Export prices of U.S. firms

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Using confidential firm-level data from the United States in 2002, we show that exporting firms charge prices for narrowly defined goods that differ substantially with the characteristics of firms and export markets. We control for selection into export markets using a three-stage estimator. We have three main results. First, we find that that highly productive and skill-intensive firms charge higher prices, while capital-intensive firms charge lower prices. Second, the very large correlation between distance and export prices found by Baldwin and Harrigan (2011) is largely due to a composition effect. Third, U.S. firms charge slightly higher prices to larger and richer markets, and substantially higher prices to markets other than Canada and Mexico.

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1. INTRODUCTION

Economists now know a lot about the characteristics of exporting plants and firms: they are bigger and more productive than non-exporters, and in many countries they are also more skill-intensive and capital-intensive.[2] For U.S. firms, recent research by Bernard, Jensen, and Schott (2005) and Bernard, Jensen, Redding, and Schott (2007) shows that exporters are also quite likely to import, and big firms trade many different products with many different countries. These facts about heterogeneous exporters have informed a vibrant theory literature, beginning with Melitz (2003) and Bernard, Eaton, Jensen, and Kortum (2003).

Economists have also documented systematic heterogeneity in the prices that are charged for the same traded products. Starting with Schott (2004), it has been established that even within narrowly defined product categories, average prices differ systematically with the characteristics of importing and exporting countries. There have been only a few studies that examine export price variation across markets using firm-level data, including Martin (2009) for France, Bastos and Silva (2010) for Portugal, Gorg, Halpern, and Murakozy (2010) for Hungary, and Manova and Zhang (2011) for China. Our paper is the first to use U.S. firm-level data to look at export pricing, and we establish some new facts:

- Within country-product categories, firms that are more productive and skill-intensive charge higher prices, while larger and more capital-intensive firms charge lower prices.
- Within narrow product categories, exporting firms charge higher prices to larger and wealthier markets, and to countries other than Canada and Mexico.
- The product-level correlation between export prices and destination market characteristics found by Baldwin and Harrigan (2011) is largely due to a selection effect, where firms that charge higher prices are more likely to select into tougher markets.

Understanding firm-level export pricing has implications for both theory and price index measurement in international economics. The facts we establish are broadly supportive of models, including those of Verhoogen (2008), Kugler and Verhoogen (2010), Johnson (2010), Hallak and Sivadasan (2009) and Baldwin and Harrigan (2011), where more successful firms produce higher cost and higher quality goods which command higher prices. An implication of such models is that the marginal firm has low marginal costs, low quality, and sells at a low price. When more firms enter, the average unit value in a market will then fall. This is the opposite of what happens to average unit values with marginal entry in international business cycle models including Ghironi and Melitz (2005) and Feenstra, Obstfeld, and Russ (2009). If follows that the interpretation of average traded goods price variation over time and/or across models should be informed by our findings here.

2. ANALYTICAL FRAMEWORK

In this section we discuss our hypotheses and how we will test them. Subsequent sections discuss data and measurement issues, and report our results.

[2] The literature documenting these facts is vast. Good summaries of the evidence include Bernard, Jensen, Redding, and Schott (2007) for the United States and Mayer and Ottaviano (2008) for Europe.

2.1. Firm-level export prices and destination market characteristics

Our primary motivation here is the finding of Baldwin and Harrigan (2011) that there is a strong and robust relationship between destination market characteristics and export prices at the HS10 product level. Baldwin and Harrigan (2011) find that product-level export prices increase strongly with distance and decrease with GDP, GDP per capita, and remoteness. Their theoretical explanation for these findings comes from a variation on the Melitz (2003) model. In their model, heterogeneous firms compete on quality as well as price, with the most profitable firms producing high quality, high price goods. Selection implies that only the best firms will enter the toughest markets, which theory suggests will be small, distant, and well-served by other exporters. The empirical findings are then explained as a composition effect: since only the best firms sell in the toughest markets, and these firms charge high prices, average prices at the product level will be increasing in measures of market toughness. This firm-level selection mechanism is not tested in Baldwin and Harrigan (2011), however, since that paper does not analyze firm-level data.

2.1.1. A simple decomposition

As a matter of arithmetic, the average price of a given product exported to destination d is a quantity-weighted average of the prices charged by all the N firms f that export the good,

$$\bar{p}_d = \sum_{f=1}^{N} w_{fd} p_{fd} \ , \qquad w_{fd} = \frac{q_{fd}}{\sum_{g=1}^{N} q_{gd}} \ , \tag{1}$$

where p_{fd} and q_{fd} are the price and quantity respectively of the good sold by firm f in destination d, N is the number of exporting firms selling the good, and the weight w_{fd} is firm *f's* quantity market share in market d. For each good, we can also define a given firms weighted average price and average market share across all D markets,

$$\bar{p}_f = \sum_{d=1}^{D} \omega_{fd} p_{fd} \ , \qquad \omega_{fd} = \frac{q_{fd}}{\sum_{d=1}^{D} q_{fd}} \ ,$$

$$\bar{w}_f = \frac{\sum_{d=1}^{D} q_{fd}}{\sum_{d=1}^{D} \sum_{g=1}^{N} q_{gd}} .$$

Considering both price and quantity differences across destinations, the difference in average prices between destination d and the world average $\bar{p}$ for any good is

$$\bar{p}_d - \bar{p} = \underbrace{\sum_{f=1}^{N} (p_{fd} - \bar{p}_f)\bar{w}_f}_{\textit{price discrimination}} + \underbrace{\sum_{f=1}^{N} (w_{fd} - \bar{w}_f)\bar{p}_f}_{\textit{market share}} + \underbrace{\sum_{f=1}^{N} (w_{fd} - \bar{w}_f)(p_{fd} - \bar{p}_f)}_{\textit{interaction}} \ , \tag{2}$$

If a given firm charges the same price in all destinations, then the first and third summations in (2) will be zero, and the average price across destinations will differ only because of differences in the quantities sold. This is the mechanism conjectured by Baldwin and Harrigan (2011). More generally, the average export price can also differ because a given firm charges different prices in different destinations, in which case the first and third summations in (2) will be non-zero.

