Markups, Quality, and Trade Costs[*][†]

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Abstract

One robust finding in the empirical trade literature is that exporters set higher prices on exports to more distant countries. We argue that the positive relationship between export prices and bilateral distance is largely driven by variable markups. Moreover, we show that this relationship is heterogeneous across products differentiated by quality. To this end, we rely on a model that features variable markups by assuming that trade costs are both ad valorem and per unit. The model shows that firms set higher markups on exports to more distant markets, but lower markups in high-tariff countries. These effects, however, are predicted to be smaller in magnitude for higher quality exports. We find strong support for the predictions of the model using a unique data set of Argentinean firm-level wine exports combined with experts wine ratings as a measure of quality.

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1 Introduction

One robust finding in the empirical trade literature is that exporters set higher Free on Board (FOB) export prices in more distant countries.[1] This empirical regularity is at odds with the predictions of mainstream trade models showing that exporters charge either the same prices in all destinations (Eaton and Kortum, 2002; Melitz, 2003), or lower prices in more distant countries (Melitz and Ottaviano, 2008). Several mechanisms have therefore been proposed to explain the positive effect of distance on export prices. The first is a *composition effect*, also known as the Alchian and Allen (1964) effect, which may arise due to the existence of per unit trade costs which lower the relative price, and increase the relative demand for higher quality goods in more distant countries. As higher quality goods are more expensive, average prices increase with distance.[2] A second mechanism is a *selection effect* which may occur if firms find it profitable to export higher quality varieties to more difficult markets only, resulting in quality sorting. The exit of cheap and lower quality exports in more distant markets implies that, on average, prices rise with distance. Finally, firms may simply *price discriminate* and charge higher markups and therefore higher prices when exporting to more distant countries.[3,4]

So far, the literature has provided evidence supporting the Alchian and Allen (1964) mechanism (Emlinger and Lamani, 2017; Hummels and Skiba, 2004; Takechi, 2015), and it has established that selection matters, not only across firms (Baldwin and Harrigan, 2011; Crozet, Head, and Mayer, 2012; Johnson, 2012), but also across products within firms (Bastos and Silva, 2010; Harrigan, Ma, and Shlychkov, 2015). It has not addressed, however, the relevance of price discrimination and of variable markups due to the lack of export price data for individual goods. Moreover, without any data on product quality, the role that the literature attributes to quality in explaining the relationship between prices and distance is only indirect.

In this paper, as we observe the export prices of individual goods, we can investigate whether variable markups matter in explaining the positive effect of distance on prices. Moreover, thanks to the availability of an observable measure of quality, we can explore how quality shapes the relationship between export prices and trade costs. To motivate our empirical specifications, we first model theoretically the effects of trade costs on the pricing strategies of exporters. The model shows that export prices and markups rise with distance, but these effects are predicted to be smaller in magnitude for higher quality exports. We find strong support for the predictions of the model using a unique data

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[1] For evidence at the product level, see Baldwin and Harrigan (2011), Hummels and Skiba (2004), Lugovskyy and Skiba (2015, 2016), and Takechi (2015). At the firm level, see Bastos and Silva (2010), Görg, Halpern, and Muraközy (2017), Harrigan, Ma, and Shlychkov (2015), Manova and Zhang (2012), and Martin (2012).

[2] Trade statistics are generally reported for product categories that combine different varieties of the same good together. Export prices may therefore rise with distance if the share of more expensive, higher quality varieties within a product category is higher in exports to more distant countries.

[3] An older literature on spatial price discrimination studies how firms change their markups depending on the distance to the buyer (Greenhut, Ohta, and Sailors, 1985; Hoover, 1937). Firms charging a lower markup in more distant markets is typically referred to as "dumping" (Brander, 1981; Brander and Krugman, 1983; Melitz and Ottaviano, 2008; Ottaviano, Tabuchi, and Thisse, 2002). Instead, "reverse dumping" arises if firms set higher markups for more distant buyers.

