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

July 28, 2016

Abstract

In this paper we analyse the relationship between distance and f.o.b. export unit values using firm-product-destination data from Hungarian manufacturing. By using 10-digit harmonized system data, we show that a doubling of distance is associated with about 7.5% increase in the average product-level price, from which 5 percentage points can be attributed to within firm-product variation. We run a number of tests to look for heterogeneity in this pattern. Interestingly, the measured effect is very similar for domestic and foreign firms but distance seems to matter somewhat more for EU countries than otside the EU. We do not find much evidence for heterogenity across product categories based on measures of vertical differentiation. The level of product aggregation matters, the distance coefficient is larger when products are aggregate to the 8 or 6-digit level.

Keywords: export, price, selection, Hungary

JEL: D40, F12

This paper is produced as part of the 'European Firms in a Global Economy: Internal policies for external competitiveness (EFIGE)', a collaborative project funded by the European Commission's Seventh Framework Programme (contract number 225551). Muraözy also thanks the funding of the Hungarian Academy of Sciences for the 'Firms, Strategy and Performance' "Lendület" Grant (LP2013-56). Part of the research was done while Muraközy stayed in Kiel at Institute for the World Economy. The authors are grateful to workshop participants at Kiel, Nottingham, Rome and Budapest for helpful comments on earlier drafts. Holger Görg Kiel Institute for the World Economy. Christian-Albrechts-University of Kiel and CEPR, László Halpern CERS HAS, CEPR, CEU, Balázs Muraközy CERS HAS

1 Introduction

Recent theories emphasize the role of firm heterogeneity and selection in international trade. More productive firms are more likely to be exporters, and the most productive exporters ship more goods to more markets (see, for example, Bernard et al. (2007)). These facts can be explained with (by now) standard heterogeneous firm type models à la Melitz (2003). More recently, the literature has also evolved towards looking into export prices in addition to quantities. Here the stylized fact emerges that exporters charge higher prices for their products on foreign markets than non-exporters on the domestic market (e.g., Johnson (2012), Hallak and Sivadasan (2013) and Iacovone and Javorcik (2012)). This may be due to exporters producing higher quality goods, or because they charge different f.o.b. prices on different markets.

This is where our paper comes in. We have access to recent highly disaggregated, firm-product category-destination data which make it possible to analyze the extent of heterogeneity in prices among exporters at a disaggregated level. In this paper we document that Hungarian firms charge different prices for the same 10-digit product category in different markets, and in particular, export unit values are increasing with distance. We show that a doubling of distance is associated with about 7.5% increase in average product category level prices. About 5 percentage points from this can be explained by within-firm-product differences and about 2 percentage points can be attributed to the composition effect, i.e. that a different set of firms export the product to different markets. The within firm-product estimates suggest an economically significant effect, about 15 per cent difference in unit values between Hungarian products exported to Germany and the US.

Our results are much in line with the findings of other researchers. To our knowledge, there are four empirical papers which start from firm-product-destination level price data and show a positive relationship between distance and export unit values, that is, the same firm charging different prices for the same product in different markets. Manova and Zhang (2012) work with Chinese micro data on firm-product-destination level export and import prices. In addition to finding a positive distance gradient, the results establish a positive link between export prices and export sales, export prices and number of destinations, and import prices and export prices. Martin (2012) builds his analysis on French data and relaxes the pricing condition in the trade model in order to reconcile higher prices with higher transport costs. Bastos and Silva (2010) using Portuguese data show that within product categories, higher productivity firms tend to export greater quantities at higher prices to a given market, consistent with higher quality. Moreover, they reveal that firm productivity tends to magnify the positive effect of distance on within-product unit values, suggesting that higher productivity, higher quality firms are more able to serve difficult markets. Finally, Harrigan et al. (2015) show that patterns are similar in US trade data and self-selection of firms explains most of the product-level differences.

Importantly, a positive relationship between export unit values and distance was also found by Feenstra and Romalis (2014) who used product-level data and these authors also show that quality-adjusted prices vary much less than unit values.

