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ABSTRACT

Why do within firm-product export prices differ across markets?

In this paper we analyse the relationship between gravity variables and f.o.b. export unit values using Hungarian firm-product-destination data. By taking firm-product level selection into account we show that export unit values increase with distance even for particular firm-product combinations. This cannot be explained by models assuming firm- or even firm-product level selection and constant markups. The differences are important quantitatively; price differences in Hungarian exports between Germany and the US are about 30%. We also show that unit values are positively related to GDP/capita and that there is a weak negative relationship between unit values and market size. We propose two possible explanations: first, firms may export different quality versions of the same product to different markets. Secondly, directly exporting firms may capture part of the markups on transport costs in their f.o.b. prices.

JEL Classification: D40 and F12
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Introduction

Recent theories emphasise the role of firm heterogeneity and selection in international trade. The literature offers an enormous degree of heterogeneity in terms of firm productivity and technology, and both at the extensive and intensive margins of trade. Prices received much less attention until recently. Highly disaggregated, firm-product-destination datasets make it possible to analyse the extent of heterogeneity at a disaggregated level. Our aim in this paper is to show that price differences are vast both across and within firms. Moreover, we demonstrate that firms charge different prices for the same product in different markets.

We provide empirical evidence for this hypothesis using disaggregated firm-product-destination trade data for Hungary. According to our estimates Hungarian exporters charge 25 to 30 % more for the same product in the United States than in Germany. The results also suggest a negative relationship between unit values and market size and a positive one between unit values and GDP/capita. These phenomena cannot be explained in a framework that builds on firm-level productivity or quality heterogeneity in a CES framework, where firms charge the same price in all markets. Also, existing models with endogenous markups are not able to fully explain these empirical patterns, as in those models f.o.b. prices are decreasing with distance for a given firm-product combination. Two kinds of model will be considered to explain within firm-product price differences. First, firms may export different quality versions of the same product to different markets, which can be dubbed 'quality-to-market'. Secondly, directly exporting firms may capture part of the markup on transaction cost, which may show up in their f.o.b. prices.

While quality-to-market seems to be rather abstract, it is not necessarily unrealistic. Consider, for example, a beer producer, who produces two versions: a cheap and a premium one. If transport costs are a function of the number of bottles exported, the firm may export only the higher quality version to more distant markets and it may export both versions to neighbouring countries. As a consequence, unit value at the firm-product-destination level – the average price – will be lower for the neighbouring countries. We provide evidence both from firm-product fixed effects and controlling for firm-product level selection explicitly that unit values increase with distance within firm-product combinations, which provides support for the quality-to-market model.

Different prices at the firm-product level may also be explained by some model of endogenous markups. However, the most well-known model – Melitz and Ottaviano (2008) – predicts the opposite relationship between distance and f.o.b. unit values. In that model f.o.b. unit values decrease with distance at the firm level, as firms absorb part of the transport cost. For generating predictions in line with the observation that unit prices are positively related to transport cost, we may assume that firms are able to acquire part of the markups on transport costs. If directly exporting firms buy transport services in a competitive market, part of the markup on the transport services may show up in their books and f.o.b. prices.

In the remaining part of the paper we first review briefly the literature on prices and selection. In Section 3 we describe the data set and analyse the extent of export unit value dispersion in the dataset. Section 4 provides descriptive evidence for quality-to-market, and section 5 describes the selection model explicitly. In section 6 we discuss the possible explanations for our empirical findings. Section 7 concludes.

International trade models and export prices

The relationship between heterogeneous firm models and export prices has received less attention in the literature than the trade volumes. It is quite clear, however, that in the workhorse model of Melitz (2003), where firms self-select into exporting solely based on their productivity, firms exporting to more distant markets should be more productive, and as a consequence ask for lower prices than firms exporting only to nearby markets (see Baldwin and Harrigan, 2007). As a result, it is natural to expect that the average export unit value observed in smaller and more distant markets tends to be lower. Recent empirical work, however, suggests the opposite.

One piece of evidence for such interesting trends comes from the decomposition of export volumes to different margins. Bernard et al (2007) decomposes US exports into three margins: number of exporting firms, number of exported products and export value per product per firm. Interestingly the authors find that the intensive margin increases with distance. For European countries, Mayer and Ottaviano (2007) calculate a similar decomposition, but, taking advantage of quantity data, they decompose further the export value per product per firm into quantity and price components. They find that the price margin decreases with distance. Bernard et al. (2007) propose the following explanation: if cost of exporting depends on quantity and weight, rather than the export value, then distance may be related to the quality composition of goods.

More directly, Baldwin and Harrigan (2007) use U.S. product-level trade data to identify the relationship between distance and export unit values. They find a strong positive relationship between distance and unit values. These authors also propose a model of firms with heterogeneous productivity and quality to explain the observed pattern of zeroes and unit values. Depending on the relationship between firm-level productivity and product quality, it is reasonable to assume that more productive firms export higher quality goods to more distant markets.

On the micro level, Hallak and Sivadasan (2006) study endogenous quality choice with minimum quality requirements in the export market. Authors provide micro evidence for higher quality and price of export goods relative to those that are produced for the domestic market for Chile, Columbia and India. Johnson (2007) also models endogenous quality choice that depends on the productivity level of the firm. He estimates a model with bilateral product-level data and shows that prices increase with distance. Crozet et al (2009) provides direct evidence for quality sorting of firms by using a sample of French wine makers. The authors are able to assess the quality of wine produced by each firm using two wine guides. They find that high quality producers export to more markets, charge higher prices and sell more in each market.

Crozet et al (2009) start from firm level data. The closest to our paper, however, is Manova and Zhang (2009), who use firm-product-destination level data for China. Authors show a number of stylised facts, and compare them with the predictions of different heterogeneous firm models, concluding that none of them match all of these facts. Similarly to our work, they find that firms charge higher prices in more distant markets and that more firms export to larger and closer markets. They, however, find that firms ask higher prices in larger markets, while we find a negative effect of market size on unit values when pooling together all products and find a positive relationship only for homogeneous goods.

Models building on CES preferences are unable to explain our observation that firms charge different prices for the same product in different markets, as selection takes place at the firm or firm-product level. One has to assume some kind of heterogeneity across markets to explain the differences within firm-product observations; contrary to the models building on CES functions, the optimal markup may differ across destination markets.

The main model of pricing-to-market in the heterogeneous firm framework is Melitz and Ottaviano (2008), which assumes heterogeneous firms with respect to productivity, but assumes a linear demand function instead of CES. As a consequence markups differ across destination markets, leading to within-firm differences in prices. The model predicts that firms absorb some of the higher transaction costs for more distant markets, thus f.o.b. export unit value is negatively associated with distance within a firm. Secondly, as more firms enter larger markets, stronger competition forces firms to ask for lower prices as compared to smaller markets. Consequently the model predicts a negative relationship between market size and unit values. Kneller and Yu (2008) modify this model to take quality heterogeneity into account. In this model firms producing higher quality goods have higher unit cost. As a consequence, in contrast to models with only productivity sorting, firms charging a higher price export to more distant and smaller markets. While this matters for selection, the within-firm predictions of the Kneller and Yu (2008) model are identical to the Melitz and Ottaviano (2008) framework.

Our paper attempts to contribute to this literature by analysing the data at a highly disaggregated level, sometimes even at the level of elementary observations. Instead of dealing with bilateral product- or firm level data, we analyse prices asked by one firm for the same product on different markets. As firms ask heterogeneous prices, our results suggest that models building on the CES function may not explain this pattern in the data. Also, the results indicate that export unit values, both statistically and economically, significantly increase with distance at this level of aggregation. This finding clearly is in contradiction to the predictions of the Ottaviano-Melitz model. After presenting the results, we discuss two possible explanations for our findings.