2.1.2. An econometric model

We now turn to a closer examination of firm-level export pricing behavior across markets. We begin with two descriptive linear equations. Let $\mathbf{X}_d$ denote a vector of destination country characteristics including distance, real GDP, etc. Linear projections of log export prices from the US of product i by firm f to destination d are given by

$$\ln p_{ifd} = \alpha_{1i} + \boldsymbol{\beta}\mathbf{X}_d + \varepsilon_{ifd} \ , \tag{3}$$

$$\ln p_{ifd} = \alpha_{1if} + \boldsymbol{\beta}\mathbf{X}_d + \varepsilon_{ifd} \ . \tag{4}$$

The parameter α_{1i} is a product fixed effect, while α_{1if} is a product-firm fixed effect. The error term is ε_{ifd}. The vector $\boldsymbol{\beta}$ is the parameter of interest, as it answers the question: how do firm-level export prices differ across destinations? Equation (3), which includes only product fixed effects, identifies $\boldsymbol{\beta}$ through variation both within firms across markets and across firms. In this way it is very similar to the specifications estimated by Baldwin and Harrigan (2011) using product level data. By contrast equation (4), which includes product-firm fixed effects, identifies $\boldsymbol{\beta}$ using only within-firm variation across markets, and thus allows a direct test of the hypothesis that firms vary their export prices systematically with export market characteristics $\mathbf{X}_d$.

Any model of product market competition suggests that market entry is a key choice for the firm, and that firm characteristics will determine which markets are entered. Theory also suggests that the price charged conditional on entry will be a key determinant of entry, which implies that the interpretation of $\boldsymbol{\beta}$ in equations (3) and (4) is complicated by a selection bias. In particular, if firms compete on quality so that higher-price firms are the most competitive, $\boldsymbol{\beta}$ will conflate selection and price discrimination effects. The key statistical issue is that we only observe a firm's pricing decision when it chooses to sell in a market. Consider the reduced form export volume equation

$$\ln y_{ifd} = Max[0, \alpha_{2i} + \boldsymbol{\delta}\mathbf{X}_d + u_{ifd}] \ , \tag{5}$$

where y_{ifd} is export sales of product i by firm f in market d. Economic theory suggests that the errors u_{ifd} from the export volume equation (5) will be correlated with the errors ε_{ifd} from the export price equations (3) and (4), $E[\varepsilon_{ifd}|\alpha_{1i}, \alpha_{2i}, \mathbf{X}_d, u_{ifd}] = \rho u_{ifd}$. This correlation is what gives rise to selection bias in the price equations (3) and (4). Given a consistent estimate $\hat{u}_{ifd}$ of the errors u_{ifd} from (5), selection bias can be controlled for by including $\hat{u}_{ifd}$ as a regressor in (3) and (4), leading to the estimating equations

$$\ln p_{ifd} = \alpha_{1i} + \boldsymbol{\beta}\mathbf{X}_d + \gamma\hat{u}_{ifd} + \varepsilon_{ifd} \ , \tag{6}$$

$$\ln p_{ifd} = \alpha_{1if} + \boldsymbol{\beta}\mathbf{X}_d + \gamma\hat{u}_{ifd} + \varepsilon_{ifd} \ . \tag{7}$$

If u_{ifd} in (5) is assumed to be normally distributed, then (5) can be estimated by Tobit, with the residuals $\hat{u}_{ifd}$ from the estimated export participation equation (5) used as a regressor in the export price equations (6) and (7), which are estimated by OLS. This is the two-step estimator developed by Wooldridge (1995). A notable feature of Wooldridge's estimator in our context is that identification of the price equations does *not* require an exclusion restriction: that is, the model is identified even if the vector of country characteristics $\mathbf{X}_d$ is the same in both the selection equation (5) and the price equations (6) and (7). The intuition is that the export volume $\ln y_{ifd}$ functions as an excluded variable in the price equations. That is, variability in $\ln y_{ifd}$ is an independent source of variation which allows $\boldsymbol{\beta}$ in the price equations to identified.

A drawback of Wooldridge's two-step estimator is that assuming that u_{ifd} in (5) is normally distributed is unnecessarily restrictive. To avoid this assumption, instead of estimating (5) by Tobit we estimate it using a two-step Heckman estimator, which assumes normality only in the Probit step but not for the equation errors u_{ifd}. To be precise, in our first step we estimate the probability of entry using a reduced form Probit,

$$\Pr\left(y_{ifd} > 0\right) = \Phi\left(\alpha_2 + \boldsymbol{\delta}\mathbf{X}_d\right) \ . \tag{8}$$

Equation (8) is estimated over all possible product×firm×destinations. From (8) we obtain the estimated inverse Mills ratio $\hat{\lambda}_{ifd}$. We then estimate the export volume equation for positive levels of exports by OLS, with the estimated inverse Mills ratio $\hat{\lambda}_{ifd}$ as an additional regressor,

$$\ln y_{ifd} = \alpha_2 + \boldsymbol{\delta}\mathbf{X}_d + \gamma\hat{\lambda}_{ifd} + u_{ifd} \ . \tag{9}$$

The residuals $\hat{u}_{ifd} = \ln y_{ifd} - \hat{\alpha}_{2i} - \hat{\boldsymbol{\delta}}\mathbf{X}_d$ from the two-step Heckman procedure are then used as the control for selection in the export price equation (6). When estimating (7), which includes product-firm fixed effects, equation (9) also includes product-firm fixed effects.

2.2. Firm level export prices and firm characteristics

The analyses above focus only on how destination market characteristics affect firm's pricing decisions. For the subset of our data that consists of exports of manufactured goods we can go one step further and see how firm characteristics such as productivity, skill intensity, and capital intensity are related to export pricing. Adding firm characteristics $\mathbf{X}_f$ to the analysis in the preceding subsection leads to selection and pricing equations

$$\ln y_{ifd} = Max[0, \alpha_2 + \boldsymbol{\delta}_1\mathbf{X}_d + \boldsymbol{\delta}_2\mathbf{X}_f + u_{ifd}] \tag{10}$$

$$\ln p_{ifd} = \alpha_{1i} + \boldsymbol{\beta}_1\mathbf{X}_d + \boldsymbol{\beta}_2\mathbf{X}_f + \gamma\hat{u}_{ifd} + \varepsilon_{ifd} \tag{11}$$

Equation (11) is our most general descriptive equation for export pricing, since it includes both destination and firm characteristics. But for the purposes of consistently estimating the effects of firm characteristics, a model with destination-product fixed effects is preferable,

$$\ln y_{ifd} = Max[0, \alpha_2 + \boldsymbol{\delta}_1\mathbf{X}_f + u_{ifd}] \tag{12}$$

$$\ln p_{ifd} = \alpha_{1id} + \boldsymbol{\beta}\mathbf{X}_f + \gamma\hat{u}_{ifd} + \varepsilon_{ifd} \tag{13}$$

For each product-destination, equation (13) uses only variation across firms to identify $\boldsymbol{\delta}$. Thus, equation (13) answers the question: within a group of firms selling product i in destination d, how do firm characterisistics affect the prices that firms charge?