[4] Composition is a demand-side effect, while selection and price discrimination are supply-side mechanisms. On the supply side, firms may also *upgrade* their quality for more distant countries (Martin, 2012). Higher quality goods would then be disproportionately shipped at longer distances, as is the case with selection and Alchian and Allen (1964).

set of Argentinean firm-level wine exports combined with experts wine ratings as a measure of quality (Chen and Juvenal, 2016, 2018; Crozet et al., 2012). Notably, we find that variable markups explain around two-thirds of the effect of distance on the variation in within firm export prices across markets, while the rest is due to selection or to composition effects across products within firms. Markups are therefore crucial in accounting for differences in the prices charged by exporters across countries. We also find that heterogeneity along the quality dimension matters in explaining the pricing decisions of exporters across markets. If distance doubles, an exporter increases its markup by 4.61 percent on average for a product at the 5^{th} percentile of the quality distribution, but by 0.28 percent only at the 95^{th} percentile. Our paper is the first to establish that variable markups and quality explain how trade costs impact export prices across international markets.

A large body of the empirical trade literature provides evidence that markups are variable. For instance, markups respond to trade liberalization (De Loecker, Goldberg, Khandelwal, and Pavcnik, 2016), to exchange rate fluctuations (Berman, Martin, and Mayer, 2012), they vary with per capita income (Simonovska, 2015), and their changes impact welfare (Feenstra and Weinstein, 2017).[5] These empirical findings therefore militate in favor of trade models that feature variable markups.[6] Of particular interest for our purposes are the models deriving predictions for the response of markups to international trade barriers. In these models, it turns out that the effect of bilateral distance on markups differs markedly depending on the nature of demand and on the structure of trade costs assumed. For instance, in models with quasi-linear demand, markups are predicted to fall with distance whether trade costs are ad valorem (Melitz and Ottaviano, 2008) or per unit (Ottaviano, Tabuchi, and Thisse, 2002; Martin, 2012).[7] Instead, in CES models, the introduction of per unit trade costs can generate endogenous markups that increase with distance (Crozet et al., 2012; Irarrazabal, Moxnes, and Opromolla, 2015; Martin, 2012).[8]

To guide our empirical specifications, our first contribution is to model theoretically the effects of trade costs on the pricing decisions of exporters. We rely on a framework with CES demand and per

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[5] See also Amiti, Itskhoki, and Konings (2014), Atkin and Donaldson (2015), Bellone, Musso, Nesta, and Warzynski (2014), Chen, Imbs, and Scott (2009), Chen and Juvenal (2016, 2018), De Loecker and Warzynski (2012), Edmond, Midrigan, and Xu (2015), Harrison (1994), Levinsohn (1993), and Mayer, Melitz, and Ottaviano (2014), among others.

[6] Many trade models, including perfect competition models such as Eaton and Kortum (2002), and monopolistic competition models such as Krugman (1980) or Melitz (2003) with heterogeneous firms assume constant markups. In Bernard, Eaton, Jensen, and Kortum (2003), markups are variable but invariant to country-level characteristics.

[7] Ad valorem trade costs (also referred to as iceberg or multiplicative) are applied as a percentage of the producer price per unit traded, while per unit (additive, or specific) costs are defined as a constant cost per unit traded.

[8] To estimate the magnitude of per unit trade costs, Irarrazabal, Moxnes, and Opromolla (2015) consider a CES model with per unit and ad valorem trade costs. Their identification strategy relies on the model prediction that higher per unit trade costs reduce the magnitude of the elasticity of demand to the FOB price. As we explain in Section 2.3, the same mechanism explains why in our model firms set higher markups and higher prices in more distant countries. In an online appendix, these authors investigate whether this mechanism holds for other demand systems that feature variable markups. With quasi-linear demand, the magnitude of the demand elasticity rises with per unit trade costs such that firms set lower prices in more distant markets. When deriving demand from a translog expenditure function (Feenstra, 2003), or from additively quasi-separable utility (Behrens and Murata, 2007), the relationship between per unit trade costs and the demand elasticity instead implies that firms set higher or lower prices in more distant countries depending on the magnitude of the deviation of the price from the price aggregator. In other words, only CES demand combined with per unit trade costs systematically predicts that firms charge higher markups in more distant countries. See also Arkolakis and Morlacco (2017) who study the properties of several demand functions that generate variable markups.

unit trade costs as this enables us to generate the prediction that markups are variable and increase with bilateral distance. Moreover, we are able to validate this modelling choice by providing evidence that per unit trade costs are pervasive in our data.[9]

We extend the monopolistic competition model of Martin (2012) where exporters maximize profits subject to a CES demand in each destination country. Trade costs are both ad valorem and per unit, and the introduction of per unit trade costs generates variable markups that depend on trade costs. The model shows that for a given quality, export prices and markups increase with per unit trade costs, such as bilateral distance. It also shows that prices and markups fall with ad valorem trade costs, such as tariffs. As we assume that producing a higher quality entails higher marginal costs, the model further predicts that the effects of trade costs (i.e., distance and tariffs) on prices and markups are heterogeneous and are smaller in magnitude for higher quality exports.

