects	firm*product*cou*year	firm*cou*year	firm*cou*year	firm*cou*year	firm*cou*year	firm*cou*year
Cluster		Product	Product	Product	Product	Product
Adj. R^2	0.981	0.357	0.354	0.353	0.358	0.287

***, **, * Statistically significant at 1, 5 and 10% respectively

CN 8-digit classification, ideally, we would like to know how many different goods are included in each CN 8-digit product category. However, we do not have this information. Hence, our strategy is to compare the CN 8-digit classification with the more disaggregated US HS 10-digit classification. As explained by Pierce and Schott (2009), these classifications have a common 6-digit HS root, but are not comparable at the 8-digit level. Our methodology is to count the number of CN 8-digit products (EU count) and the number of HS 10-digit products (US count) in each HS 6-digit product. Then, we divide the US count by the EU count. For each HS 6-digit product, this ratio measures the extent to which the US HS 10-digit classification is more disaggregated than the EU CN 8-digit classification. If a CN 8-digit product category did not include different goods, we would expect the ratio to be 1. In contrast, if a CN 8-digit classification included different goods, we would expect a ratio > 1. We use this ratio as a proxy for the number of different goods included in a CN 8-digit product category. Note that all the CN 8-digit products having the same HS 6-digit root will command the same ratio.

To determine whether export price dispersion is higher for product categories containing a larger number of goods, we estimate the following regression

$$sdp_{fdkt} = \beta \ln ratio_k + \gamma_{fdt} + \epsilon_{fdkt} \tag{4}$$

where sdp_{fdpk} is the standard deviation of (log) export prices for firm f in destination d, product k and year t; $ratio_k$ is the ratio of HS10 to CN8 product lines in product k, where k refers to a CN 8-digit product.[10] γ_{fdt} is a firm-destination-year fixed effect, and ϵ_{fdkt} is the independent disturbance term. Hence, the regression equation analyzes the differences in the standard deviation of (log) export prices across products for the same firm, destination and year. We expect a positive correlation between the standard deviation of (log) export prices and the ratio of product lines.

Table 4, column 3 presents the results of the estimation. The ratio of product lines coefficient is positive and statistically significant. In particular, a 100% increase in the ratio of product lines leads to a 1% rise in the standard deviation. Bearing in mind the limitations of our number of products per category measure, this result suggests that the dispersion of prices can be positively correlated with the range of goods included in each product category.

We also test whether the price dispersion is larger for differentiated products. To do so, we classify products into differentiated and non-differentiated using Rauch (1999) criteria. We estimate the following regression equation

$$sdp_{fdkt} = \beta Differentiated_k + \gamma_{fdt} + \epsilon_{fdkt} \tag{5}$$

where $Differentiated_k$ takes the value of 1, and zero otherwise, if product k is differentiated. We expect the β coefficient to be positive. Table 4, column 4, shows that, as expected, export price dispersion is larger for differentiated goods. However, this coefficient is not precisely estimated. In column 5, we estimate the regression introducing the three product-level independent variables. The coefficients for the

[10] It is important to stress that, as mentioned above, all CN 8-digit products belonging to the same HS 6-digit root have the same $ratio_k$ value.

number of transactions and the ratio of product lines remain positive and statistically significant. The coefficient for differentiated products, although positive, is not statistically significant. In column 6, we introduce an alternative variable to measure the dispersion of prices: the (log) of the 75th percentile export price—the (log) of the 25th percentile export price. The number of transactions and the ratio of product lines remain positive and statistically significant, and differentiation remains statistically not different from zero.

Differences in prices within firms, destinations and products can also be explained because firms offer vertically-differentiated varieties of a product. According to this hypothesis, the variation in prices will be capturing the differences in unit values across vertically-differentiated varieties. We follow Manova and Yu (2017), who argue that firms produce a core quality, but can offer other vertically-differentiated varieties with rising quality-adjusted marginal costs. We test two predictions of this model. First, we analyze whether more productive firms export a larger range of varieties. We proxy the range of varieties exported by a firm by the standard deviation of (log) export prices. We test the following equation

$$sdp_{fdkt} = \beta TFP_{ft} + \gamma_{dkt} + \epsilon_{fdkt} \tag{6}$$

where sdp_{fdkt} is the standard deviation of (log) export prices, TFP_{ft} is the total factor productivity, which is estimated using the Levinsohn and Petrin (2003) methodology.[11] γ_{dkt} is a destination + product + year fixed effect. Hence, we analyze the dispersion of prices across firms, once we have controlled for differences in product, destination and year.