Besides heterogeneous firm trade models, a number of other papers examine the relationship between export prices and gravity variables. First, differences in the quality of exported goods were emphasised in the literature initiated by Alchian and Allen (1964) which analyse the phenomenon that countries are more likely to ship out better quality goods. A more recent empirical investigation of this hypothesis is conducted by Hummels and Skiba (2004), which extends the original model and tests it with bilateral data at the 6-digit level between 6 exporters and all other countries of the world. The results show that observed export unit values are positively related to trade costs and negatively correlated with tariffs. Our contribution is to show that the Alchian-Allen conjecture is present even for firm-product pairs, not only across firms, as commonly assumed.

Beside firm level selection, the recent literature emphasised the role of multi-product firms. Bernard et al. (2006) analysed the response of multi-product firms to trade liberalisation. The model shows that when firms have different expertise in producing different products, selection may appear at the firm-product level. Trade liberalisation forces firms to adjust their product- and export mix leading to further gains from trade. In this work we take firm-product level selection seriously and model selection at this level. Our findings extend earlier results by showing that heterogeneity and possibly selection still persists even within firm-product combinations.

Hungarian export prices: descriptive evidence

In this paper we analyse Hungarian trade data. Hungary, a small open economy, is ideal for this exercise. First of all, data is available at a highly disaggregated level and its coverage is exceptionally wide. Secondly, exports played an important role in economic growth during the 1990s and at the beginning of the millenium. The phase of economic transition was more or less over after 1997; the overwhelming majority of firms were privately owned, and the structural transformation led to strong integration with EU-markets, especially after the collapse of the eastern markets following the Russian crisis. As a result, we expect that the phenomena emerging from Hungarian trade data reflect the trade patterns of a country benefiting from export led growth rather than transition-specific patterns. Consequently, the stylised facts reported in this paper may show general patterns that can potentially reflect those in other economies as well.

We apply three approaches to assess within firm-product unit value differences. First, we decompose the variance of normalised unit values into between-firm and within-firm parts, and show that within-firm variance is important quantitatively. Secondly, we use disaggregated analysis to explore the relationship between gravity variables and unit values within firm-product combinations. Besides some evidence at the level of elementary observations, we estimate gravity regressions separately for a larger number of firm-product combinations and show that the relationship between distance and f.o.b. unit values is positive. We also combine these observations into one regression using firm-product fixed effects to show that the descriptive results are valid. This analysis, however, requires firms which export the same product to a relatively large number of destination markets. In Section 6 we use the whole universe of Hungarian exports (to the top 50 export markets) and model selection explicitly. Our results obtained using this model confirm the earlier, more descriptive conclusions.

Data

The data used for our empirical analysis was obtained from the Customs Statistics. The dataset consists of *all Hungarian exports* between 1992 and 2003. In this paper we rely on cross-sections of this data only. As our analysis is mainly concerned with identifying firm-product heterogeneity, a time dimension would not add too much to our analysis. Hence, we avoid the additional problems that a time dimension would imply and focus only on information for one year in most of the analysis. We have chosen the last year, 2003.[5] One observation in the database is the export of product i by firm j to country k in year t.[6]

The product dimension of the dataset is highly disaggregated; it is broken down to 6-digit Harmonized System (HS) level. We define a product as a 6-digit category, although using more aggregated (4-digit) categories does not change our results. "Motor cars and vehicles for transporting persons" is an example of a 4-digit category, while "Other vehicles, spark-ignition engine of a cylinder capacity not exceeding 1,500 cc" is an example of a 6-digit category. Note that in most cases (as in the car example) further disaggregation of the data would not reduce potential quality differences within each category to zero. The dataset includes both export values and quantities at this highly disaggregated level, thus unit values are calculated as the ratio of these two variables.

In this paper – as is standard in the literature – we restrict our attention to manufacturing firms. Theories of heterogeneous firms can be applied in a more straightforward way to direct export of manufacturing firms than to exports of services or exports of manufacturing products by wholesalers or retailers.

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[5] We have re-run our regressions for earlier years, and on the full panel. The results did not change significantly.

[6] A more detailed description of our data can be found in Békés at el (2009).

We delete all observations which do not exceed at least 1 percent of the firm's export revenues. This constitutes about 50% of the observations, but only about 6% of export value. Also, exports below US$2000 will be disregarded. We also drop outliers for which the log difference from average export price is larger in absolute value than 4 – around 2% of the observations. Muraközy and Békés (2009) show that such small and temporary exports behave differently from larger exports and standard trade theories – and for example gravity equations – are unable to provide satisfactory rationales for such trade transactions.

The Hungarian customs database can be merged with the panel of balance sheet data for most firms. This database includes information on employment and whether the firm is foreign-owned (we use a 10 % threshold). Using this data we can estimate TFP using the method proposed by Levinsohn and Petrin (2003).

The distance variables are obtained from the databases of CEPII.[7] GDP data is from the OECD. In the regressions we also control for tariffs, in which we rely on the HS2-country level bilateral data from the MAcMap database of CEPII.[8]

Price dispersion

Price dispersion in 2003 is to be studied along different dimensions. We restrict our attention to EU-25 countries as most Hungarian exports are directed to these markets, and the presence of outliers is less important in this subsample. We have repeated these calculations for a larger number of destinations – the 50 largest export markets – and we have not found any important difference in the statistics. First we calculated the standard error and interquartile range of the log normalised price for each 6-digit product, and then we averaged this up to more aggregated product categories (weighted by export value).[9]

Figure 1 shows the results. Numbers suggest that for most product categories prices vary by 30 to 50 percent around their average. Such differences suggest that it can be useful to look for systematic patterns in unit value data, and that quality differences may really matter within highly disaggregated product categories even within small countries.

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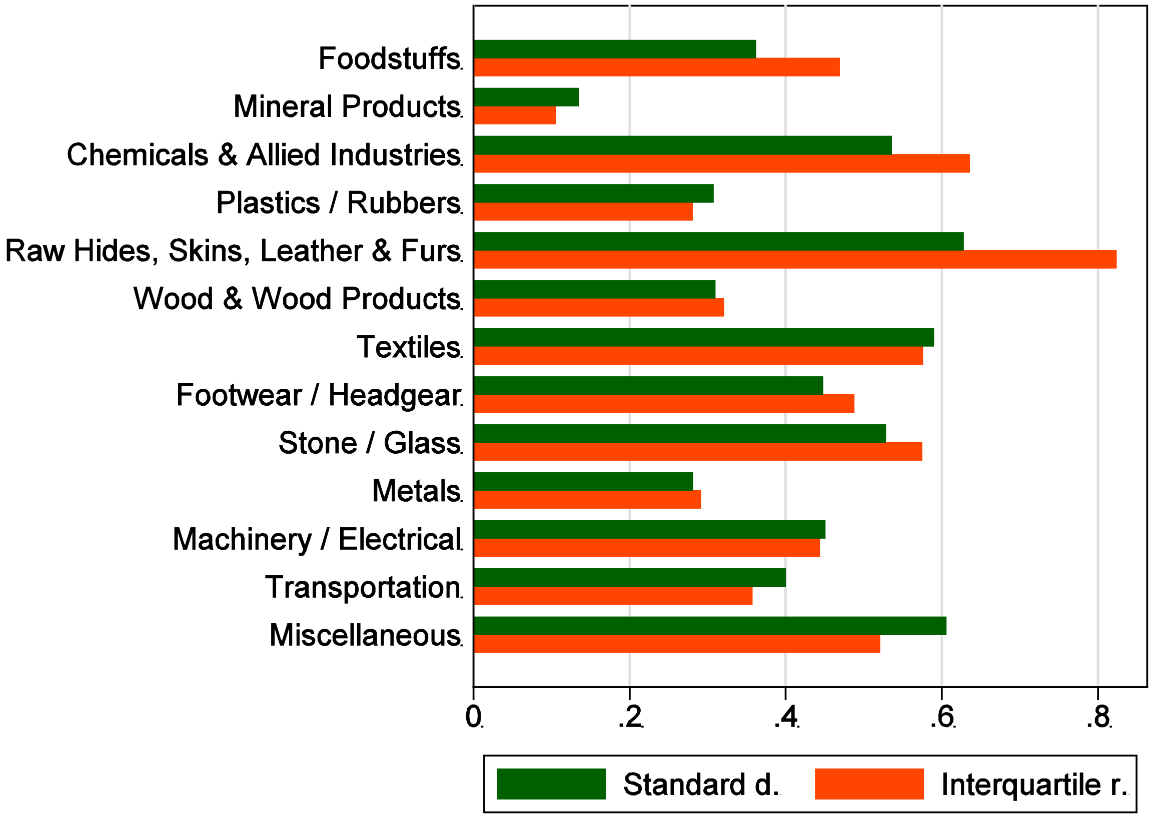
[7] This can be downloaded from http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