The positive relationship between distance and unit values does not emerge in the most widely used trade models. In models with CES demand and iceberg transportation costs firm-level productivity (Melitz (2003)) or quality heterogeneity (Baldwin and Harrigan (2011)) do not result in pricing-to-market at the firm level. Also, some existing variable markup models predict a negative gradient: in Melitz and Ottaviano (2008) f.o.b. prices are decreasing in distance for a given firm-product combination.

There are two kinds of possible explanations for the positive relationship between distance and prices. The first is based on recent extensions of Alchian and Allen (1964), as in Hummels and Skiba (2004). According to this supply-side explanation, firms produce different quality versions of their products, and under additive transportation costs they shift the composition of their export products to higher quality, more expensive goods at more distant markets: they ship the good apples out. This may happen across firms but also within firms: firms can export more expensive products or higher quality versions of the same product to more distant markets. We will call this mechanism the Alchian-Allen-type mechanism. A possible prediction of this supply-side explanation is that the relationship between distance and unit values may be larger when the possibility of vertical differentiation is larger. Second, under additive transportation costs it can be optimal for firms to increase their markup with distance, as suggested by Martin (2012). This is, in effect, a pricing-to-market explanation.

Our contribution to this literature is threefold. First, we document that the patterns in Hungary are very similar to those found in other, more advanced EU countries, and qualitatively similar to those found for the US and China.

Second, we study whether the relationship between distance and export unit values is heterogeneous in a number of dimensions. We show that domestic and foreign-owned firms behave very similarly. This is somewhat surprising because foreign-owned firms may use transfer pricing. Importantly, the estimated coefficients are somewhat larger within the EU than outside it. We also show that while the coefficient for distance differs between product categories classified according to across-firm price variation, we find no significant differences when product categories are grouped by proxies for vertical differentiation (following Khandelwal (2010) and Kugler and Verhoogen (2012) and the elasticity of demand (based on Broda et al. (2006)). The lack of evidence for this channel may suggest that pricing-to-market plays a larger role in the positive gradient than the Alchian-Allen channel.

Third, to shed some light on the role of product aggregation selection, we run the regressions for different aggregation levels (HS6, HS8 and HS10). This question is of practical importance for empirical work but may also provide indirect evidence for a selection of more expensive or higher quality HS10 products into more distant markets within 6- and 8-digit categories. We indeed find that the elasticity at the 6-digit level is about 30 percent larger than on the 10-digit level. This means that within 6-digit categories firms ship out more expensive 10-digit varieties. This can be interpreted as evidence for Alchian-Allen type effects at this level of aggregation.

All in all, we confirm that the relationship between export unit values and distance is positive. We find some evidence for heterogeneity in terms of geography (within the EU and outside it), but we find limited heterogeneity based on possibility for vertical differentiation or elasticities of demand. We also conclude that product aggregation matters, i.e. using data at 6- or 8-digit level yields different results than using 10-digit categories.

In the remaining part of the paper we first describe the data set and show a few descriptive statistics. Section 3 presents the baseline results, and Section 4 describes the calculations regarding the composition effect. In Section 5 we discuss and conclude.

2 Data

In this paper we analyze Hungarian trade data. Hungary, a small open economy, is ideal for this exercise, because data is available at a highly disaggregated level and its coverage is exceptionally wide.[1]

The data used for our empirical analysis were obtained from the Customs Statistics. The dataset consists of all Hungarian exports between 1992 and 2003. In this paper we rely on the second half of this sample, between 1998 and 2003 to make sure that transition does not play a role in our results. One observation in the database is the export of product i by firm j to country k in year t.[2]

The product dimension of the dataset is highly disaggregated; it is broken down to 10-digit Harmonized System (HS) level. In what follows, we will use the term 'product' for a 10-digit category, and indicate when we are writing about more aggregated categories. Table 7 in the Appendix shows an example for the different levels of aggregation.

The dataset includes both export values (x_{ijkt}) and quantities in natural units of measurement (q_{ijkt}) at this highly disaggregated level, thus unit values are calculated as the ratio of these two variables:

$$uv_{ijkt} = \frac{x_{ijkt}}{q_{ijkt}}$$

We restrict our attention to manufacturing firms. Theories of heterogeneous firms can be applied to direct export of manufacturing firms more straightforwardly than to exports of services or exports of manufacturing products by wholesalers or retailers. Also, we restrict our attention to manufacturing products, to get rid of the noise caused by manufacturing firms exporting a few agricultural products and services.