As shown in Table 5, column 1, the TFP coefficient is positive, but it is not precisely estimated. In column 2, we introduce the number of transactions that a firm carries out for the same product, destination and year in the regression. The number of transactions coefficient is positive and statistically significant. The TFP coefficient remains positive, but it is not statistically significant. In column 3, we use an alternative measure for price dispersion: the difference between the (log) 75th percentile export price and the (log) 25th percentile export price. We find that the TFP coefficient remains positive, but is not statistically different from zero.

TFP is estimated using revenue data, rather than quantity data. Therefore, productivity, in addition to improvements in efficiency, might also capture differences in mark-ups and demand shocks (De Loecker 2011). Moreover, since prices are a component of revenue, by construction, there could be a positive relationship between TFP and prices. In order to address this problem, in columns 4 and 5 we use an alternative productivity measure: Domestic sales. As shown by heterogeneous firm models (Melitz 2003), more productive firms have larger domestic sales, so this

[11] We estimate a separate production function for each 4-digit NACE rev 2 industry using all firms with complete information about output, materials, tangible assets and employment. Output is deflated using 4-digit NACE rev 2 industrial prices. Materials and tangible assets are deflated using 2-digit NACE rev 2 input and capital prices, respectively. We use the Stata routine *levpet* to estimate the production coefficients using intermediate inputs (materials) as control for unobservable productivity shocks.

Table 5 Vertically-differentiated varieties: Firm characteristics

	(1)	(2)	(3)	(4)	(5)
TFP (ln)	0.006	0.001	0.006		
	(0.010)	(0.011)	(0.016)		
Employees (ln)		− 0.000			
		(0.002)			
Number of transactions (ln)		0.024***	0.030***	0.024***	0.029***
		(0.002)	(0.003)	(0.002)	(0.003)
Domestic sales (ln)				− 0.000	0.001
				(0.001)	(0.002)
Dep.var.	sd (ln)price	sd (ln)price	(ln)price75-(ln)price25	sd (ln)price	(ln)price 75-(ln)price25
N.observ	189,656	189,656	189,656	189,656	189,656
Fixed effects	prod*cou*year	prod*cou*year	prod*cou*year	prod*cou*year	prod*cou*year
Cluster	Firm	Firm	Firm	Firm	Firm
Adj. R^2	0.240	0.245	0.188	0.245	0.188

***, **, * Statistically significant at 1, 5 and 10% respectively

latter variable can be used as a proxy for productivity. As shown in the table, the domestic sales coefficient is positive, but it is not statistically different from zero.

Second, destination characteristics determine the range of vertically-differentiated varieties exported by a firm in Manova and Yu (2017). In particular, we expect firms to sell a lower range of varieties in distant markets, and a larger range of varieties in markets where demand is larger and competition lower. To test this hypothesis, we estimate the following regression equation:

$$sdp_{fdkt} = \beta_1 dist_d + \beta_2 GDPpc_{dt} + \beta_3 GDP_{dt} + \beta 4 REM_{dt} + \gamma_{fkt} + \epsilon_{fdkt} \quad (7)$$

where $dist_d$ is the distance between Spain and the foreign market d, $GDPpc_{dt}$ is the GDP per capita of the foreign market at year t, GDP_{dt} is the GDP of the foreign market and REM_{dt} is the remoteness of the foreign market. This variable aims to capture the level of competition, measured by the price index, in the destination country.[12] Models assume that the price index will be larger the lower the number of varieties available in the destination; this number will be negatively correlated with distance to large suppliers. Based on these assumptions remoteness is calculated as follows:

$$REM_{dt} = \left[\sum_s GDP_{st} / dist_{sd} \right]^{-1} \quad (8)$$

where GDP_{st} is the GDP of the supplier country s and year t, and $dist_{sd}$ is the distance between the supplier and the destination country. According to Eq. (8), a country will be more economically remote the larger the weighted distance to its partners, using GDP as weight. Equation (7) includes firm + product + year fixed effects, so it measures how the dispersion of export prices for a firm, product and year varies when the characteristics of the destination are altered.

Table 6, presents the results of the estimations. Since there might collinearity among the independent variables, first, we estimate the specification introducing the independent variables one by one. As expected, we find that the GDP and Remoteness coefficients are positive and statistically significant. These results suggests that firms export a larger range of quality-differentiated varieties in larger markets and in destinations where competition is lower. However, contrary to expectations, we find that the distance coefficient is also positive and statistically significant. As expected, the GDP per capita coefficient is not statistically different from zero. When we introduce all the destination characteristics in the regression (column 5), GDP and Remoteness remain positive and statistically significant. Distance has the expected negative sign, but it is not statistically different from zero. In column 6, we control for the number of transactions at the firm + product + destination + year level. GDP and Remoteness remain positive and statistically significant. The distance coefficient

[12] In bilateral trade gravity models remoteness is denoted as the multilateral index (Anderson and van Wincoop 2003), and is proxied by a destination fixed effect. We cannot follow this procedure because it would preclude the estimation of other destination-specific variables, such as distance, GDP or GDP per capita.