[8] http://www.cepii.fr/anglaisgraph/bdd/macmap.htm

[9] We omit product groups with only one observation. The comparisons are, of course, not perfect, given the differences in importance of both products and transactions of various 6 digit categories within the more aggregated categories. However, they still give a rough indication of the raw level of price dispersion that we observe in our data.

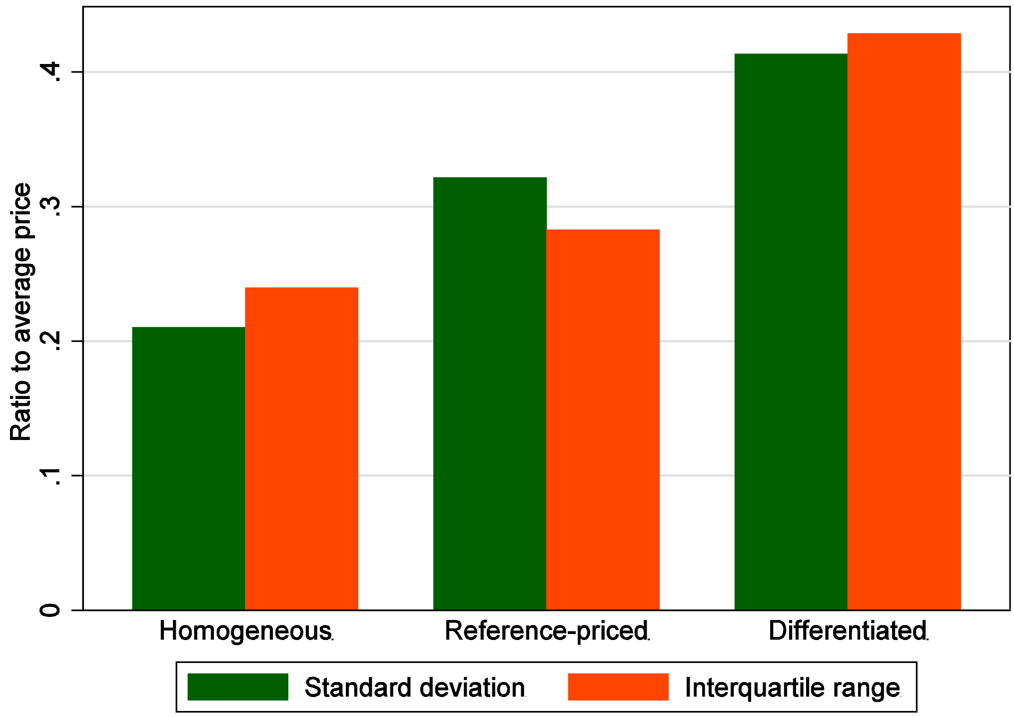
Figure 1. Price dispersion in different product categories



A first step in trying to find systematic differences in price dispersion is to see whether they are related to the heterogeneity of products. We proxy heterogeneity using the categorisation of Rauch (1999), shown in Figure 2.[10] The results show, not surprisingly, that price dispersion is smaller within more homogeneous product categories; the difference between homogenous and differentiated goods is as large as 100 %. Enormous differences in price dispersion suggest that the variation in export unit values does not constitute a random noise, so it may be explained by economic models.

[10] In particular, we use the liberal categories, but the conservative classification leads to very similar results.

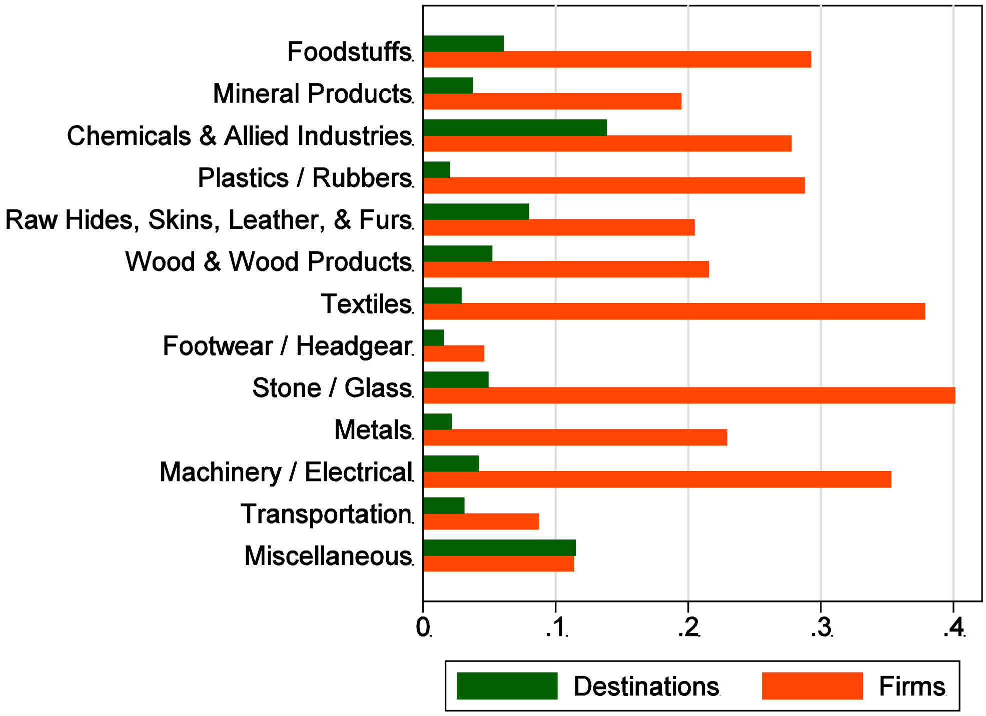
Figure 2: Price dispersion by product homogeneity



Inspired by heterogeneous firm theories of international trade, it is important to know, how much of this variation is explained by firm heterogeneity. By using ANOVA, we decompose variance into two parts: one that is explained by different destination markets and the other one explained by firm fixed effects.[11] The prices are averages at the 6-digit level, so product heterogeneity is already controlled for. In this calculation, we only include fixed effects for firms for which we have at least 5 observations. The results are presented in Figure 3.

[11] We get a similar picture for other ANOVA models, e.g. sequential ANOVA.

Figure 3. Decomposition of unit value variance



While the results differ across product categories, the relative importance of the two sets of variables is clear; while destination fixed effects do not explain more than 15 percent in any product category, firm fixed effects have a much larger explanatory power, between 20 and 35% in most cases. Both sets of fixed effects are highly significant (jointly) in almost all product groups.