3. DATA SOURCES AND MEASUREMENT

We use both firm-level and country-level data, and discuss sources and measurement issues in the next two subsections.

3.1. Firm-level data

We use data on firm-level U.S. exports in 2002. For manufacturing firms, the export data is linked with production data from the 2002 Census of Manufactures. Use of this data was pioneered by Bernard, Jensen, and Schott (2005), who provide a detailed discussion of numerous important issues related to construction of the dataset. The data has also been analyzed by Bernard, Jensen, Redding, and Schott (2007).[3]

The firm-level export data comes from transaction-level export declarations filed by exporting firms with the U.S. Customs. The transaction-level data contain information about value, HS10-digit product code, quantity, relationship (intra-firm or arm's-length),[4] export destination, date, and transport mode for every shipment. Firm-level data are simply sums of transaction-level data. Our empirical definition of a product in all of what follows is an HS10-digit code, of which there were almost 9,000 in 2002. Our measure of price is unit value (value divided by quantity) for a given exporter-product-country observation.

The production data for 2002 comes from the Census of Manufactures, which collects information on the universe of U.S. manufacturing plants. For the purposes of computing firm-level productivity, we also use Annual Survey of Manufactures data from 1997 to 2002. In each of these years the sample consists of 50,000-60,000 plants.[5]

The unified dataset contains annual plant information that includes total value of shipments, change in inventories, total employment, numbers of production and nonproduction workers, cost of materials, and 6-digit NAICS industry. Due to missing data on capital stocks in the Annual Survey of Manufactures, the capital series was constructed using data for capital from the Census of Manufactures, industry depreciation rates from the Bureau of Economic Analysis, and investment series available for all years.

The export and manufacturing data sets are linked at the level of the firm. The links between the data sets are made using the Employer Identification Number (EIN) where possible and using "alpha", an identifier of multi-unit firms that have exports to Canada, when the EIN is not available (in particular, for exports to Canada). This identifier is assigned using the business name information from the Census Bureau Business Register, also called Standard Statistical Establishment List (SSEL).

[3] We are very grateful to J. Bradford Jensen and Peter Schott for extensive and gracious help with the data.

[4] According to Section 402(e) of the Tariff Act of 1930 the firms are defined as "related parties" if one of them owns, controls, or holds voting power equivalent to 6 percent of the outstanding voting stock or shares of the other organization.

[5] Some 10,000 plants are selected with certainty (including all plants with total employment above 250 workers), and more than 40,000 plants are selected with probability proportional to a composite measure of establishment size. See http://www.census.gov/ for details.

3.2. Country-level data

Our measurements of country characteristics are much the same as those used in Baldwin and Harrigan (2011), and our discussion here is drawn from Baldwin and Harrigan (2011). The objective is to measure features of export markets that affect competition in the market, and that will thus have effects on which firms enter and what prices they charge when they do enter.

Trade costs While trade costs are likely to be weakly monotonic in distance, there is no reason to expect them to have any particular functional form, so we specify the distance proxy in two ways. The first is simply log distance, which we measure as kilometers from Chicago to the capital city of the importer, which comes from CEPII.[6] Our second trade cost measure breaks distance down into bins, derived from looking for natural breaks in distance among U.S. trading partners. These bins are described in Table 3 of Baldwin and Harrigan (2011).

Market size: Our measure of market size is real GDP, from the Penn World Tables. We also include real GDP per worker as a demand-related control.

Remoteness: The structural gravity literature (including Eaton and Kortum (2002) and Anderson and Van Wincoop (2003)) emphasizes that demand conditions in country d depend on the supply conditions of all countries that potentially sell there. The proper specification of this "remoteness" effect is model-specific, but most theoretically consistent measures of remoteness have a common structure as they all work via the average price of goods sold in a destination market. This average price in turn depends upon the number of varieties produced locally in the destination market, and the number of imported varieties and the bilateral trade costs they face. As the number of varieties coming from each exporting nation is – roughly speaking – related to the origin-nation's size, a reasonable proxy for remoteness involves market-size weighted sums of an inverse power function of trade costs. Following this logic, we adopt the following measure of remoteness in our empirical work,

$$R_d = \left[\sum_{o=1}^{C} Y_o dist_{od}^{-\eta} \right]^{-1} , \tag{14}$$

where Y_o is real GDP in origin country o, and $dist_{od}$ is distance between countries o and d. Harrigan (2003) shows that this remoteness index is an approximation to the model-specific measures of Anderson and Van Wincoop (2003), and Novy (2010) shows that similar expressions hold in the model of Eaton and Kortum (2002) and other bilateral trade models with CES preferences. Empirical implementation of (14) involves some potentially important choices about how to measure within-country distance $dist_{dd}$ and what value to use for the exponent η. Fortunately, our empirical results are entirely insensitive to any reasonable choice of how to construct (14), and in what follows we include within country distance as reported in the CEPII data, and set η equal to 1. The reason for this robustness is simply that the cross section variation in (14) is overwhelmingly dominated by differences in the GDP-weighted raw distances (consider New Zealand versus Belgium), so that different choices about including own distance and what value to choose for η lead to very highly correlated measures.

[6] http://www.cepii.fr/anglaisgraph/bdd/distances.htm

4. EMPIRICAL RESULTS: FIRM-LEVEL EXPORT PRICES

In this section we investigate the relationship between export prices, firm characteristics, and destination market characteristics. We begin by analyzing our full sample of U.S. firms in 2002, which includes exporters of both manufactured and non-manufactured goods. Our second set of results uses data only on manufactured goods exports, and we establish new facts about how export prices vary with firm characteristics.

4.1. Export price decompositions

As a preliminary, we report a very simple variance decomposition exercise for log export prices. Once we remove product means, so that price variation is comparable across products, we find that the standard deviation of log export price variation within products is 1.508. This implies an enormous amount of within-product variation in prices: if we treat log prices as approximately normally distributed, then prices at the 90th percentile are a factor of 48 higher than prices at the 10th percentile. Next, we remove firm×product means from log export prices, so that we retain only variation across export markets within firm×products. The resulting standard deviation is 0.709, implying a 90-10 ratio of 6, one-eighth the level of variation in prices that we find when we remove only product means. This simple exercise clearly illustrates two features of our data. First, most of the variation in product-level prices is between firms rather than within. Second, there is still a substantial amount of within-firm price variation across destination markets. A 90-10 price ratio of 6 is inconsistent with a simple price discrimination explanation, which implies that there must be some compositional variation within firm×products across markets.