[1] In Hungary, exports played an important role in economic growth during the 1990s and in the beginning of the 2000s. 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 are reflecting the trade structure of a country benefiting from export led growth rather than transition-specific patterns. Consequently, the stylized facts reported in this paper may show general patterns that can potentially reflect those in other economies as well.

[2] A more detailed description of our data can be found in Békés et al. (2011).

year	prods	firms	firm-product	firm-country	firm-product country
1998	1796	1701	4300	9622	18638
1999	1879	1761	4463	10355	19677
2000	1889	1883	4617	11633	21713
2001	2007	2020	5051	12584	23708
2002	1875	1961	4649	11595	21283
2003	1864	2015	4737	12284	22488

Table 1: Number of observations

We delete all products 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$500 will be disregarded. We also drop outliers for which the log difference between the unit value and the product-year average is larger than 3 – around 2% of observations. Bekes and Murakozy (2012) 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.[3]

The number of observations is presented in Table 1. There are about 5000 firms and 3500 product categories in the database in each year. A firm exports a little bit more than two products on average and exports one product to a mean of somewhat more than two countries.

The unit value variable has a large variance even within 10-digit categories across our observations.[4] On average, its coefficient of variation is about 60 percent, varying between 22 percent for mineral goods and 86 percent for Machinery and Electrical goods. Importantly, an ANOVA decomposition of this within 10-digit-product variation reveals that about 40 percent of it is explained by firm fixed effects and about 15 percent by destination fixed effects. The role of destination markets differs across types of products: country fixed effects explain only 3 percent of the variation for Machinery and Transportation while they explain 55 percent in the case of Mineral Products. To sum up, there is significant unit value variation within narrow product categories, and a substantial part of it can be explained by destination country characteristics, the focus of this paper.

The distance variables are obtained from the databases of CEPII.[5] GDP data is from the OECD.

In order to handle possible omitted variables, we include three controls into all our equations. First, export prices may depend on the intensity of competition, which may be proxied by the average prices on the destination market. Note that his variable may also capture differences in demand for quality in the destination (not fully captured by income per capita). We follow Martin (2012)

[3]We have re-run our regressions on the original sample, and the results were very similar.

[4]In the analysis described in this paragraph, we normalized log unit values with their mean in each 10-digit category.

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

in constructing these measures by using product-level trade data. In particular, we have downloaded total import value and quantity data at the country-HS6-year level from the Comtrade database to calculate (log) average unit values at this level. Second, we control for tariffs at the country-HS6-year level by using the weighted average of effectively applied ad valorem rates from the UN TRAINS database. Finally, we also control for (log) real effective exchange rates provided by Bruegel.

When we test for heterogeneity across products, we use four variables. First, we simply calculate the dispersion of unit values within each product from the data at hand. Second, we use the 'ladder' variable as a proxy for potential vertical differentitation from Khandelwal (2010). Third, to a similar effect, we use the R&D + advertising intensity variable suggested by Kugler and Verhoogen (2012). Finally, to test whether the coefficient varies by the elasticity of demand, we rely on the elasticities estimated at the country-product level by Broda et al. (2006) at the HS3 level. The advantage of these data is that elasticities differ across 73 countries[6] but using the estimated elasticities for the US yields similar results.

3 Baseline results

In this section we estimate the within-firm relationship between unit values uv_{ijkt} and gravity variables to shed light on within firm-product price differences. In section 4 we dig somewhat deeper to see whether this effect is different across different kinds of products.

We run a firm-product fixed effects specification with gravity variables and tariff rates to gain insights into the within firm-product variation in unit values.

$$\ln uv_{ijkt} = \beta_0 + \beta_1 \ln dist_k + \beta_2 \ln GDP_{kt} + \beta_3 \ln \frac{GDP_{kt}}{pop_{kt}} + \gamma X_{ijkt} + \eta_{ijt} + \epsilon_{ijkt} \quad (1)$$

where X_{ijkt} includes tariffs, average import unit value and the real exchange rate. η_{ijt} is fixed effects at the 10-digit product-firm-year level.[7] We cluster standard errors at the year-destination level.