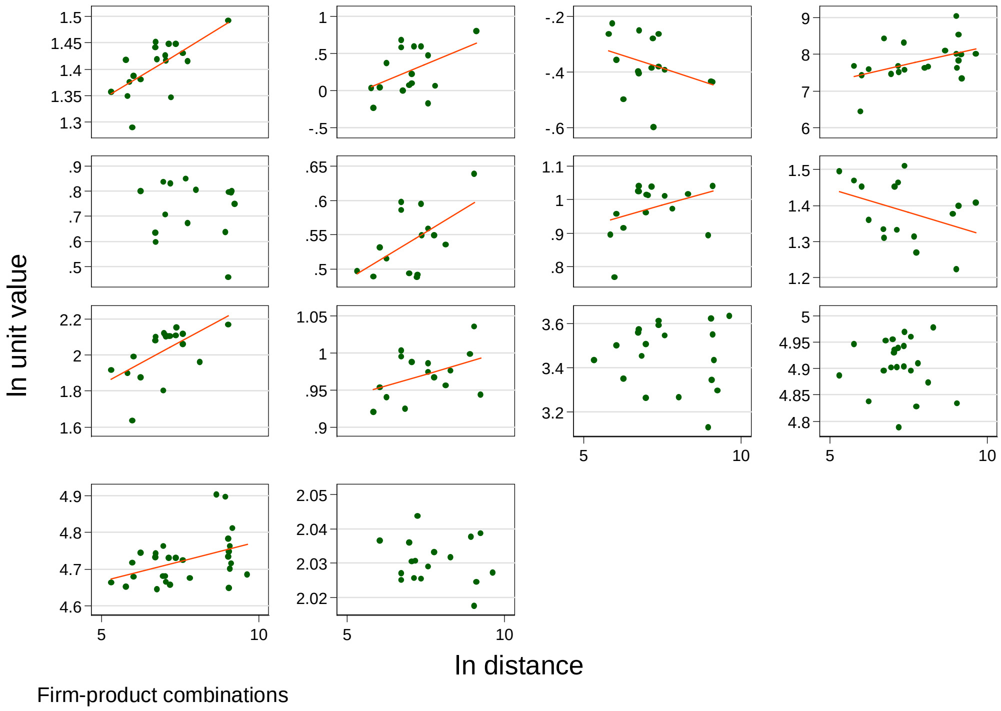
These decompositions suggest a stunning degree of heterogeneity, even after dropping small transactions and destinations. However, a very large amount of heterogeneity remains even after controlling for destination and firm fixed effects. These numbers suggest that for all product groups more than 50 per cent of the variance is unexplained by destination and firm fixed effects.

Unit values and distance at the firm-product level

Unit values charged by the same firm for the same product in different countries are to be analysed for our central hypothesis. First, as an illustration, we present simple graphs showing the relationship between distance and (conditional) export unit values. Then unit value is explained by GDP and GDP/capita to control for differences in country size and wealth.

The scatterplots in Figure 4 show the relationship between the predicted unit value – conditional on country size and wealth – and distance. A linear trend, if the t-value of the trend is at least 1 in a simple regression, is also added. We show the firm-product combinations for which we have the largest number of positive observations above our threshold, US$2000, and for which we can observe exports outside the EU (as otherwise t-values are usually small)[12]. The Figure suggests that in half of the 14 cases one can observe a clear positive relationship. In two cases, the relationship is negative, and in 5 cases the trend is insignificant. This Figure provides simple, but quite visual evidence for the main hypothesis of this paper; product unit values are systematically different across destination markets even when controlling for firm-level heterogeneity entirely and for product heterogeneity to a very high level of disaggregation. It also suggests that unit values are more likely to increase with distance, but this is not always the case.

Figure 4. Relationship between distance and unit values for selected product-firm pairs in 2003



Note: firm-product combinations are those with the largest number of observations and exported outside the EU.

The next step is to see whether the systematic relationship between distance and unit values is present for a larger sample of firm-product pairs. Instead of concentrating only on 14 firm-product combinations, we include all those combinations which are exported to at least 7 destinations.[13] For each combination of firm i and product j, we run the following regression separately:

[12] These are all firm-product combination with at least 15 observations, including at least one observation outside the EU.

[13] Modifying this threshold to 5 or 10 does not change the results.

$$\ln unit\ value_{ijk} = \beta_{ij}^0 + \beta_{ij}^1 \ln distance_k + \beta_{ij}^2 \ln GDP_k + \beta_{ij}^3 \ln \frac{GDP_k}{capita_k} + \beta_{ij}^4 tariff_{jk} + \varepsilon_{ijk}$$

Thus we get β_{ij}^1 for each firm-product combination. These coefficients – obtained from directly comparing prices asked by the same firm for the same product in different markets – purely reflect firm-product level price differences across countries; these estimates do not contain selection at the firm level or at the firm-product level. The distribution of these parameters gives valuable insights. Table 1 shows means and medians for the estimated β_{ij}^1s. It suggests that these point estimates are positive in every year and every subgroup, providing evidence for the hypothesis that firms sell the same product at more distant markets for higher unit values. The estimated coefficients tend to be larger in 2000, 2001 and 2002 than in 1999 and 2003.

Table 1. Estimated effect of distance on unit value for firm-product pairs with the largest number of observations

	mean	mean if exports outside EU25	mean if exports outside EU25 and |t-value|>1	median	median if exports outside EU25	median if exports outside EU25 and |t-value|>1
1999	0.024	0.046	0.080	0.016	0.034	0.115
2000	0.054	0.064	0.130	0.043	0.050	0.114
2001	0.056	0.068	0.138	0.037	0.042	0.148
2002	0.068	0.062	0.104	0.040	0.045	0.149
2003	0.032	0.055	0.121	0.014	0.011	0.084

As a final step we run firm-product fixed effects regressions for each year restricted to firms exporting to at least 10 destinations. The estimated equation is the following:

$$\ln unit\ value_{ijk} = \beta_{ij}^0 + \beta_{ij}^1 \ln distance_k + \beta_{ij}^2 \ln GDP_k + \beta_{ij}^3 \ln \frac{GDP_k}{capita_k} + \beta_{ij}^4 tariff_{jk} + \mu_{ij} + \varepsilon_{ijk}$$

where μ_{ij} is the firm-product fixed effect. The results in Table 2 are in line with the earlier descriptive results; there is a strong and highly significant positive relationship between distance and unit value within firm-product combinations. The coefficient is similar for every year, and it is between 0.05 and 0.06. This suggests about 25-30 per cent price difference between Hungarian exports to Germany and to the United States. This statistically and economically significant difference suggests that the selection models alone cannot account for heterogeneity in unit values. Also, it shows that the Melitz-Ottaviano prediction of unit values decreasing with distance is not supported by the data. The results on this small sample do not indicate a significant relationship between unit values and GDP or GDP/capita.

Table 2. Firm-product fixed effects regressions

Year	1999	2000	2001	2002	2003
Log distance	0.057 *	0.045 *	0.057 ***	0.066 ***	0.056 **
	0.031	0.023	0.019	0.017	0.023
Log GDP	0.001	-0.005	0.003	0.008	-0.008
	0.015	0.015	0.009	0.012	0.012
Log GDP/capita	0.040	0.053 *	0.009	0.008	0.028
	0.031	0.030	0.021	0.029	0.029
Tariff rate	0.545 **	-0.074	-0.168	-0.164	-0.442 **
	0.260	0.207	0.109	0.225	0.196
Constant	0.608	0.724 *	0.991 ***	1.016 ***	1.450 ***
	0.384	0.383	0.315	0.317	0.323
Observations	676	789	1155	1037	1091
Firm-product	53	61	88	77	82
R-squared	0.038	0.02	0.029	0.04	0.02

Modelling selection

While the firm-product fixed effects approach provides strong evidence for within firm-product differences across markets and for a robust positive relationship between distance and unit value, modelling selection explicitly may yield further important insights. First, modelling the selection process provides an estimate for the relative importance of heterogeneity within firm-product combinations in the aggregate positive relationship between distance and unit values. Secondly, this approach may ensure that the previous results are not biased by concentrating our attention on some special subsample.