Our next results come from implementing the product-level decomposition of how export prices differ across destinations which is given by (2). The decomposition in (2) holds for each HS10 product, and to make the results comparable across products we divide by the product-specific average world prices $\bar{p}$. This implies that the three terms in (2) sum to one for all products and destinations. We compute the scaled decomposition for the 187,300 product×destination observations in our data for 2002. The results are reported in Table 1, and illustrated vividly in Figure 1. The figure shows that in the bulk of cases the market share effect accounts for all or nearly all of the variation in average prices across markets, with the price discrimination and interaction terms tightly clustered around zero. The implication is that firms *do not* do much price discrimination across markets: for a given HS10 product, firms charge much the same price in all markets. This implies that the differences in product-level average prices across destination documented by Baldwin and Harrigan (2011) are due primarily to differences in which firms sell to which markets. Since tougher markets have higher product-level prices, it follows that high-price firms have larger market shares in tougher markets. Figure 1 thus confirms the mechanism conjectured by Baldwin and Harrigan (2011).

4.2. Export prices and destination market characteristics

We now look more carefully at what explains export price variation across markets. In this subsection we report the results of estimating equations (6) and (7), which relate export prices to characteristics of the destination market. Equations are estimated by the three-stage selection correction procedure described above, with third-stage standard errors clustered by country. We estimate the equations on various sub-samples of the data:

- all firms/manufacturing firms only
- all countries/excluding Canada and Mexico

We also report results using different specifications:

- log linear distance/distance step function
- OLS/controlling for selection
- product fixed effects/product×firm fixed effects

Our estimates of equations (6) and (7) are reported in Tables 2 and 3. Panel A of Table 2 reports our benchmark estimates, which includes the broadest sample (all countries and firms). The first two columns of Table 2A are the simplest: distance is measured as log kilometers, and there is no control for selection. Consistent with the simple decomposition results of the previous section, moving from product to product×firm fixed effects leads to much smaller effects of country characteristics: the distance elasticity falls from 0.263 to 0.195, the real GDP elasticity falls from 0.027 to -0.02, etc. When we control for selection the effects are smaller still: in column 4, the distance elasticity is 0.168, and the real GDP and real GDP per worker effects are statistically insignificant. The remoteness effect is statistically significant but economically small: the sample standard deviation of log remoteness is 0.05, so the estimate implies that a one standard deviation increase in remoteness reduces within product×firm export prices by just 6 log points.

When we allow for a non-linear effect of distance, the story changes somewhat. Focusing on our preferred specification (product×firm fixed effects, selection control) in column 8 of Table 2A, we find that the effect of distance is to raise log prices by about 0.25 relative to the excluded category (Mexico and Canada). While much smaller than the effect found when we control for neither selection nor firm effects (see column 5, as well as the results of Baldwin and Harrigan (2011)), this is nonetheless a large effect. Interestingly, the effect is not increasing in distance, with the estimated effects for the different distance categories all statistically insignificant from each other. The effects of GDP (0.046) and GDP per capita (0.071) in this specification are statistically significant but rather small in economic terms: bigger and richer countries are charged slightly higher export prices within product×firms. Remoteness has a small and statistically insignificant effect.

Table 2B, which excludes exports to Canada and Mexico, tells a similar story[7]. Focusing on the last column of Table 2B, we find that export prices are statistically significantly lower relative to the excluded category (1 to 400km), but the size of the effect is not very economically important, nor does it vary by distance. The real GDP and real GDP per worker elasticities remain statistically significant but small. The two panels of Table 3, which exclude non-manufacturing observations, are generally consistent with the message of Table 2, though the distance effect is a bit larger (in column 8 of Table 3A, for example, the effect relative to Canada/Mexico is around 0.30, as opposed to 0.25 when all products are included in the corresponding column of Table 2A).

Our conclusions from Tables 2 and 3 can be summarized simply. Controlling for firm effects (through the use of product×firm fixed effects) and selection into exporting leads to

[7] Columns 3 and 4 in Table 2B are blank because the estimator failed to converge in this specification.

much smaller effects of country characteristics on export prices than those found in specifications which include only product fixed effects. Real GDP and real GDP per capita have small positive elasticities, while the distance effect is well approximated by a simple step function, where prices sold to markets other than Canada and Mexico are 25 to 30 log points higher.

What might account for the large within product×firm price premium for selling to countries other than Canada and Mexico? This effect seems too large to be accounted for by price discrimination, and in any case there is no particular reason to think that demand for U.S. exports is more elastic in North America than elsewhere. Our conjecture is that the Canada/Mexico price effect has to do with vertical integration. As argued by Yi (2003), low transport costs (such as across a border) make it possible for firms to adopt offshoring strategies that involve low-value trade transactions which would not be profitable if transport costs were higher. To the extent that such trade occurs within product categories that also feature higher-value finished exports, it would explain our findings that within product×firm export prices to destinations other than Canada and Mexico are substantially higher.

4.3. Comparing our results to existing literature

There are four recent papers that also analyze firm-level export pricing across markets: Martin (2009) for France, Bastos and Silva (2010) for Portugal, Gorg, Halpern, and Murakozy (2010) for Hungary, and Manova and Zhang (2011) for China. Each of these four papers works with a specification similar to our equation (4), and each finds that firm-level export prices are systematically correlated with destination market characteristics. Here we discuss the relevant results of these four papers in some detail.

Manova and Zhang (2011) analyze firm-level export prices from China. They perform a wealth of interesting empirical exercises, including estimating an equation which is essentially identical to our equation (4). They find small but statistically significant elasticities of within-firm export prices with respect to export market GDP, distance, and remoteness: for example, their estimated distance elasticity is about 0.01, with a standard error of about 0.002.[8]

Unlike China, France is economically similar to the United States, so it might be reasonable to expect that French and U.S. export prices would behave similarly. Martin (2009) finds no effect of real GDP on French firm-level export prices, but he does find substantial effects of distance: for example, export prices are 11 to 14 log points higher for markets that are at least 3000 kilometers from Paris, when compared to more nearby destinations.[9] The most direct comparison between Martin's results and ours is between his Table 2 and our Table 2A. Martin (2009) finds a distance elasticity of between 0.02 and 0.05 with standard errors of around 0.01, while in Column 4 of our Table 2A we find an elasticity of 0.17 with a standard error of 0.02. We regard these results as quantitatively similar, although our point estimate is somewhat bigger.