The baseline results are reported in Table 2. The first column shows results with product-year fixed effects while the second includes firm-product-year fixed effects. We have omitted firm-product combinations with less than two observations from the first column to make these results comparable.[8] The main result is that the coefficient on distance is 0.076 when estimated with product-year fixed effects, and 0.053 in the specification with firm-product year fixed effects. This means that about a third of the product-level gradient can be explained

[6]For countries where this measure is missing, we use the US measure. Dropping these countries do not affect the results

[7]We use the reghdfe command in Stata to estimate the model with so many fixed effects.

[8]Including these observations or excluding firm-products with less than 3 or 4 observations does not change the results importantly.

by the different composition of firms exporting to different markets while about two-thirds come from within-firm variation.

It is important to note that our results are very much in line with that of other European studies. First, Martin (2012) finds that the firm-product level distance elasticity for French firms (similar to our FE estimate) is between 0.02 and 0.05, which is very close to our estimate. Similarly, Bastos and Silva (2010) finds a distance elasticity of 0.05. The similarity of these findings to our results in Hungary shows that in this respect firms in different European countries behave very similarly.

Results for other countries are somewhat different. Harrigan et al. (2015) find an elasticity of 0.17 for US firms, which is somewhat larger than those for European firms. On the other hand, Manova and Zhang (2012) find a smaller distance elasticity around 0.01 for Chinese firms. Such differences may be explained by the differences across these economies and the different geography of their trade.

The results on the other gravity variables are as expected. The coefficient for market size is negative, which is in line with the predictions of Melitz and Ottaviano (2008): stronger competition on larger markets drives prices down. The coefficient on per capita GDP is positive, which may arise from higher demand for quality in these markets or from price discrimination, namely that higher-income consumers are likely to be less price sensitive (Bastos et al. (2014)).

The other three controls also have the expected sign and a reasonable magnitude. First, higher prices in the export market are associated with higher Hungarian export prices: 10 percent higher destination market prices imply about 0.5 percent higher Hungarian export prices. Second, higher tariffs are associated with lower f.o.b. prices suggesting the presence of variable markups. Finally, the coefficient of the real exchange rate is only marginally significant, but its point estimate suggests that pass-trough is imperfect, f.o.b. prices are affected to some extent by the exchange rate.[9]

In columns (3) and (4) we study whether foreign (at least 10% foreign ownership share) and domestic-owned firms differ in their behavior. Our concern was that transfer pricing of multinationals may be responsible for price differences across markets. We find, however, that the coefficients of all variables are similar between the two groups of firms with the exception of the real exchange rate, which is only significant for domestic firms. These specifications reinforce that the main results are not a consequence of transfer pricing.

One possible concern with our estimates is that export prices to distant markets may be correlated with some variables following a trend (e.g. the change in transportation costs). One possibility to handle this problem is to estimate the distance coefficient from cross-sectional variation by including its interaction with year dummies. Results in Appendix Table 8 show these results. These estimates suggest that the role of distance has become somewhat stronger over time. The qualitative results remain similar to the main result, though.

[9]Note that because of the fixed effects we identify this coefficient from cross-sectional variation, hence this coefficient is not really comparable with results from studies estimating exchange rate pass-through, which rely on longitudinal indentification

	(1) PY FE	(2) FPY FE	(3) Dom. FPY FE	(4) For. FPY FE
log distance	0.076***	0.053***	0.052***	0.053***
	(0.004)	(0.003)	(0.004)	(0.003)
log real gdp	-0.016***	-0.018***	-0.014***	-0.020***
	(0.003)	(0.002)	(0.003)	(0.002)
log real gdp p.c.	0.029***	0.022***	0.020**	0.023***
	(0.008)	(0.005)	(0.008)	(0.006)
Imp. price level	0.042***	0.026***	0.033***	0.023***
	(0.005)	(0.004)	(0.006)	(0.004)
Tariff	-0.002***	-0.001*	-0.000	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
REER	0.034*	0.023	0.043**	0.010
	(0.020)	(0.014)	(0.020)	(0.017)
Observations	127,508	127,508	52,924	74,584
R-squared	0.876	0.943	0.949	0.940

Dependent variable is the ln unit value of the product. One observation is one firm-HS10-destination-year combination for Hungarian exports between 1998 and 2003. Column (1) includes product-year fixed effects while the other columns include firm-product-year fixed effect. Columns (3) and (4) distinguish between domestic-owned and foreign-owned firms. Standard errors are clustered at the destination-year level.