Heckman sample selection model (Heckman, 1979) is used for modelling selection. Following the theoretical framework, we assume that firm i gains the unobserved π^*_{ijk} net profit (gross profit minus trade cost) by selling product j at market k. We only observe the unit value, uv_{ijk} if the net profit is positive; otherwise the unit value is missing. The unit values are normalised by sample mean for the same HS-6 product.[14] We assume that gravity variables may affect net profit and unit value, but there are some Z_{ijk} variables, which are only related to fixed costs and not to the actual unit values. We include firm-level variables – denoted by X_i – into each equation: employment, foreign ownership dummy and TFP which is estimated by the Levinsohn-Petrin procedure separately for each 2-digit industry (see Levinsohn and Petrin, 2003). Formally:

$$\pi^*_{ijk} = \gamma^0 + \gamma^1 \ln distance_k + \gamma^2 \ln GDP_k + \gamma^3 \ln \frac{GDP_k}{capita_k} + \gamma^4 tariff_{jk} + \gamma^5 X_i + \gamma^6 Z_{ijk} + u_{ijk}$$

[14] Normalising unit values by average unit values for all Hungarian exports or by average import or export unit values in the EU-15 does not change the results significantly (the source of these data is Eurostat).

The unit value is only observed if gross profit is positive:

$$\ln uv_{ijk} = \begin{cases} missing & if \pi^*_{ijk} < 0 \\ \beta^0 + \beta^1 Gravity_k + \beta^2 Tariff_{jk} + \beta^3 X_i + u_{ijk} & if \pi^*_{ijk} \geq 0 \end{cases}$$

Where $Gravity_k$ denotes the three gravity variables.

When modelling selection in this framework the crucial issue is how to find the appropriate set of country-product pairs, what and to where the firm can potentially export, but does not actually do. Potentially all firms can export all possible products to every destinations, but allowing for this in the empirical model would lead to very large matrices and low explanatory power of the selection equation. The other extreme would be to restrict our attention to products that the firm *actually* exports somewhere only. The problem with this, however, is that larger and more productive firms are willing to export more products, most of them to only 1 or 2 markets while less productive firms may export only 1-2 products to more markets. Such a construction would bias upwards the export propensity of smaller firms. A reasonable compromise can be struck if we restrict each firm's choice set to the products exported by firms in the same 3-digit industry, and to destinations to which firms in the same industry export.

The second issue is that of the excluded variables Z_{ijk}, that is, a set of variables that are correlated with selection but not with the unit values. These should be variables that proxy the sunk costs of exporting, thus determine selection but do not directly impact on unit values. Helpman, Melitz and Rubinstein (2008) face the same problem and a measure of regulation of entry costs and an index for common religion as proxies for sunk costs were chosen for inclusion. In contrast to our analysis, theirs is at the country level and therefore these aggregate measures seem appropriate. Our analysis is at the product/destination level and therefore including such aggregate country level variables do not provide enough variation. Instead, we use our data to calculate two variables that reflect the importance of the market and the product in the firm's industry. These may correlate with the fixed cost of exporting but not necessarily with unit values of firm i after controlling for other variables. [15]

More specifically, we calculate a variable $Prodshare_{jk}$ that shows the share of the 4-digit product in the exports of the two-digit industry[16]:

$$Prodshare_{jk} = \frac{\sum_{l \in 4-digit\ category\ of\ j} \sum_{g \in 2-digit\ industry\ of\ i} q_{glk}}{\sum_{l} \sum_{g \in 2-digit\ industry\ of\ i} q_{glk}}$$

where q_{ijk} is the quantity sold by firm i from product j on market k. Similarly, $Destshare_{jk}$ shows the share of destination k in the total exports of the 2-digit industry:

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[15] We also tried to follow Johnson (2007) by using lagged variables showing whether the product was exported in previous periods. In order to make the lag relatively long but meaningful, we use values from 1999. This variable seemed to be strongly related to both prices and selection, and seemed to be unsuitable for the purpose of excluded variable (but did not change the results significantly). We also experimented with the regulation variables in Helpman et al (2008) but, given that they vary only across countries they proved to be very weak in describing selection at this highly disaggregated level.

[16] Recalculating this variable by leaving out the values of firm ***i*** itself does not change the results significantly.

$$Destshare_{jk} = \frac{\sum_{g \in 2-digit\ industry\ of\ i} q_{glk}}{\sum_k \sum_{g \in 2-digit\ industry\ of\ i} q_{glk}}$$

Furthermore we control for product group and 2-digit industries in the selection equation, because they are not related to normalised prices.

Also, to reduce the number of zeroes, we focus our attention on the 50 top export markets of Hungary (in terms of total export volume). Table 3 and Figure 5 show these countries. The map shows that the identification of distance does not come from a few outliers only, as Hungary exports to a number of geographically distant countries outside Europe.

Table 3. Hungary's top 50 export markets in 2003

Name	Export (M USD)	Obs.	Firms	Name	Export (M USD)	Obs.	Firms
DE	12326.4	6151	2603	SI	127.2	452	311
FR	2121.2	1365	632	IE	118.8	72	56
AT	2031.7	3121	1488	GR	117.6	152	119
IT	1776.2	1602	816	MX	104.6	32	31
GB	1638.6	778	480	CN	83.9	69	53
NL	1326.6	844	482	IL	83.5	83	61
SE	1216.1	412	285	ZA	83.0	43	37
US	1084.7	632	418	BA	82.4	217	139
ES	1002.2	287	227	NO	68.5	110	94
BE	885.7	543	335	SA	68.0	37	33
PL	720.7	776	523	HK	56.9	34	29
CZ	607.5	809	588	IN	51.8	39	31
SK	569.0	1302	812	AU	45.9	68	63
RU	482.5	488	259	LT	45.0	147	119
AE	451.7	42	36	MK	28.2	51	42
CH	422.1	786	465	BR	27.9	35	34
FI	317.1	193	136	SG	25.7	44	31
TR	255.9	141	116	KZ	24.0	31	25
DK	241.2	226	179	EG	18.0	29	26
CA	238.7	110	85	IR	15.7	29	22
PT	227.7	81	73	EE	14.7	65	56
JP	194.1	159	116	KR	13.3	33	30
HR	153.1	654	422	TW	12.2	42	31
YU	150.5	761	448	MY	9.2	23	21
UA	129.2	421	249	PH	6.1	17	12

Figure 5. Hungary's top 50 export markets in 2003

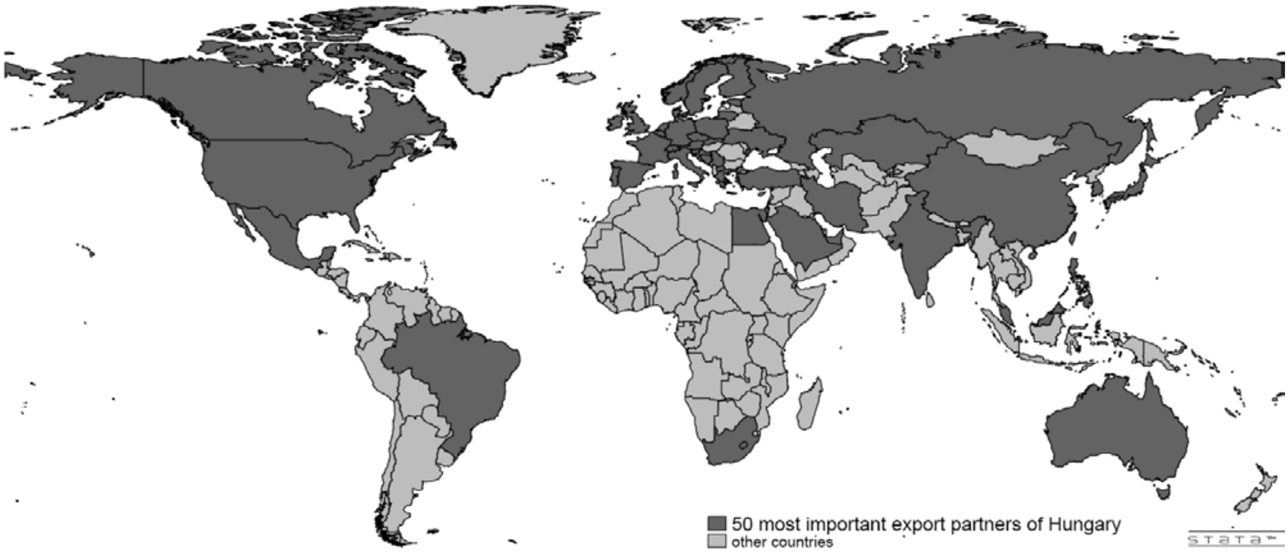

Table 4 presents the OLS estimates. In the first two columns the regression is run on the whole sample. In the last two columns, as a robustness check, we restrict our attention to firm-product pairs for which we have at least 6 or 9 observations, to identify the effect of within firm-product variation to a larger extent.