The results of Bastos and Silva (2010) for Portugal are quite consistent with the results of Martin (2009) for France. In the specification closest to our equation (4)[10], without a selection correction, Bastos and Silva (2010) find a distance elasticity of around 0.05 with a standard error of 0.013.

[8] Table 8, Manova and Zhang (2011).

[9] Table 3, Martin (2009)

[10] Reported in columns 5, 6, 11, and 12 of Table 6, Bastos and Silva (2010).

Gorg, Halpern, and Murakozy (2010) looks at firm level export prices for Hungary. Results from their version of our equation (4), without a selection correction, are remarkably consistent with the results of Martin (2009) and Bastos and Silva (2010): a distance elasticity of between 0.05 and 0.07 depending on the year, with standard errors of about 0.02[11]. Unlike the other three papers discussed here, Gorg, Halpern, and Murakozy (2010) make an attempt to address the selection issue in later specifications, but they do so in a model without product×firm fixed effects. This makes their results that correct for selection both hard to interpret and not comparable to ours, since their parameters are identified using cross-firm and cross-product variation.

In summary, our results are quite consistent with the results of the four previous papers that have looked at export price variation within product×firms. Data from France, Portugal, and Hungary all give essentially the same answer: within product-firms and across export destinations, the distance elasticity of export unit values is close to 0.05, with a 95% confidence interval of about [0.03,0.07]. The results from Chinese data show a smaller elasticity, while our results for the United States are somewhat higher.

4.4. Export prices and firm characteristics

We now turn to estimation of equations (11) and (13) , which relate export prices to firm characteristics. Because we only have data on the characteristics of manufacturing firms, all the results in this section are for manufactured goods.

Tables 4A and 4B report our estimates of equation (11) , which includes product fixed effects, a control for selection, and both country and product characteristics. Thus the parameters are identified from variation within products, across firms and destinations. The estimates of the country-level effects are broadly similar to what we found in the corresponding columns of Table 3 (that is, the columns reporting results with product fixed effects), which is an interesting finding, since it suggests that firm characteristics are not highly correlated with country characteristics within products, after controlling for firm selection into exporting. Turning to the effects of firm characteristics on export prices, we find that more productive firms charge *higher* prices on average: looking at columns 3 and 4 of Table 4A, the TFP elasticity of 0.39 means that firms with ten percent higher total factor productivity charge about 4 percent higher prices. Equally striking are the large and precisely estimated effects of factor shares on export prices: skill-intensity raises export prices with an elasticity of about 0.17, while capital intensity lowers prices with an elasticity of around -0.1. Interestingly, the effect of firm size is zero: the point estimates are very close to zero, and the standard errors are small. Table 4B repeats the analysis excluding Canada and Mexico, and the coefficients on the firm characteristics are essentially the same, except that the firms size effect is precisely estimated and very slightly negative, at about -0.02.

Table 5 reports our estimates of equation (13), which includes country×product fixed effects. Thus the estimated effects of firm characteristics are estimated purely across firms, within country-products. The results are similar in sign and statistical significance to what we found in Table 4, but somewhat smaller in size: the overall TFP elasticity is 0.35, the skill elasticity is 0.16, and the capital elasticity is -0.08. The effects are somewhat larger when we exclude Canada and Mexico (Panel B): the TFP elasticity is 0.38, the skill elasticity

[11] Reported in Table 2, Gorg, Halpern, and Murakozy (2010). It appears that these standard errors are clustered by importing country, as is appropriate.

is 0.19, and the capital elasticity is -0.1. The total employment elasticity is zero in the full sample, and -0.02 for the sample excluding shipments to Canada and Mexico.

Our conclusions from this section are quite strong: firms that are more productive and more skill-intensive charge substantially higher prices, while more capital-intensive firms charge lower prices. We emphasize how we identify these effects: they are found within narrowly defined products across export markets. If HS10 products were homogeneous, the law of one price implies that our results are impossible: the lowest price firm would simply take the entire market. The fact that highly productive, skill-intensive firms charge higher prices is suggestive of quality competition: the higher measured prices in our data are probably hiding important quality variations across firms, with higher quality associated with higher costs and thus higher prices. This interpretation is consistent with the evidence of Gervais (2011), who uses plant-level data from the U.S. Census of Manufactures to show that higher quality firms have both higher productivity and charge higher prices.

4.5. Firm-level export prices: interpreting our results

To summarize our findings, we focus on the specifications with the cleanest identification: the columns from Table 2 with product×firm fixed effects, and Table 5, which includes product×country fixed effects. The cross-country variation that is used in Table 2 shows that firms charge systematically higher prices to destinations other than Canada and Mexico, and to larger and richer destinations. These results may be partially explained by price discrimination, but our conjecture is that they are driven primarily by within-firm composition effects instead: firms sell more expensive varieties to richer markets, and sell fewer semi-finished products to markets other than Canada and Mexico. The cross-firm variation that is used in Table 5 shows that more productive and skill-intensive firms charge higher prices, while more capital-intensive firms charge lower prices, and these effects are economically sizeable and precisely estimated. This pattern is suggestive of quality competition within export markets, with the most capable and skill-intensive U.S. exporters producing higher quality goods that sell for a premium over goods sold by more capital-intensive and less productive firms.

5. CONCLUSION

This paper is the first to analyze firm-level data on the export pricing decisions of U.S. exporters. We use a three-stage estimator to control for firm selection into different export markets. Using restricted firm-level information on exports and firm characteristics, combined with widely available data on country characteristics, we find that

- More productive and skill-intensive firms charge higher unit prices, while more capital-intensive firms charge lower prices
- The strong correlations between product-level prices and country characteristics found by Baldwin and Harrigan (2011) are largely due to a combination of selection and aggregation bias, which is the mechanism that they conjectured but could not test with their data.

- In the markets that they choose to serve, firms charge prices that are weakly correlated with real GDP and real GDP per capita, and prices are substantially higher for goods sold outside North America.