Table 2: Baseline results

Table 3 shows the relationship between quantities and gravity variables with the same right-hand side. The within-firm-product elasticity of quantity with respect to distance is about -0.5 and it is somewhat larger for foreign-owned firms. Quantity is also increasing in market size. Foreign firms seem to export more to more developed countries while we do not find such a correlation for domestic firms.

4 Heterogeneity across markets and products

After documenting the importance of the within firm-product relationship between distance and export prices, we will take a look at the differences across markets and products. Such heterogeneity or the lack thereof may shed light on the relative importance of mechanisms. First, we study whether the patterns are similar within the EU and outside it. Second, we classify products according to vertical differentiation and the elasticity of demand. Finally we re-run the regressions for different aggregation levels.

4.1 Different markets

Studying whether the observed patterns are present in different markets is an important robustness check. Also, if there are important differences between

	(1) PY FE	(2) FPY FE	(3) Dom. FPY FE	(4) For. FPY FE
log distance	-0.473***	-0.506***	-0.355***	-0.582***
	(0.021)	(0.024)	(0.022)	(0.028)
log real gdp	0.428***	0.453***	0.382***	0.496***
	(0.017)	(0.019)	(0.017)	(0.024)
log real gdp p.c.	0.151***	0.174***	0.001	0.230***
	(0.029)	(0.029)	(0.034)	(0.033)
Imp. price level	-0.080***	-0.058***	-0.088***	-0.047***
	(0.015)	(0.014)	(0.021)	(0.016)
Tariff	0.003*	0.000	0.000	-0.000
	(0.001)	(0.002)	(0.002)	(0.002)
REER	0.128	0.071	0.198*	0.047
	(0.103)	(0.105)	(0.118)	(0.117)
Observations	127,508	127,508	52,924	74,584
R-squared	0.558	0.681	0.705	0.665

Dependent variable is the ln quantity of the product. One observation is one firm-HS10-destination-year combination for Hungarian exports between 1998 and 2003. Column (1) includes product-year fixed effects while the other columns include firm-product-year fixed effect. Columns (3) and (4) distinguish between domestic-owned and foreign-owned firms. Standard errors are clustered at the destination-year level.

Table 3: Baseline results for quantity

EU and non-EU countries, that could suggest that tariffs or long transportation lags may play an important role in the mechanisms behind the gradient.

Table 4 shows the estimates for different country groups: the EU 15, the EU 25 and non-EU countries. Note that Hungary had only joined the EU in 2004 but most tariff barriers were absent by 1998.[10]

We see two interesting differences between EU15 and non-EU countries. First the point estimate of distance is much larger for the EU. While this may reflect larger price differences across EU countries, it may also result from the fact that distance is a better measure of transportation costs within the EU than outside it. Second, while the coefficients on distance in columns (1) and (2) differ, they are fairly similar in columns (5) and (6). This is in line with the idea that composition effect plays a much larger role in the positive relationship betwen distance and unit values within the EU than outside. This suggests that firm composition, hence the extensive margin, is more important within the FTA while the composition of outside-EU exporters is more similar across countries.

[10]Hence we have dropped the tariff variable for this country group, as it only varies for very few observations which are likely to be outliers. Including it, however, does not affect the results.