Our predictions rely crucially on the introduction of per unit trade costs in the model because the latter create a wedge between the elasticity of demand to the Cost, Insurance, and Freight (CIF) price and the elasticity of demand to the FOB price (Irarrazabal et al., 2015; Martin, 2012). For a given CIF elasticity, the magnitude of the FOB elasticity falls with per unit trade costs, and therefore with distance, but it increases with ad valorem costs, such as tariffs. Firms therefore find it profitable to raise export prices in more distant markets, and to lower them in high-tariff countries. But holding trade costs constant, the magnitude of the FOB elasticity rises with quality. The prices of higher quality exports thus respond less to changes in trade costs because their demand is more elastic to changes in the FOB price.

Our second contribution is to bring the predictions of the model to the data. Our firm-level trade data set reports, for each export transaction between 2002 and 2009, the name of the exporting firm, the country of destination, the date of shipment, the FOB value (in US dollars) and the volume (in liters) of each wine exported. A crucial feature of our data set is that exports are reported at the *individual* product level as each wine is identified according to its name, grape (Chardonnay, Malbec, etc.), type (white, red, or rosé), and vintage year. This level of detail is unique given that trade statistics are generally reported for product categories defined at the Combined Nomenclature (CN) or at the Harmonized System (HS) levels, and therefore combine within each product category the trade flows of different varieties of the same good together (Bastos and Silva, 2010; Görg, Halpern, and Muraközy, 2017; Harrigan et al., 2015; Manova and Zhang, 2012; Martin, 2012).[10]

We rely on the value and the volume exported at the firm-product-destination-time level to compute FOB unit values as a proxy for export prices. Our unit values can plausibly be interpreted as prices

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[9] Hummels and Skiba (2004), Lashkaripour (2017), and Lugovskyy and Skiba (2015) provide evidence that trade costs have a per unit component. Bosker and Buringh (2017), Daudin, Héricourt, and Patureau (2018), Irarrazabal et al. (2015), and Takechi (2015) evaluate that per unit trade costs are large.

[10] For instance, HS 2204 for "wine of fresh grapes" is split into five different 6-digit subheadings such as "wine; still, in containers holding two litres or less" (HS 220421). Argentina disaggregates the HS classification at the 12-digit level, resulting in eleven different subcategories for HS 2204. Instead, in our data set we observe 8,426 different wine products.

as they are defined at the individual product level. To measure the quality of each wine at the name-grape-type-vintage year level, we rely on two well-known experts wine ratings, the Wine Spectator and Robert Parker (Chen and Juvenal, 2016, 2018).[11] Once we match the unit values from the customs data set with the quality ratings of the Wine Spectator which has the largest coverage of Argentinean wines, we observe 237 multi-product wine producers shipping 8,426 different wines with heterogeneous levels of quality. Our focus on wine producers implies that each wine is exported by a single firm only.

For our purposes, our data set offers important advantages. First, thanks to the granularity of our data, we can compare the prices of a given product exported by a single producer at a given point in time across destinations, holding quality constant. Second, we can identify the variation in markups by controlling for product-time fixed effects which absorb the variation in product-specific marginal costs. Third, in contrast to papers relying on unit values as a proxy for quality (Hallak, 2006; Hummels and Skiba, 2004; Kugler and Verhoogen, 2012, among others), the availability of an observable measure of quality allows us to explore how firms set their prices across destinations depending on the quality they export. Fourth, exports are reported as FOB and therefore measure the revenue received by exporters at the border, excluding transport costs, tariffs, and distribution costs in the importing country. Fifth, shipping fees for wine are based on the volume exported, while other costs such as insurance fees or tariffs are proportional to value (Crozet et al., 2012). As assumed in our model, wine exports are therefore subject to both per unit and ad valorem trade costs (we confirm in Appendix A that both per unit and ad valorem trade costs are pervasive in our data).