Table 6 Panel C: Vertically-differentiated varieties: Destination characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Distance (ln)	0.014***				0.002	0.006	0.007
	(0.004)				(0.004)	(0.004)	(0.004)
GDP (ln)		0.009***			0.012***	0.008***	0.009***
		(0.002)			(0.001)	(0.001)	(0.002)
Remoteness (ln)			0.026***		0.029***	0.023***	0.026***
			(0.006)		(0.006)	(0.005)	(0.007)
GDPpc (ln)				− 0.005	− 0.004	− 0.005	− 0.006
				(0.003)	(0.004)	(0.004)	(0.004)
Number of transactions (ln)						0.026***	0.028***
						(0.001)	(0.002)
Dep.var.	sd (ln)price	sd (ln)price	sd (ln)price	sd (ln)price	sd (ln)price	sd (ln)price	(ln)price75–(ln)price25
N.observ	739,300	739,300	739,300	739,300	739,300	739,300	739,300
Fixed effects	firm*prod*year	firm*prod*year	firm*prod*year	firm*prod*year	firm*prod*year	firm*prod*year	firm*prod*year
Cluster	Destination	Destination	Destination	Destination	Destination	Destination	Destination
Adj. R^2	0.443	0.444	0.443	0.442	0.447	0.451	0.385

***, **, * Statistically significant at 1, 5 and 10% respectively

is not precisely estimated. Finally, we use the (log) difference between the 75th percentile export price and the 25th percentile export price as an alternative price dispersion measure. Distance becomes statistically not different from zero; GDP and Remoteness remain positive and statistically significant.

To sum up, the empirical analyses support that pricing to customers, the number of transactions and differences in the number of products covered with each CN8 product category provide plausible explanations for the dispersion of export prices within firms, products and destinations. We also find that price dispersion is higher for differentiated products. However, the coefficient is not precisely estimated. We also find some support for the vertically-differentiated varieties hypothesis. However, some of our results are not in line with the predictions of this latter hypothesis.

6 Conclusion

This paper shows that there are very important differences in the prices that a firm charges for the same product and destination. We test five explanations for this new price variation component. First, we show that firms with a higher number of transactions have a larger dispersion of prices. This result suggests that there might be some randomness or measurement errors in export prices, leading to a higher dispersion of export prices when firms carry out a large number of transactions. Second, we find that even highly disaggregated product categories might cover different goods. Hence, firms might charge different prices for the same product in the same destination because they are selling different goods. Third, we show that exporters have a larger price dispersion in differentiated goods. However, the coefficients is not precisely estimated. Fourth, firms might offer price discounts to customers that place large orders. We show that there is a negative correlation between export prices and quantities for the same firm, product and destination. Finally, firms may offer vertically-differentiated varieties of a product. Since we cannot observe vertically-different varieties, we analyze whether exporters behave in a way consistent with producing a range of varieties. First, more productive firms should export a larger set of varieties. Second, exporters should offer a narrower range of varieties in more distant markets, and a wider range in larger markets and in markets where competition is lower. We do not find a statistically significant positive association between TFP and the dispersion of export prices. We find that dispersion of prices is larger in bigger markets and in markets where competition is lower. However, we do not find that the price dispersion is lower in more distant markets.

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Appendix

See Table 7.

Table 7 Decomposition of the variance in prices: 2010–2013

	All		Multi		CDS	
	Unweighted	Weighted quantity	Unweighted	Weighted quantity	Unweighted	Weighted quantity
Year 2010						
Across firms	83.7	81.6	55.8	62.5	46.3	52.9
Across destinations	1.9	3.9	1.3	3.5	2.0	3.2
Across transactions	7.2	9.6	33.6	25.5	37.8	30.7
Year 2011						
Across firms	83.4	81.5	55.9	63.0	45.1	52.1
Across destinations	2.1	4.1	1.4	2.7	2.2	3.8
Across transactions	7.4	9.7	33.8	25.8	38.4	30.1
Year 2012						
Across firms	84.5	81.8	56.1	63.1	44.1	50.7
Across destinations	2.1	4.3	1.5	2.6	2.7	4.2
Across transactions	6.5	9.1	33.4	25.1	37.8	29.8
Year 2013						
Across firms	84.7	81.5	57.9	64.4	48.2	53.4
Across destinations	2.1	4.3	1.5	2.9	2.6	4.3
Across transactions	6.4	9.4	31.9	24.1	35.3	28.5

Results for the median product (%)

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