	(1)	(2)	(3)	(4)	(5)	(6)
	eu15	eu15	eu25	eu25	not EU25	not EU25
	PY FE	FPY FE	PY FE	FPY FE	PY FE	FPY FE
log distance	0.083***	0.061***	0.071***	0.045***	0.049***	0.041***
	(0.007)	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)
log real gdp	-0.020***	-0.021***	-0.015***	-0.019***	-0.009***	-0.010***
	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
log real gdp p.c.	-0.032	-0.004	0.046***	0.017	0.027***	0.025***
	(0.035)	(0.027)	(0.016)	(0.011)	(0.008)	(0.007)
Imp. Price level	0.039***	0.026***	0.046***	0.028***	0.029***	0.019***
	(0.007)	(0.006)	(0.006)	(0.005)	(0.008)	(0.006)
Tariff			-0.003***	-0.001***	-0.001*	-0.001**
			(0.001)	(0.000)	(0.001)	(0.000)
REER	0.444***	0.423***	-0.093**	-0.011	0.056***	0.052***
	(0.109)	(0.093)	(0.037)	(0.026)	(0.020)	(0.017)
Observations	57,262	57,262	90,169	90,169	26,107	26,107
R-squared	0.874	0.948	0.876	0.948	0.918	0.952

Dependent variable is the ln unit value. One observation is one firm-product-destination-year combination for Hungarian exports between 1998 and 2003. Columns (1), (3) and (5) include product-year fixed effects while the other columns include firm-product-year fixed effect. Standard errors are clustered at the destination-year level.

Table 4: Country groups

4.2 Heterogeneity across products

Different mechanisms may imply that the relationship between distance and unit values may differ across different product groups. In this subsection we classify products according to measures proxying the potential of vertical differentiation and the elasticity of demand to test for such heterogeneity. The econometric specification is always such that we create quartile dummies from the relevant variable and interact these dummies with the distance variable.[11] These results are presented in Table 5.

Columns (1) and (2) investigate whether the potential for vertical differentiation is related to the distance elasticity of unit values. In column (1) we use the 'ladder' measure of vertical differentiation calculated by Khandelwal (2010). Khandelwal (2010) uses both price and quantity information in order to estimate the quality of products exported to the United States. His empirical strategy assigns higher quality to products with higher market share conditional on price. Khandelwal (2010) estimates the range of these quality levels for each product category and interprets this product-level range, or the length of the quality ladder, as a proxy for the product markets' scope for quality differentiation.[12] We also rely on this measure to see whether products with different potential quality range have different distance gradients. In particular, if vertical differentiation (within-firm-product Alchian-Allen effect) plays an important role in this gradient, then the gradient should be lower for products with shorter ladders. The results, however, suggest that this is not the case: if anything, the gradient is actually lower for products with higher quality ladder.

In column (2) we focus on another measure of potential differentiation based on the theory of Sutton (2001) and calculated by Kugler and Verhoogen (2012). This measure is calculated as the R&D and advertising intensity of firms from US data.[13] Again, the coefficient does not provide evidence for a robust positive relationship between this variable and the elasticity of unit values with respect to distance.

Finally, in column (3) we study whether the gradient is related to demand elasticities based on the sigmas estimated by Broda et al. (2006).[14] Note that these estimates differ across 73 countries, hence they handle potential differences coming from different levels of development or openness. Again, the gradient does not differ across product groups defined by this variable.

All in all we do not find evidence that the elasticity is related to the possibil-

[11]The quartiles are created at the observation (firm-product-destination-year) level, so a quarter of observations are in each quartile. The results are similar if the quartiles are defined at the 6-digit HS category level.

[12]This variable is at the 10-digit HS level, hence it fits the classification in our database quite neatly.

[13]This measure is given by the Online Appendix of Kugler and Verhoogen (2012) for four-digit ISIC rev. 2 industries. With concordances from the OECD, we first transform it to ISIC rev 3.1 and then to Nace 1.1 and merge the data with the industry identifier of our firms. When an industry has multiple pairs in the concordance, we take a simple average. As a result, probably we measure this variable with a significant amount of noise.

[14]These elasticities are calculated at the 3-digit HS level, hence for heterogeneous 3-digit categories they can be quite noisy.