Our main results can be summarized as follows. First, consistent with prior studies in the literature, we confirm that firms set on average higher prices on exports to more distant countries. We then demonstrate that this positive relationship between distance and prices survives the inclusion of product-time fixed effects. As this specification compares the prices of a given wine exported by a given firm at a given point in time across destinations, it controls for selection and for Alchian and Allen (1964) effects across products within firms. Moreover, it absorbs the variation in product-specific marginal costs such that the positive coefficient on distance captures the effect on variable markups. In other words, a given firm exports a given wine at a higher price in more distant markets because the markup is larger. Quantitatively, we evaluate that around two-thirds of the impact of distance on the variation in within firm prices across destinations is due to variable markups, while the rest is due to selection or to composition effects across products within firms. Consistent with the predictions of our model, we also find that higher tariffs reduce markups and export prices across destinations.

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[11] A large body of theoretical and empirical work shows that quality plays a key role as a determinant of the global patterns of bilateral trade flows and prices (Feenstra and Romalis, 2014; Hallak, 2006; Hummels and Klenow, 2005; Hummels and Skiba, 2004; Schott, 2004). As quality is unobserved, trade unit values are often used as a proxy. Recently, some papers have started to exploit direct measures of product quality. Atkin, Khandelwal, and Osman (2017) use artisan assessments for Egyptian rugs. Chen and Juvenal (2016, 2018) use the same quality ratings for Argentinean wines as in this paper. Crozet, Head, and Mayer (2012) use quality scores for Champagne. Emlinger and Lamani (2017) rely on the amount of time the eau-de-vie used to produce Cognac spends in oak. Goetz and Rodnyansky (2019) and Medina (2018) classify apparel products as high or low quality based on their composition of primary materials. Martin and Mayneris (2015) assume that high-end quality exporters belong to the Comité Colbert, a group of the main brands of the French luxury industry. Other papers derive alternative measures of quality. Khandelwal (2010) compares exporters' market shares conditional on price to infer export quality. Piveteau and Smagghue (2019) estimate quality using trade data.

Second, we demonstrate that the elasticities of export prices and markups with respect to distance and tariffs are smaller in magnitude for the wines of higher quality. For markups, the distance and tariff elasticities are on average 14 and four times smaller in magnitude at the 95^{th} than at the 5^{th} percentile of the quality distribution.

We also provide extensions to our main specifications. We show that the heterogeneous effects of distance and tariffs on prices and markups are stronger for exports to richer destinations, and they are predominantly driven by the higher quality firms, the larger firms, and the exporters who own a large share of the export market. Next, using data on the universe of Argentinean firm-level manufacturing exports, we provide evidence that our results for export prices extend to industries other than wine. As quality is unobserved, we follow Khandelwal (2010) to estimate quality for each 8-digit HS-level product exported by each firm to each destination country in each time period. The level of disaggregation of the data (at the HS level) prevents us from identifying variations in the markup, but we find that trade costs have heterogeneous effects on the prices of exports differentiated by quality. Finally, we derive the predictions of our model for the effects of distance and tariffs on export volumes across quality levels, and we provide evidence that those predictions hold in our data set of wine exports.

Overall, our findings are important for a variety of reasons. First, they shed light on how the export prices of traded products differentiated by quality are determined in international markets. This question is important because traded goods represent a large share of the consumption basket of individuals, and their prices therefore affect consumer welfare.[12] Second, as we demonstrate that a given firm exports a given product at a higher price in more distant markets, and at a lower price in high-tariff destinations, we conclude that trade costs play a key role in generating deviations from the Law of One Price. Trade costs thus matter in explaining the degree of international market segmentation. Third, the finding that variable markups explain a large share of the variation in within firm prices across destinations implies that, due to market power, firms actively price discriminate across markets. Finally, as our results are mainly driven by the high performance firms that contribute to the bulk of aggregate exports, we expect our findings to matter quantitatively in explaining aggregate export prices and markups.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 describes the firm-level exports data, quality ratings, macroeconomic indicators, and provides descriptive statistics. Section 4 presents the empirical methodology and our main results. Section 5 discusses extensions. Section 6 offers robustness checks and Section 7 concludes.