In terms of the distance variable, we estimate a coefficient of about 10 per cent for the total sample, while the estimated effect is somewhat smaller in the restricted sample. The very high significance of this variable suggests that export unit values increase with distance. GDP/capita has a positive but insignificant coefficient. In line with the Melitz-Ottaviano hypothesis, market size is negatively associated with unit values. Interestingly, tariffs do not affect f.o.b. unit values significantly.

Firm size seems to be the most important from among firm controls. TFP is positively associated with unit values, suggesting that more productive firms are more likely to produce higher quality – and priced – goods. Controlling for productivity, larger firms sell goods at lower unit values on export markets. Foreign ownership does not seem to be an important determinant of export unit values, but becomes significant when we identify the model from within firm-product variation in column (4).

We report the results from the Heckman regressions in Table 5. The results in the selection equations are in line with the theory of heterogeneous firm models. Firms are more likely to export a product to closer and larger markets.[17] GDP/capita does not seem to be a very important determinant of selection. As expected, tariffs are strongly and negatively related to selection. Also, larger, more productive and foreign-owned firms are more likely to export a product to any market. The excluded variables and lambda are highly significant suggesting that we are able to distinguish between selection and quality-to-market to some extent.

[17] The table shows marginal effects at sample mean. As the probability is very low at sample mean, the estimated effects are large relative to this probability.

When explaining unit values, we find results very similar to the OLS estimates. The effect of distance is between 8 and 11% suggesting that export prices are larger by 24-33% in the US than in Germany, in contrast with the Melitz-Ottaviano prediction. Also, GDP seems to be strongly correlated with unit prices: firms charge lower prices in larger markets, which is in line with both models. The point estimate of GDP/capita and the tariff rate are insignificant in all specifications.

Table 4. OLS estimates on the determinants of export unit value

	(1)		(2)		(3)		(4)	
	whole sample		whole sample		observations for firm-product pairs > 5		observations for firm-product pairs > 8	
Log employment			-0.05	***	-0.029	***	-0.05	***
			0.008		0.010		0.010	
TFP			0.067	***	0.034	***	0.015	**
			0.015		0.009		0.008	
Foreign			0.007		-0.035		-0.077	***
			0.015		0.021		0.026	
Log distance	0.096	***	0.102	***	0.075	***	0.08	***
	0.017		0.016		0.015		0.021	
Log gdp	-0.025	**	-0.024	**	-0.009		-0.006	
	0.011		0.011		0.011		0.013	
Log GDP/capita	0.036		0.032		0.023		0.057	
	0.030		0.029		0.023		0.035	
Tariff rate	-0.057		-0.051		-0.051		0.231	
	0.123		0.126		0.138		0.163	
Constant	-0.460**	**	-0.310		-0.381	**	-0.671	**
	0.203		0.189		0.168		0.255	
Observations	23774		22758		3775		1827	
R-squared	0.006		0.013		0.016		0.036	

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors below coefficients

Notes: The reported results are all from OLS regressions. In all equations we included 14 product categories and NACE-2 dummies. The unit of observation is a firm-HS6 product pair. The estimation was run for 2003.

Table 5. Heckman model for the determinants of unit value

	(1) Whole sample		(2) Whole sample		(3) Firm-product pairs: >5 observations	
	selection	unit value	selection	unit value	selection	unit value
Log employment			0.003 ***	-0.058 ***	0.023 ***	-0.032 ***
			0.000	0.005	0.006	0.009
TFP			0.001 ***	0.06 ***	0.064 ***	0.027 *
			0.000	0.012	0.015	0.015
Foreign			0.001 ***	0.002	0.015	-0.037
			0.000	0.013	0.014	0.023
Log distance	-0.001 ***	0.099 ***	-0.001 ***	0.106 ***	-0.029 ***	0.084 ***
	0.000	0.017	0.000	0.009	0.009	0.014
Log gdp	0.001 ***	-0.028 **	0.001 ***	-0.027 ***	0.018 ***	-0.018 *
	0.000	0.011	0.000	0.006	0.006	0.010
Log GDP/capita	0.000	0.036	0.000	0.032 **	-0.018	0.032
	0.000	0.03	0.000	0.013	0.012	0.022
Tariff rate	-0.004 *	-0.073	-0.004 ***	-0.062	-0.040	0.058
	0.002	0.119	0.001	0.079	0.075	0.127
Lambda		-0.119 ***		-0.073 **		-0.126 **
		0.019		0.028		0.051
Prodshare	0.022 ***		0.020 ***		-0.875 ***	
	0.005		0.001		0.096	
Destshare	0.007 ***		0.007 ***		0.707 ***	
	0.001		0.001		0.107	
Observations	2243473	2243473	2051301	2051301	5588	5588

Clustered standard errors below coefficients

*** p<0.01, ** p<0.05, * p<0.1

Notes: The reported results are all from one-step Heckman regressions. In all equations we included 14 product categories and NACE-2 dummies. The unit of observation is a firm-HS6 product pair. In the selection equations we report marginal effects. The estimation was run for 2003.

The role of the European Union raises interesting questions in this framework.[18] Most importantly of all, from a theoretical point of view, distance may play a different role within the EU than in the larger distances outside it, because of lower transportation/administrative costs. We rely on two methods in handling this problem. Firstly, we re-estimate our models with additional interactions of the EU-25 dummy and the gravity variables. The results of this (estimated using the Heckman model) are shown in the first two columns of Table 6. Secondly, we omit observations from the EU altogether to see whether the results differ in this restricted sample, which is reported in columns (3) and (4).

These results reinforce our earlier conclusions. In (1) the coefficient of distance is positive and highly significant, as before. The interaction of the EU dummy and distance is negative and significant, suggesting that the mechanism which relates unit values and distance is weaker

[18] While Hungary became a member only in May 2004, it had already been strongly integrated into the EU in the period under study.

within the strongly integrated EU markets. This result is very much in line with both lower transport costs and weaker quality differentiation within the EU single market. The coefficient of log GDP/capita is also positive, but insignificant. Column (2) shows similar results, with the difference that the interaction of distance and the EU dummy is insignificant, but the point estimate is still negative.

The estimated coefficients for observations outside the EU are remarkably close to the estimates derived for the whole sample. These results can be reassuring in the sense that identification not only comes from within-EU differences, or the differences between unit values in the EU and some unimportant outliers.