Our results on correlations between export prices and country-level are broadly consistent with earlier studies on export pricing by firms in China, France, Hungary, and Portugal. To our knowledge, we are the first to connect firm-level characteristics to export pricing, and our results are supportive of models of monopolistic competition where firms compete on quality rather simply unit cost.

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Table 1

Distribution of Export Unit Price Change Decomposition Elements

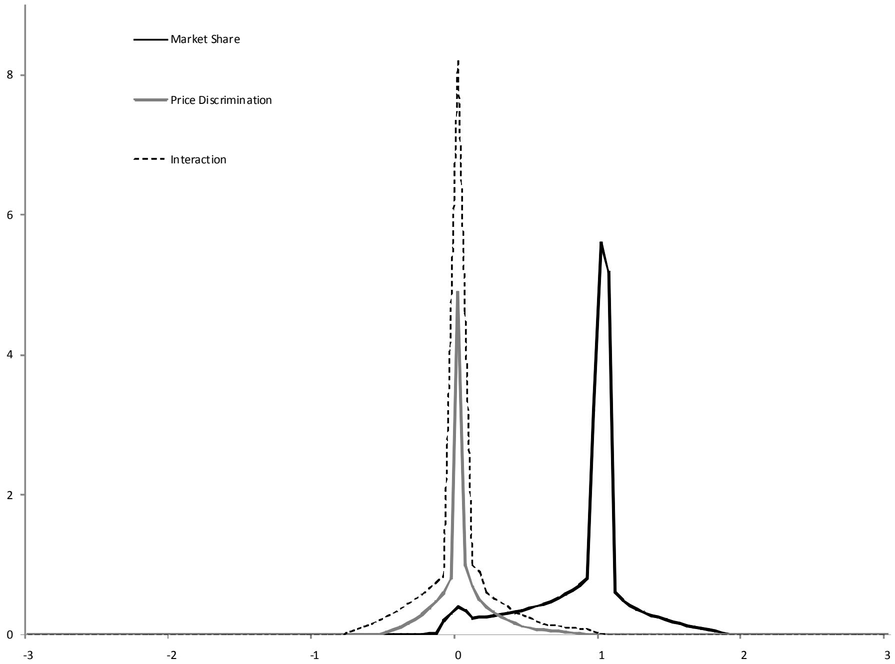
Percentile	Price Discrimination	Market Share	Interaction
0.05	-0.416	-0.552	-1.680
0.10	-0.053	-0.003	-0.528
0.25	0.000	0.575	-0.003
0.50	0.000	1.000	0.000
0.75	0.057	1.000	0.276
0.90	0.536	1.336	0.854
0.95	1.107	2.072	1.568

Sources: U.S Census Bureau, authors' calculations.

Notes: This table reports results of computing equation (2) across all products, scaled by product-means. The table reports quantiles of the empirical distribution of the three terms in equation (2).

Figure1

Distribution of Export Unit Price Change Decomposition Elements



Sources: U.S Census Bureau.

Notes:

Table 2: Impact of Importing Country Characteristics on Export Unit Prices of All Firms
Panel A: Exports to All Countries

	Linear Distance				Distance Step Function			
	OLS Estimation		Selection Correction		OLS Estimation		Selection Correction	
	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE
log distance	0.263***	0.195***	0.248***	0.168***				
	(0.016)	(0.021)	(0.016)	(0.021)				
1<km≤4,000					0.326***	0.386***	0.204	0.261**
					(0.111)	(0.093)	(0.133)	(0.105)
4,000<km≤7,800					0.584***	0.485***	0.323**	0.239**
					(0.091)	(0.091)	(0.139)	(0.115)
7,8000<km≤14,000					0.603***	0.493***	0.339**	0.248**
					(0.095)	(0.089)	(0.144)	(0.115)
14,000<km					0.632***	0.473***	0.390***	0.248**
					(0.084)	(0.088)	(0.131)	(0.111)
log real GDP	0.027**	-0.020***	0.036***	-0.004	0.039***	-0.010*	0.100***	0.046***
	(0.011)	(0.007)	(0.011)	(0.008)	(0.013)	(0.005)	(0.018)	(0.009)
log real GDP/worker	0.079***	-0.017	0.093***	0.01	0.046	-0.006	0.126***	0.071***
	(0.025)	(0.016)	(0.025)	(0.015)	(0.042)	(0.016)	(0.044)	(0.016)
log remoteness	-2.495***	-1.343***	-2.365***	-1.183***	-1.417***	-0.344	-1.075**	-0.114
	(0.347)	0.191	(0.336)	(0.184)	(0.489)	(0.249)	(0.486)	(0.234)
selection control			-0.074***	-0.058***			-0.072***	-0.056***
			(0.014)	(0.007)			(0.014)	(0.007)
R^2 (within)	0.030	0.015	0.035	0.019	0.029	0.015	0.034	0.019
N	1,185,000	1,185,000	1,185,000	1,185,000	1,185,000	1,185,000	1,185,000	1,185,000

Note: This table contains the estimation of a sample of all U.S. export trade flows over $250 to all destination countries. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of export destinations. The first four columns measure distance as kilometers and the last four columns measure distance using the step function. Results of HS10 product fixed effects estimation are shown in the 1st, 3rd, 5th and 7th columns and results of firm-product fixed effects estimation are shown in the the rest of the columns. The 1st, 2nd, 5th and 6th columns use OLS as the method of estimation. The 3rd, 4th, 7th and 8th columns use the 3-stage selection correction procedure. Standard errors are clustered at the country level. Asterisks denote statistical significance.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table 2: Impact of Importing Country Characteristics on Export Unit Prices of All Firms
Panel B: Exports to Countries excluding Canada and Mexico

	Linear Distance				Distance Step Function			
	OLS Estimation		Selection Correction		OLS Estimation		Selection Correction	
	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE
log distance	0.125***	0.019	-	-				
	(0.036)	(0.016)	-	-				
4,000<km≤7,800					0.180***	0.033*	0.069	-0.052***
					(0.050)	(0.018)	(0.05)	(0.018)
7,8000<km≤14,000					0.236***	0.058***	0.125***	-0.027*
					(0.043)	(0.014)	(0.047)	(0.015)
14,000<km					0.229***	0.013	0.130***	-0.062***
					(0.045)	(0.018)	(0.045)	(0.018)
log real GDP	0.048***	-0.008	-	-	0.041***	-0.011***	0.086***	0.026***
	(0.011)	(0.005)	-	-	(0.010)	(0.004)	(0.012)	(0.005)
log real GDP/worker	0.119***	0.005	-	-	0.118***	0.010	0.180***	0.065***
	(0.022)	(0.008)	-	-	(0.024)	(0.008)	(0.023)	(0.009)
log remoteness	-1.656***	-0.167	-	-	-1.414***	-0.083	-1.175***	0.058
	(0.364)	(0.138)	-	-	(0.388)	(0.170)	(0.371)	(0.158)
selection control			-	-			-0.058***	-0.041***
			-	-			(0.005)	(0.003)
R^2 (within)	0.012	0.000	-	-	0.013	0.000	0.015	0.003
Number of Observations	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000