We also provide an appendix with additional results. Appendix A shows that both per unit and ad valorem trade costs are pervasive in our data. In Appendix B we estimate the elasticity of demand to the FOB price and show how it varies with per unit trade costs and quality. Appendix C demonstrates that our results remain robust to controlling for selection bias across firms. The estimation of quality for manufacturing exports is explained in Appendix D, while the sensitivity tests are presented in Appendix E.

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[12] Our analysis only focuses on export prices. We do not observe the destination countries' consumer prices.

2 The Model

The prediction that distance has a positive effect on export prices arises in a few models. In Hummels and Skiba (2004), per unit trade costs lower the relative price, and increase the relative demand for higher quality goods in more distant countries. Since higher quality goods are more expensive, the average price increases with distance. Instead, ad valorem tariffs are predicted to lower export prices. Lugovskyy and Skiba (2015, 2016) rely on a CES model and also predict that sector-level export prices rise with per unit trade costs (and therefore with distance) and fall with ad valorem costs (such as tariffs).[13] Baldwin and Harrigan (2011) propose a version of the Melitz (2003) model where consumers care about quality and firms produce quality differentiated varieties. The increase of unit values with distance is driven by the self-selection of heterogeneous firms as only the higher quality producers, setting higher prices, enter more distant markets. As the model only considers ad valorem trade costs, it predicts that distance and tariffs affect unit values in the same direction. Notably, these models do not consider variable markups.[14]

In what follows we extend the model of Martin (2012).[15] Exporters maximize profits subject to a CES demand in each destination country, and trade costs are both ad valorem and per unit. The introduction of per unit trade costs generates variable markups that depend on trade costs. The model shows that export prices and markups increase with per unit costs, and fall with ad valorem costs. We assume that quality is exogenous, but we consider that producing a higher quality entails higher marginal costs because it requires sophisticated inputs, skilled workers, and specialized equipment which are expensive. As a result, the effects of per unit and ad valorem trade costs on prices and markups are heterogeneous and are smaller in magnitude for higher quality exports. For simplicity, we assume that firms produce a single product, but we extend the framework to multi-product firms in the empirical analysis.

2.1 Setup

Since Samuelson (1954), researchers typically model trade costs as ad valorem such that more expensive products are more costly to trade. As in Martin (2012), we instead assume that trade costs t_{ij} have the following structure:

$$t_{ij} = p_{ij}^{cif} - p_{ij}^{fob} = (\tau_{ij} - 1)\, p_{ij}^{fob} + T_{ij}, \tag{1}$$

where p_{ij}^{cif} and p_{ij}^{fob} are the CIF and FOB prices of a monopolistically competitive firm i exporting to country j, and τ_{ij} and T_{ij} are the ad valorem and per unit components of trade costs, respectively.

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[13] In contrast to Irarrazabal et al. (2015) and Martin (2012), the CES models of Lugovskyy and Skiba (2015, 2016) only predict that export prices vary with trade costs because the latter affect marginal costs while keeping markups constant.

[14] To study the gains from trade across income groups, Fajgelbaum, Grossman, and Helpman (2011) rely on a nested-logit demand system and predict that export prices rise with both per unit and ad valorem costs while markups are invariant to trade costs. To quantify the effects of selection on bilateral trade flows and prices, Johnson (2012) considers a CES model with constant markups and predicts that aggregate export prices increase with the difficulty of entering a destination market (and, therefore, with distance).

[15] The theoretical model is only available in the Martin (2010) working paper.

Trade costs are ad valorem only if T_{ij} is zero, while they are per unit only if τ_{ij} is equal to one. As long as T_{ij} is positive, trade costs are less than proportional to the FOB price.

The relationship between the CIF and FOB prices can be expressed as:

$$p_{ij}^{cif}\left(\tau_{ij}, T_{ij}, c_i\left(\theta\right)\right) = \tau_{ij} p_{ij}^{fob}\left(\tau_{ij}, T_{ij}, c_i\left(\theta\right)\right) + T_{ij}, \tag{2}$$

where $c_i\left(\theta\right)$ is the marginal cost of production of firm i which increases with quality θ.[16] Producing a higher quality entails higher marginal costs because it requires higher quality, and therefore more expensive inputs.[17]

When exporting to country j, firm i maximizes profits π_{ij}:

$$\pi_{ij} = \left[p_{ij}^{fob} - c_i\left(\theta\right)\right] q_{ij} = \left[\left(\frac{p_{ij}^{cif} - T_{ij}}{\tau_{ij}}\right) - c_i\left(\theta\right)\right] q_{ij}, \tag{3}$$

where q_{ij} is the quantity sold by firm i in market j (which depends on p_{ij}^{cif}).