	(1) Khandelwal ladder	(2) R&D + adv. intensity	(3) BW sigmas
log distance * 1st quartile	0.052***	0.043***	0.054***
	(0.005)	(0.005)	(0.003)
log distance * 2nd quartile	0.058***	0.054***	0.056***
	(0.005)	(0.004)	(0.003)
log distance * 3rd quartile	0.046***	0.079***	0.053***
	(0.005)	(0.007)	(0.003)
log distance * 4th quartile	0.039***	0.052***	0.051***
	(0.006)	(0.004)	(0.003)
log real gdp	-0.020***	-0.020***	-0.018***
	(0.002)	(0.002)	(0.002)
log real gdp p.c.	0.022***	0.023***	0.021***
	(0.006)	(0.005)	(0.005)
Imp. Price level	0.018***	0.023***	0.026***
	(0.004)	(0.004)	(0.004)
Tariff	0.001	-0.000	-0.000
	(0.001)	(0.000)	(0.000)
REER	-0.004	0.017	0.020
	(0.018)	(0.014)	(0.014)

Dependent variable is the ln unit value. One observation is one firm-product-destination-year combination for Hungarian exports between 1998 and 2003. All specifiacations include interactions of quartiles of a variable with distance. In colums (1) we include interactions based on the the quartiles of the ladder variable calculated by Khandelwal (2010), in column (2) the variable is R&D + adv. intensity from Kugler and Verhoogen (2012) while in column (3) it is the sigmas at the country-product level from Broda et al. (2006). All specifications include firm-product-year dummies. Standard errors are clustered at the destination-year level.

Table 5: Product heterogeneity

ity of within-firm-product vertical differentiation. As our test is quite indirect and some of the variables we use may provide very noisy measures for the potential for vertical differentiation for Hungarian firms (either because different classifications or because they are calculated from US data), we would not consider the lack of heterogeneity as a proof that within firm-product vertical differentiation is not important. Still, these results suggest that price dicrimination may play a primary role in the distance gradient.

4.3 Different aggregation levels

Finally, we test whether the results differ when more aggregate product definitions are used. There are two rationales for this test. First, in a practical sense it is interesting to see whether different aggregation levels lead to different results. Second, if the results differ, that can be interpreted as indirect evidence for the importance of a composition effect within broader product categories. Further, if the gradient is larger for more aggregated product categories this suggests that Alchian-Allen type effects may play a role within HS6 and HS8 categories: probably its not shipping the good apples out, but shipping grapes rather than apples out.

Hence, in Table 6 we show the results for 10-digit categories together with regressions run on the dataset aggregated up to 6 and 8-digit categories. Importantly, we restrict the sample to firms which produce at least two 10-digit products within the 6-digit category.[15]

Table 6 shows the results from this exercise. First, there are very few observations when more than one 10-digit product is produced within an 8-digit category. There are more products within 6-digit categories. There is also an interesting difference between 6-digit product-level results and the other two columns: the coefficient is about 25 percent larger at the 6-digit level. One can interpret this result as suggesting that there is some Alchian-Allen type selection within 6-digit categories: even within firms, more valuable 10-digit categories are shipped out within each 6-digit category.

5 Conclusion

In this paper we have shown at a very disaggregated level (10-digits) that Hungarian firms charge different prices in different export markets. In particular, firms charge higher prices on more distant and more wealthy markets, and they charge lower prices on larger markets. These results, both in qualitatively and quantitatively, reinforce earlier results for other countries.

The positive relationship between within firm-product unit values is significant economically, as it suggests a 15% difference between unit values of Hungarian exports to Germany and to the US. This finding cannot be easily explained by the most important heterogeneous firm models. Two main mechanisms were proposed by the literature as an explanation for this phenomenon. First, an Alchian-Allen type selection may take place even within firm-product combinations; firms may export higher quality (and more expensive) versions of the product to remote markets when transportations costs have a per-unit component. Second, firms may charge a higher markup on more distant markets, which can be optimal under non-iceberg transportation costs.

Our aim in this paper was to shed some light on the heterogeneity of such effects and possibly derive some conclusions on the importance of different mechanisms behind the positive relationship between distance and export unit values. First, we show that domestic and foreign firms behave very similarly, hence the gradient is not a consequence of transfer pricing. Second, the coefficients differ

[15] An important problem is that there is no guarantee that the 10-digit variants within an 8-digit category mainly differ in quality. Finding such products is a hard task. Alessandria and Kaboski (2011) has collected a number of such products, but merging their database with ours yielded very few observations.