Table 6. The role of the EU

	(1)	(2)	(3)	(4)
VARIABLES	Full sample	Full sample	Outside EU	Outside EU
Log employment		-0.057 ***		-0.075 ***
		-0.005		-0.011
TFP		0.058 ***		0.063 ***
		-0.012		-0.023
Foreign		0.002		0.017
		-0.013		-0.029
Log distance	0.094 ***	0.091 ***	0.094 ***	0.095 ***
	-0.020	-0.021	-0.021	-0.021
Log gdp	-0.019	-0.014	-0.019	-0.015
	-0.013	-0.013	-0.013	-0.013
Log GDP/capita	0.064 ***	0.054 ***	0.066 ***	0.058 ***
	-0.018	-0.019	-0.019	-0.020
Tariff rate	-0.144 *	-0.119	-0.100	-0.026
	-0.079	-0.081	-0.118	-0.120
EU25*log distance	-0.059 **	-0.036		
	-0.024	-0.025		
EU25*log GDP	0.003	-0.005		
	-0.014	-0.015		
EU25*log GDP/capita	-0.026	-0.012		
	-0.030	-0.031		
EU25	0.500 *	0.375		
	-0.265	-0.268		
Observations	2243473	2051301	555279	507919
Lambda	-0.0671	-0.0763	-0.0123	-0.0609

Notes: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The reported results are all from Heckman regressions. In all equations we included 14 product category and NACE-2 dummies. The unit of observation is a firm-HS6 product pair. In the selection equations are not reported. The estimation was run for 2003.

Another very important question is to what degree do the results reflect the pricing strategies of multinational firms? As we do not know the nationality of each firm's owner, we cannot exclude trade flows of multinationals to their home country. We exclude all foreign owned firms from the sample, and re-estimate the model only for domestic-owned firms to be as conservative as possible. The results presented in Table 7 are very similar to earlier findings in qualitative terms, suggesting that the relationship between normalised unit values and our variables are very similar for domestic and foreign firms.

Table 7. Estimates for domestic firms only

	(1)		(2)		(3)		(4)	
	whole sample		whole sample		observations for firm-product pairs > 5		Heckman	
Log employment			-0.059	***	-0.055	***	-0.068	***
			0.01		0.012		0.015	
TFP			0.107	***	0.09	***	0.096	***
			0.030		0.021		0.026	
Log distance	0.088	***	0.096	***	0.084	***	0.102	***
	0.021		0.02		0.026		0.021	
Log gdp	-0.022	*	-0.023	*	-0.003		-0.027	**
	0.013		0.012		0.016		0.014	
Log GDP/capita	0.027		0.027		0.001		0.027	
	0.035		0.035		0.035		0.035	
Tariff rate	-0.198		-0.133		-0.204		-0.156	
	0.166		0.174		0.172		0.164	
Constant	-0.35		-0.239		-0.267		0.083	
	0.256		0.242		0.246		0.308	
Observations	15162		14464		1874		1572200	
R-squared	0.005		0.015		0.026			

*** p<0.01, ** p<0.05, * p<0.1

Clustered standard errors below coefficients

Notes: Standard errors are clustered by destination country. *** p<0.01, ** p<0.05, * p<0.1. The reported results are from OLS in (1)-(3) and Heckman in (4). In all equations we included 14 product category and NACE-2 dummies. The unit of observation is a firm-HS6 product pair. In the selection equations are not reported. The estimation was run for 2003.

As a further exercise, we study whether the results differ across differentiated and homogeneous products. We use again the liberal product classification of Rauch (1999). Table 8 shows the results for these product categories. The most important finding is that the effect of distance is stronger for more differentiated products, suggesting that quality differences across destinations are more important for these goods. In terms of GDP, the negative effect is only present for differentiated goods, and the point estimate is even positive for homogeneous goods. This result is consistent with the Melitz-Ottaviano framework, as one may argue that even a small number of competitors may drive down the price close to marginal cost in the case of homogeneous goods, while market size and a larger number of competitors have a more continuous effect on the price of differentiated goods.

Table 8. Heckman model for the determinants of unit values by homogeneity of the product

	(1)		(2)		(3)	
	Homogeneous goods		Reference-priced goods		Differentiated goods	
	selection	unit value	selection	unit value	selection	unit value
Log employment	0.005 ***	0.181 ***	0.003 ***	-0.045 ***	0.002 ***	-0.060 ***
	0.000	0.041	0.000	0.013	0.000	0.012
TFP	0.003	0.000	0.000	0.042 **	0.001 ***	0.088 ***
	0.002	0.081	0.000	0.019	0.000	0.019
Foreign	0.004 **	0.030	0.002 ***	0.027	0.001 ***	-0.007
	0.002	0.065	0.001	0.030	0.000	0.023
Log distance	0.000	-0.007	-0.001 ***	0.084 ***	-0.001 ***	0.119 ***
	0.001	0.047	0.000	0.031	0.000	0.018
Log gdp	0.000	0.041	0.001 *	-0.006	0.001 ***	-0.038 ***
	0.001	0.034	0.000	0.020	0.000	0.012
Log GDP/capita	0.001	-0.018	-0.001 **	0.071 *	0.000	0.035
	0.001	0.060	0.000	0.038	0.000	0.034
Tariff rate	0.005	0.148	-0.004	-0.120	-0.008 ***	-0.028
	0.004	0.179	0.003	0.206	0.003	0.143
Prodshare	0.074 ***		0.034 ***		0.018 ***	
	0.025		0.006		0.005	
Destshare	0.010 ***		0.000		0.006 ***	
	0.004		0.002		0.001	
Observations	30377	30377	238082	238082	1556634	1556634

Standard errors below coefficients

*** p<0.01, ** p<0.05, * p<0.1

Notes: The reported results are from two-step Heckman regressions. The standard errors are clustered by destination. In all equations we included 14 product category and NACE-2 dummies. The unit of observation is a firm-HS6 product pair. The estimation was run for 2003.

Second degree price discrimination

Our results may fully or partly be driven by second-degree price discrimination. Our data, however, is not detailed enough to test all possible forms of price discrimination as for example, we are unable to identify the other partner of the export transaction which would be necessary for complete testing, an examination based on annual quantities is only possible. It would be desirable to build a structural model to encompass the inherent endogeneity of prices and quantities, but our aim is much more modest, namely, whether quantity explains anything in unit values and if the answer is positive, then whether the inclusion of quantities has any impact on our already presented results.

Although our regressions are not run at the level of individual transactions, the average transaction size may be smaller in more distant markets. This may lead to a positive relationship between distance and unit values (and to a negative one between distance and market size). Whether this is the case, we include the export quantity in our regressions. We divide export quantity by the total Hungarian exports of that product in order to normalise across products, and include this normalised variable in our regressions in addition to the gravity variables. If it is significant, it suggests the presence of second-degree price discrimination or simultaneous determination of unit values and export quantity. However, if the gravity variables are also significant when export quantity is included in the regression, then second-degree price discrimination is not the whole story.

We start with a graph on quantity and unit values for the same products as in Figure 4, shown in Figure 6. There are 9 firm-product combinations out of 14 for which the relationship between quantities and unit values is significant and for 8 the coefficient is negative.

Table 9 presents the econometric results estimated by both OLS and Heckman. The quantity variable is significantly negative, suggesting a relationship between unit values and shipment size. The other estimates, however, change only marginally. In particular, the estimated coefficient of distance is again very close to 10 percent in each specification, and the coefficients of the two other gravity variables are also very similar to the baseline results. This shows that gravity variables affect unit values through price discrimination both directly and indirectly.