Firm i faces the following inverse CES demand in country j (Krugman, 1980; Melitz, 2003):

$$p_{ij}^{cif} = \kappa_j q_{ij}^{-\frac{1}{\sigma}} \theta^{\frac{(\sigma-1)}{\sigma}}, \tag{4}$$

where $\sigma > 1$ is the elasticity of substitution, and κ_j is a positive parameter (exogenous to the firm) which is a function of the size and price index of the destination country.[18] A higher quality θ shifts up the demand curve faced by the firm.

When firm i maximizes profits in (3) subject to the demand in (4), the first order condition is:

$$p_{ij}^{cif} = \frac{\sigma}{\sigma - 1}\left(T_{ij} + \tau_{ij} c_i\left(\theta\right)\right). \tag{5}$$

This yields the FOB price:[19]

$$p_{ij}^{fob} = \frac{1}{\sigma - 1}\left(\frac{T_{ij}}{\tau_{ij}} + \sigma c_i\left(\theta\right)\right), \tag{6}$$

and the corresponding markup:

$$\mu_{ij}^{fob} = p_{ij}^{fob} - c_i\left(\theta\right) = \frac{1}{\sigma - 1}\left(\frac{T_{ij}}{\tau_{ij}} + c_i\left(\theta\right)\right). \tag{7}$$

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[16] Quality can be defined as any tangible or intangible attribute of a product that makes it more valuable to consumers. As in Kugler and Verhoogen (2012), we assume that quality is exogenous and is therefore only chosen by firms.

[17] See Crinò and Epifani (2012), Feenstra and Romalis (2014), Hallak and Sivadasan (2013), Johnson (2012), Kugler and Verhoogen (2012), Manova and Zhang (2012), and Verhoogen (2008). For evidence that producing higher quality wines entails higher marginal costs, see Chen and Juvenal (2016). For instance, the oak barrels in which higher quality wines mature are more expensive than stainless-steel tanks.

[18] The predictions of our model remain similar if we let the elasticity of substitution vary with quality.

[19] A similar expression is found in Crozet et al. (2012) and Irarrazabal et al. (2015).

As producing a higher quality entails higher marginal costs $c_i(\theta)$, a higher quality sells at a higher price with a higher markup. For a given quality, the FOB price and markup depend positively on the per unit cost T_{ij}, and negatively on the ad valorem cost τ_{ij}. If trade costs are ad valorem only (i.e., $T_{ij} = 0$), the FOB price and markup do not depend on trade costs. If trade costs are per unit only (i.e., $\tau_{ij} = 1$), the FOB price and markup increase with trade costs.

2.2 Trade Costs and Quality

We calculate the elasticities of the FOB price and markup with respect to bilateral distance and tariffs by deriving the elasticities with respect to T_{ij}/τ_{ij} and τ_{ij}, respectively. We hypothesize that T_{ij}/τ_{ij} increases with distance as the latter is typically assumed to have a larger (positive) effect on per unit than on ad valorem trade costs (Crozet et al., 2012; Feenstra and Romalis, 2014; Hummels and Skiba, 2004; Irarrazabal et al., 2015; Lugovskyy and Skiba, 2015; Takechi, 2015).[20] We also show how the elasticities of the price and markup with respect to distance and tariffs vary with the quality of exports.

In our model, the introduction of per unit trade costs is crucial to derive our predictions. In Appendix A we replicate estimations from the literature to demonstrate that, in our data, both per unit and ad valorem trade costs matter. We also provide evidence that distance has a larger positive effect on per unit than on ad valorem trade costs, as assumed in our model.