Note: This table contains the estimation of a sample of U.S. export trade flows over $250 to destination countries except Canada and Mexico. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of export destinations. The first four columns measure distance as kilometers and the last four columns measure distance using the step function. Results of HS10 product fixed effects estimation are shown in the 1st, 3rd, 5th and 7th columns and results of firm-product fixed effects estimation are shown in the rest of the columns. The 1st, 2nd, 5th and 6th columns use OLS as the method of estimation. The 3rd, 4th, 7th and 8th columns use the 3-stage selection correction procedure. Standard errors are clustered at the country level.

Table 3: Impact of Importing Country Characteristics on Export Unit Prices of Manufacturing Firms
Panel A: Exports to All Countries

	Linear Distance				Distance Step Function			
	OLS Estimation		Selection Correction		OLS Estimation		Selection Correction	
	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE
log distance	0.269***	0.203***	0.228***	0.157***				
	(0.015)	0.02	(0.015)	(0.021)				
1<km≤4,000					0.345***	0.411***	0.245*	0.283***
					(0.109)	(0.086)	(0.136)	(0.100)
4,000<km≤7,800					0.602**	0.521***	0.373***	0.313***
					(0.093)	(0.084)	(0.134)	(0.106)
7,8000<km≤14,000					0.626***	0.527***	0.394***	0.318***
					(0.090)	(0.082)	(0.135)	(0.106)
14,000<km					0.643***	0.499***	0.446***	0.320***
					(0.080)	(0.080)	(0.120)	(0.101)
log real GDP	0.023**	-0.023***	0.053***	0.009	0.035***	-0.012*	0.090***	0.036***
	(0.011)	(0.008)	(0.012)	(0.009)	(0.012)	(0.006)	(0.017)	(0.009)
log real GDP/worker	0.050**	-0.021	0.088***	0.026	0.021	-0.008	0.089**	0.058***
	(0.024)	(0.017)	(0.026)	(0.017)	(0.041)	(0.017)	(0.043)	(0.017)
log remoteness	-2.579***	-1.412***	-2.194***	-1.060***	-1.448***	-0.318	-1.210**	-0.184
	(0.342)	(0.208)	(0.318)	(0.198)	(0.506)	(0.281)	(0.493)	(0.259)
selection control			-0.085***	-0.063***			-0.084***	-0.060***
			(0.016)	(0.008)			(0.016)	(0.008)
R^2 (within)	0.031	0.017	0.038	0.023	0.030	0.019	0.037	0.024
N	652,000	652,000	652,000	652,000	652,000	652,000	652,000	652,000

Note: This table contains the estimation of a sample of all U.S. export trade flows over $250 from manufacturing firms to all destination countries. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of export destinations. The first four columns measure distance as kilometers and the last four columns measure distance using the step function. Results of HS10 product fixed effects estimation are shown in the 1st, 3rd, 5th and 7th columns and results of firm-product fixed effects estimation are shown in the rest of the columns. The 1st, 2nd, 5th and 6th columns use OLS as the method of estimation. The 3rd, 4th, 7th and 8th columns use the 3-stage selection correction procedure. Standard errors are clustered at the country level.

Table 3: Impact of Importing Country Characteristics on Export Unit Prices of Manufacturing Firms
Panel B: Exports to Countries excluding Canada and Mexico

	Linear Distance				Distance Step Function			
	OLS Estimation		Selection Correction		OLS Estimation		Selection Correction	
	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE	Product FE	Firm-Product FE
log distance	0.104***	0.016	0.071**	-0.004				
	(0.028)	(0.018)	(0.028)	(0.016)				
4,000<km≤7,800					0.128**	0.051*	0.007	-0.028
					(0.053)	(0.026)	(0.052)	(0.023)
7,8000<km≤14,000					0.195***	0.075***	0.070*	-0.006
					(0.034)	(0.015)	(0.036)	(0.015)
14,000<km					0.163***	0.007	0.086*	-0.041**
					(0.046)	(0.022)	(0.046)	(0.020)
log real GDP	0.040***	-0.014**	0.080***	0.017**	0.035***	-0.020***	0.101***	0.028***
	(0.012)	(0.007)	(0.012)	(0.007)	(0.011)	(0.005)	(0.012)	(0.006)
log real GDP/worker	0.081***	0.009	0.141***	0.059***	0.086***	0.016	0.173***	0.082***
	(0.022)	(0.012)	(0.022)	(0.011)	(0.024)	(0.011)	(0.024)	(0.012)
log remoteness	-1.498***	-0.183	-1.102***	0.051	-1.325***	-0.026	-1.063***	0.113
	(0.405)	(0.188)	(0.400)	(0.184)	(0.416)	(0.216)	(0.388)	(0.193)
selection control			-0.081***	-0.051			-0.081***	-0.050***
			(0.005)	(0.003)			(0.005)	(0.003)
R^2 (within)	0.008	0.000	0.014	0.005	0.008	0.001	0.014	0.005
N	377,000	377,000	377,000	377,000	377,000	377,000	377,000	377,000

Note: This table contains the estimation of a sample of all U.S. export trade flows over $250 from manufacturing firms to destination countries except Canada and Mexico. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of export destinations. The 1st four columns measure distance as kilometers and the last four columns use the step function to measure distance. Results of HS10 product fixed effects estimation are shown in the 1st, 3rd, 5th and 7th columns and results of firm-product fixed effects estimation are shown in the rest of the columns. The 1st, 2nd, 5th and 6th columns use OLS as the method of estimation. The 3rd, 4th, 7th and 8th columns use the 3-stage selection correction procedure. Standard errors are clustered at the country level.