Figure 6. Unit values and quantities

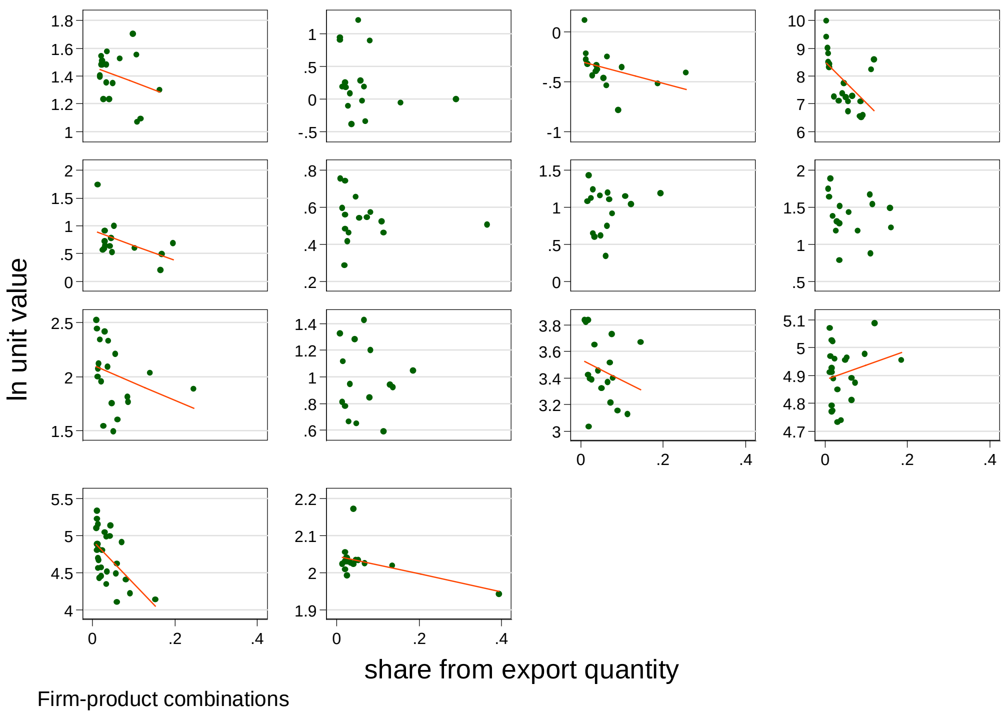

Table 9. Unit value with quantities

	(1) OLS		(2) OLS		(3) Heckman		(6) Heckman	
Log employment			-0.046	***			-0.056	***
			-0.004				0.005	
TFP			0.077	***			0.068	***
			-0.009				0.012	
Foreign			0.029	**			0.023	*
			-0.013				0.013	
Log distance	0.092	***	0.095	***	0.097	***	0.101	***
	0.009		-0.009		0.009		0.009	
Log gdp	-0.021	***	-0.019	***	-0.025	***	-0.024	***
	0.006		-0.006		0.006		0.006	
Log GDP/capita	0.025	*	0.021		0.024	*	0.020	
	0.013		-0.014		0.013		0.013	
Tariff rate	-0.079		-0.078		-0.115		-0.103	
	0.057		-0.058		0.077		0.078	
Normalised quantity	-0.608	***	-0.598	***	-0.614	***	-0.602	***
	0.022		-0.023		0.025		0.025	
Observations	23774		22758		2278164		2083061	
R-squared	0.031		0.037					
Lambda					-0.106		-0.113	

*** p<0.01, ** p<0.05, * p<0.1

Clustered standard errors below coefficients

Quality-to-market and alternative pricing-to-market approaches

The empirical results suggest a number of patterns in the data:

1) All results suggest that firms charge different prices even for the same product in different markets.
2) These differences are systematic. Practically all of our different approaches suggest a robust and significant positive relationship between f.o.b. unit values and bilateral distance at the firm-product level.
3) There is evidence for a positive relationship between unit values and GDP/capita within firm-product combinations.
4) Unit values and GDP seem negatively related.
5) Differences are more important for differentiated products.

All these stylised facts suggest a systematic variation of unit values within firm-product combinations. This contradicts the story that unit value differences can be explained by firm or firm-product level selection and, as a consequence, by composition effects. Models building only on selection cannot account for these patterns. Also, fact 2) contradicts the endogenous markup model of Melitz and Ottaviano (2008), in which firms absorb part of the transportation cost in their f.o.b. prices.

As a consequence, the revealed within firm-product heterogeneity has to be explained in a somewhat different framework. In this section we propose two explanations that are in line with the stylised facts. First, it is possible that firms are able to produce different quality versions of their products, and within firm-product selection may explain differences in observed unit values. This effect can be called quality-to-market. Secondly, directly exporting firms may buy transport services in a competitive market, and as a consequence markups on transaction cost may appear in f.o.b. prices.

In the quality-to-market hypothesis prices may correspond to quality differences across markets. These quality differences may come from customisation to market; if firms produce slightly differentiated versions of the product for each market (e.g., package with different language), then some quality differentiation can also be added at a relatively low cost. If transport costs depend on the number of units exported, as in the Alchian-Allen framework, it is profitable to differentiate in such a way that the quality is somewhat higher in more distant markets. Also, firms may create higher-quality versions for richer markets, if those markets are more demanding in terms of quality.

One may assume that firms are producing a range of different versions of the same product. Consider a firm producing a cheap and a 'premium' version of the same product (e.g. beer). If the transportation cost of beer has per unit components, rather than being fully *ad valorem*, it is easily possible that the firm exports both versions to nearby markets, but exports only the high quality version to more distant markets. This would mean that observed unit values, that is, the weighted average unit value of all versions of the same HS-6 product category increases with distance.

More generally, this framework would represent within firm-product selection. Assume that a firm produces different quality versions of the same good. If the marginal cost of producing different versions increases more slowly in product quality than the consumers' willingness to pay for quality, then – assuming unit transport costs – firms may export only higher quality goods to more distant markets.

What are the predictions of such a quality-to-market model for within firm-product patterns? First, f.o.b. unit values certainly increase with distance within firm-product combinations. Second, if relative demand for higher quality goods is larger in richer countries, one may expect a positive relationship between observed unit value and GDP/capita.

The effect of market size is less clear cut. In a framework without fixed costs of exporting, market size should not affect the relative share of high and low quality goods. Assuming fixed exporting cost however firms would export more versions of the same good, that is, exporting even the low quality versions. As a consequence, with fixed export costs the framework would predict a negative relationship between distance and unit value within firm-product combinations. Also, these effects should be more important for products with a possibility of stronger quality differentiation. This would mean that the explanatory power of the gravity variables is positively related to the differentiated nature of the good. All these predictions are in line with our stylised facts.

Our second proposed explanation starts from assuming that firms export the same good to all markets, but its markup varies across destinations (as in the Melitz-Ottaviano model). Here, however, instead of absorbing part of transport cost, the firm adds a markup to them and this shows up in the f.o.b. price. We can easily imagine a situation in which the firm, after finding a foreign partner, looks for a transporting firm in a competitive market. If the firm charges a markup on its marginal cost plus the transport cost, the markup on the transport cost may show up in the f.o.b. price.

This explanation may have less important theoretical consequences than the possibility of quality-to-market. It is mainly an empirical issue as f.o.b. prices are in fact not necessarily f.o.b. This empirical problem, however, may have important consequences in different applications. For example, the decomposition of trade into intensive and extensive margins may easily become biased if price differences and their association with gravity variables are ignored. Thus, theoretical models that attempt to explain this decomposition, may assume too much selection as opposed to a natural difference between the accounting standards used by the firms and imagined by trade economists.

Conclusions

This paper attempts to gain more insights into differences in export unit values across destination markets. The effect of gravity variables on unit values remains even for firm-product combinations. The relationship between distance and unit values is particularly important - representing between 25-30% difference between Hungarian exports to Germany and to the US. Similar, but somewhat weaker relationships emerged between unit values and other gravity variables. These results are robust to a number of different approaches: either using very elementary data or estimating firm-product fixed effect regressions or even modelling heterogeneity explicitly. We have also shown that the main results hold within and outside the EU market, and that the distance and unit values are positively associated for both domestic and foreign firms.

Our findings are not in line with models emphasising only firm-level selection, and the relationship between unit values and distance is exactly the opposite to the prediction made by Melitz and Ottaviano (2008). We propose two explanations for these stylised facts. First, firms may produce different versions of their products, and only export higher quality versions to more distant markets if transport costs are also related to the number of units transferred, and not only to export value. Secondly, it is possible that the markup on transport costs acquired in a competitive market also appears in observed f.o.b. prices, leading to a positive relationship between distance and unit values.

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