Bilateral Distance Under the assumption that T_{ij}/τ_{ij} increases with distance, we use equations (6) and (7) and we derive the elasticities of the FOB price and markup with respect to T_{ij}/τ_{ij}:

$$\epsilon_{T/\tau}^{p^{fob}} = \frac{1}{\left(1 + \frac{\sigma c_i(\theta)}{T_{ij}/\tau_{ij}}\right)} > 0, \tag{8}$$

$$\epsilon_{T/\tau}^{\mu^{fob}} = \frac{1}{\left(1 + \frac{c_i(\theta)}{T_{ij}/\tau_{ij}}\right)} > 0. \tag{9}$$

Equations (8) and (9) imply that both the FOB price and markup increase with distance, and the two elasticities are smaller than one. In addition, as marginal costs increase with quality (i.e., $c_i'(\theta) > 0$), the magnitude of the two elasticities falls with quality.

Prediction 1 *The elasticities of the FOB price and markup with respect to bilateral distance are positive, and their magnitude decreases with quality.*

From an empirical point of view, Prediction 1 implies that in regressions that explain FOB prices or markups, we expect the coefficient on distance to be positive, and the coefficient on the interaction between distance and quality to be negative.

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[20] Our predictions remain similar if we derive the elasticities with respect to T_{ij} only. See Irarrazabal et al. (2015) for examples illustrating that per unit trade costs vary with the origin and the destination.

Tariffs The elasticities of the FOB price and markup with respect to ad valorem trade costs τ_{ij}, such as tariffs, are given by:

$$\epsilon_{\tau}^{p^{fob}} = \frac{-1}{\left(1 + \frac{\sigma c_i(\theta)}{T_{ij}/\tau_{ij}}\right)} < 0, \tag{10}$$

$$\epsilon_{\tau}^{\mu^{fob}} = \frac{-1}{\left(1 + \frac{c_i(\theta)}{T_{ij}/\tau_{ij}}\right)} < 0. \tag{11}$$

Both the FOB price and markup decrease with tariffs, but as marginal costs increase with quality the magnitude of the two elasticities in (10) and (11) falls with quality.

Prediction 2 *The elasticities of the FOB price and markup with respect to ad valorem trade costs, such as tariffs, are negative, and their magnitude decreases with quality.*

When explaining FOB prices or markups, Prediction 2 implies that the coefficient on tariffs should be negative, and the coefficient on the interaction between tariffs and quality should be positive.

The conclusion that the FOB price (and markup) rises with per unit trade costs (and therefore with distance) and falls with ad valorem costs (such as tariffs) is consistent with Crozet et al. (2012), Irarrazabal et al. (2015), and Martin (2012). Instead, the prediction that the magnitude of the elasticities of the price and markup with respect to distance and tariffs falls with quality is novel.[21]

2.3 Mechanisms

Our predictions are driven by the introduction of per unit trade costs in the model as the latter create a wedge between the elasticity of demand to the CIF price, ϵ^{cif}, and the elasticity of demand to the FOB price, ϵ^{fob}. To see this, we can show that the two elasticities are related as follows:

$$\epsilon^{fob} = \frac{\epsilon^{cif}}{\left(1 + \frac{T_{ij}}{\tau_{ij} p_{ij}^{fob}}\right)} = \frac{-\sigma}{\left(1 + \frac{1}{\left(\frac{\sigma}{\sigma-1}\right)\left[\frac{1}{\sigma} + \frac{\tau_{ij}}{T_{ij}}\left(\frac{\sigma}{\sigma-1}\right)c_i(\theta)\right]}\right)}. \tag{12}$$

If trade costs are ad valorem only ($T_{ij} = 0$), the two elasticities are identical (and equal to $-\sigma$). Instead, if trade costs are also per unit, for a given CIF elasticity the magnitude of the FOB elasticity falls with per unit costs, and therefore with distance. As the demand in more distant markets is less elastic to changes in the FOB price, exporters raise their FOB prices to compensate for the lower demand they face due to higher transport costs. This explains why FOB prices increase with distance.[22] However, for a given per unit trade cost, the magnitude of the FOB elasticity increases with marginal costs $c_i(\theta)$