Table 4: Impact of Importing Country and Firm Characteristics on Export Unit Prices of All Firms
Panel A: Exports to All Countries

	OLS Estimation		Selection Correction	
	Linear Distance	Distance Step Function	Linear Distance	Distance Step Function
log distance	0.263***		0.287***	
	(0.015)		(0.016)	
1<km≤4,000		0.037***		0.413***
		(0.109)		(0.104)
4,000<km≤7,800		0.588***		0.671***
		(0.094)		(0.082)
7,8000<km≤14,000		0.611***		0.692***
		(0.091)		(0.080)
14,000<km		0.624***		0.696***
		(0.082)		(0.072)
log real GDP	0.021*	0.034***	0.005	0.014
	(0.011)	(0.013)	(0.012)	(0.013)
log real GDP/worker	0.042*	0.015	0.022	-0.009
	(0.024)	(0.041)	(0.022)	(0.043)
log remoteness	-2.480***	-1.358***	-2.711***	-1.462***
	(0.336)	(0.500)	(0.340)	(0.493)
log TFP	0.377***	0.378***	0.392***	0.392***
	(0.066)	(0.062)	(0.065)	(0.061)
log S/L	0.172***	0.171***	0.171***	0.169***
	(0.016)	(0.016)	(0.016)	(0.016)
log K/L	-0.085***	-0.089***	-0.096***	-0.101***
	(0.011)	(0.012)	(0.013)	(0.013)
log total employment	-0.003	0.000	-0.005*	-0.003
	(0.002)	(0.003)	(0.003)	(0.003)
selection control			-0.081***	-0.080***
			(0.016)	(0.016)
R^2 (within)	0.042	0.042	0.049	0.048
N	643,000	643,000	643,000	643,000

Note: This table contains the estimation of a sample of U.S. export trade flows over $250 from manufacturing firms to all destination countries. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of exporting firms and export destinations as well as HS10 product fixed effects. The first four columns measure distance as kilometers and the last four columns measure distance using the step function. The method of estimation of the first two columns is OLS. We use the 3-stage selection correction procedure in the last two columns. Standard errors are clustered at the country level.

Table 4: Impact of Importing Country and Firm Characteristics on Export Unit Prices of All Firms
Panel B: Exports to Countries excluding Canada and Mexico

	OLS Estimation		Selection Correction	
	Linear Distance	Distance Step Function	Linear Distance	Distance Step Function
log distance	0.096***		0.120***	
	(0.028)		(0.026)	
4,000<km≤7,800		0.117**		0.139***
		(0.051)		(0.048)
7,8000<km≤14,000		0.181***		0.202***
		(0.034)		(0.033)
14,000<km		0.149***		0.164***
		(0.045)		(0.044)
log real GDP	0.038***	0.033***	0.012	0.022**
	(0.012)	(0.010)	(0.011)	(0.010)
log real GDP/worker	0.071***	0.076***	0.036*	0.064***
	(0.021)	(0.024)	(0.021)	(0.023)
log remoteness	-1.407***	-1.253***	-1.710***	-1.311***
	(0.393)	(0.396)	(0.382)	(0.375)
log TFP	0.378***	0.379***	0.392***	0.394***
	(0.023)	(0.023)	(0.022)	(0.022)
log S/L	0.188***	0.188***	0.186***	0.189***
	(0.005)	(0.005)	(0.005)	(0.005)
log K/L	-0.098***	-0.098***	-0.111***	-0.108***
	(0.006)	(0.006)	(0.006)	(0.006)
log total employment	-0.019***	-0.019***	-0.024***	-0.021***
	(0.004)	(0.004)	(0.004)	(0.004)
selection control			-0.070***	-0.070***
			(0.005)	(0.005)
R^2 (within)	0.024	0.024	0.028	0.028
N	372,000	372,000	372,000	372,000

Note: This table contains the estimation of a sample of U.S. export trade flows over $250 from manufacturing firms to destination countries except Canada and Mexico. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of exporting firms and export destinations as well as HS10 product fixed effects. The first and the third columns measure distance as kilometers and the other two columns use the step function to measure distance. The method of estimation of the first two columns is OLS. We use the 3-stage selection correction procedure in the last two columns. Standard errors are clustered at the country level.

Table 5: Impact of Firm Characteristics on Export Unit Prices of All Firms
Panel A: Exports to All Countries

	OLS Estimation	Selection Correction	
		Using Linear Distance in the First Two Steps	Using Distance Step Function in the First Two Steps
log TFP	0.342***	0.350***	0.349***
	(0.048)	(0.048)	(0.048)
log S/L	0.162***	0.163***	0.162***
	(0.011)	(0.011)	(0.011)
log K/L	-0.072***	-0.083***	-0.084***
	(0.011)	(0.011)	(0.011)
log total employment	-0.007	-0.009**	-0.009**
	(0.004)	(0.004)	(0.004)
selection control		-0.076***	-0.076***
		(0.003)	(0.003)
R^2 (within)	0.011	0.018	0.018
N	684,000	643,000	643,000

Note: This table contains the estimation of a sample of U.S. export trade flows over $250 from manufacturing firms to all destination countries. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of exporting firms as well as country-product fixed effects. The method of estimation of the first column is OLS. We use the 3-stage selection correction procedure in the last two columns. In the first two stages, distance is measured as kilometers in the second column and measured using the step function in the third column. Standard errors are clustered at the firm level.

Table 5: Impact of Firm Characteristics on Export Unit Prices of All Firms
Panel B: Exports to Countries excluding Canada and Mexico

	OLS Estimation	Selection Correction	
		Using Linear Distance in the First Two Steps	Using Distance Step Function in the First Two Steps
log TFP	0.376***	0.378***	0.379***
	(0.062)	(0.064)	(0.064)
log S/L	0.184***	0.186***	0.189***
	(0.015)	(0.015)	(0.015)
log K/L	-0.089***	-0.105***	-0.102***
	(0.014)	(0.014)	(0.014)
log total employment	-0.021***	-0.026***	-0.023***
	(0.007)	(0.007)	(0.007)
selection control		-0.074***	-0.074***
		(0.004)	(0.004)
R^2 (within)	0.015	0.020	0.020
N	405,000	372,000	372,000

Note: This table contains the estimation of a sample of U.S. export trade flows over $250 from manufacturing firms to destination countries except Canada and Mexico. Dependent variable is log unit price of exports by firm, HS10 product and destination. Independent variables are characteristics of exporting firms as well as country-product fixed effects. The method of estimation of the first column is OLS. We use the 3-stage selection correction procedure in the last two columns. In the first two stages, distance is measured as kilometers in the second column and measured using the step function in the third column. Standard errors are clustered at the firm level.