	(1) HS10 FE	(2) HS8 FE	(3) HS6 FE
log distance	0.056***	0.061***	0.075***
	(0.005)	(0.005)	(0.006)
log real gdp	-0.008**	-0.009***	-0.008*
	(0.003)	(0.003)	(0.004)
log real gdp p.c.	0.040***	0.041***	0.064***
	(0.010)	(0.010)	(0.012)
Imp. Price level	0.056***	0.051***	0.059***
	(0.009)	(0.009)	(0.011)
Tariff	-0.002***	-0.002***	-0.003***
	(0.001)	(0.001)	(0.001)
REER	0.100***	0.094***	0.092***
	(0.025)	(0.027)	(0.034)
Observations	33,453	31,606	22,719
R-squared	0.910	0.903	0.875

Dependent variable is the unit value of the product normalized at the 10-digit-year level. One observation is one firm-product-destination-year combination for Hungarian exports between 1998 and 2003. Fixed effects specifications include firm-product-year dummies. Standard errors are clustered at the destination-year level.

Table 6: Different aggregation levels

somewhat between EU and non-EU countries, suggesting that FTAs may affect the mechanisms behind the positive relationship between distance and unit values. Third, studying heterogeneity across products, we find no evidence that it is increasing in the possibility of vertical differentiation of products. Hence, our results do not support the within-firm-product vertical differentiation across markets; pricing-to-market seems to describe the data better. Fourth, the estimated coefficient is somewhat larger at higher levels of aggregation (6-digit vs. 10 digit product categories). This may suggest that firms are 'shipping out' more expensive 10-digit variants within 6-digit categories. In this sense, there seems to be an Alchian-Allen type composition effect at this level of aggregation.

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6 Appendix

Aggregation	Code	Description
4-digit	8802	Other aircraft (for example, helicopters, airplanes); spacecraft (including satellites) and spacecraft launch vehicles
6-digit	8802.11	Helicopters of an unladen weight $\leq$ 2,000 kg
10-digit	8802.11.0030	Non-military, new, of an unladen weight not exceeding 998 kg (2,200 pounds)

Table 7: Examples for product categories

	(1) PY FE	(2) FPY FE	(3) Dom. FPY FE	(4) For. FPY FE
log distance * 1998	0.050***	0.043***	0.040***	0.044***
	(0.009)	(0.007)	(0.011)	(0.008)
log distance * 1999	0.058***	0.046***	0.055***	0.041***
	(0.009)	(0.008)	(0.011)	(0.009)
log distance * 2000	0.077***	0.055***	0.054***	0.054***
	(0.008)	(0.008)	(0.009)	(0.009)
log distance * 2001	0.089***	0.058***	0.054***	0.060***
	(0.007)	(0.005)	(0.011)	(0.006)
log distance * 2002	0.088***	0.062***	0.057***	0.064***
	(0.009)	(0.007)	(0.007)	(0.009)
log distance * 2003	0.085***	0.051***	0.051***	0.051***
	(0.006)	(0.006)	(0.007)	(0.008)
log real gdp	-0.016***	-0.018***	-0.014***	-0.020***
	(0.003)	(0.002)	(0.003)	(0.002)
log real gdp p.c.	0.028***	0.022***	0.020**	0.023***
	(0.007)	(0.005)	(0.008)	(0.006)
Imp. Price level	0.041***	0.026***	0.033***	0.023***
	(0.005)	(0.004)	(0.006)	(0.004)
Tariff	-0.002***	-0.001*	-0.000	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
REER	0.038**	0.023*	0.043**	0.012
	(0.018)	(0.014)	(0.019)	(0.016)
Observations	127,508	127,508	52,924	74,584
R-squared	0.876	0.943	0.949	0.940

Dependent variable is the ln unit value of the product. One observation is one firm-HS10-destination-year combination for Hungarian exports between 1998 and 2003. Column (1) includes product-year fixed effects while the other columns include firm-product-year fixed effect. Columns (3) and (4) distinguish between domestic-owned and foreign-owned firms. Standard errors are clustered at the destination-year level.

Table 8: Results with year interactions