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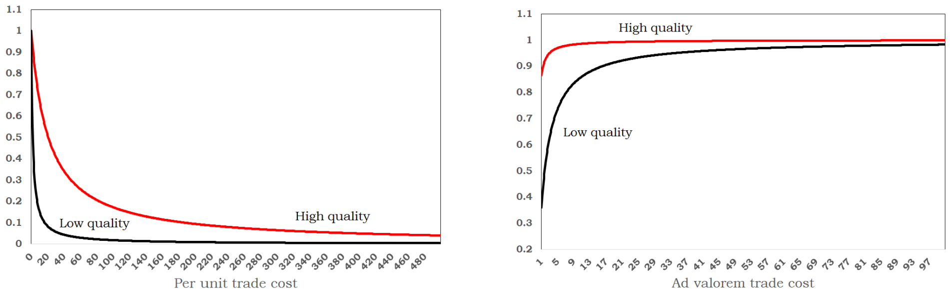
[21] Crozet et al. (2012) derive the elasticity of the FOB price with respect to quality, and show that this elasticity falls with distance. Focusing on Champagne exports they do not find, however, evidence supporting this mechanism.

[22] This mechanism assumes that distance affects the FOB price only through the per unit trade cost. In a wide range of models such as quasi-linear demand models, the introduction of per unit trade costs implies that distance also affects the FOB price through the CIF price. See Martin (2012) for a discussion.

and therefore with quality. As a result, the prices of higher quality exports increase less with distance because their demand is more elastic to changes in the FOB price.

Instead, for a given CIF elasticity the magnitude of the FOB elasticity increases with ad valorem trade costs such as tariffs. The demand faced by exporters is therefore more elastic to changes in the FOB price in countries with higher tariffs. To compensate for the lower demand they face due to higher tariffs, firms now reduce their FOB prices. But for a given tariff, the magnitude of the FOB elasticity increases with quality. Firms therefore reduce less the prices of higher quality exports as their demand is more elastic to changes in the FOB price.

As an illustration, based on equation (12) Figure 1 plots $\epsilon^{fob}/\epsilon^{cif}$ against per unit T_{ij} or ad valorem τ_{ij} trade costs. To contrast the predictions of our model across quality levels, we plot $\epsilon^{fob}/\epsilon^{cif}$ separately for lower and for higher quality exports (the FOB prices of lower and higher quality exports are measured at the 5^{th} and 95^{th} percentiles of the quality distribution in our sample, and are equal to 1.4 and 16 US dollars per liter of wine exported, respectively). In Panel (a), we set $\tau_{ij} = 1.3$ (Ghironi and Melitz, 2005), and for both quality levels we plot $\epsilon^{fob}/\epsilon^{cif}$ against the per unit trade cost T_{ij} starting at $T_{ij} = 0$. The CIF and FOB elasticities are identical when $T_{ij} = 0$. As T_{ij} increases, the FOB elasticity falls in magnitude relative to the CIF elasticity, but by less for the higher quality. In the limit, for both levels of quality the FOB elasticity converges towards zero.



(a) Per unit trade cost

(b) Ad valorem trade cost

Figure 1: Based on equation (12), the figure plots $\epsilon^{fob}/\epsilon^{cif}$ against (a) per unit trade costs and (b) ad valorem trade costs, separately for lower and for higher quality exports (the FOB prices of lower and higher quality exports are evaluated at the 5^{th} and 95^{th} percentiles of the quality distribution in our sample). We set the ad valorem trade cost at $\tau_{ij} = 1.3$ in (a), and the per unit trade cost at $T_{ij} = 2.5$ in (b).

In Panel (b), we postulate that T_{ij} is equal to 2.5 US dollars (Daudin, Héricourt, and Patureau, 2018), and for both levels of quality we plot $\epsilon^{fob}/\epsilon^{cif}$ against the ad valorem trade cost τ_{ij} starting at $\tau_{ij} = 1$.[23] As the per unit trade cost is positive, the FOB elasticity is smaller in magnitude than the CIF elasticity. As τ_{ij} increases, the magnitude of the FOB elasticity rises relative to the CIF elasticity, but it is consistently larger for higher than for lower quality exports. In the limit, for both levels of quality the FOB elasticity converges towards the CIF elasticity.

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[23] As reported by Chen and Juvenal (2016), the retail prices of non-EU wines sold in the UK include 13 pence per bottle for shipping and a duty of 1.90 pound sterling per bottle. Assuming a per unit cost of 2.5 US dollars per liter is therefore reasonable. The patterns depicted in Figure 1 remain similar, however, for alternative values of the per unit cost.

The identification strategy adopted by Irarrazabal et al. (2015) to estimate the magnitude of per unit trade costs relies on the mechanism described in equation (12). These authors provide evidence that higher per unit trade costs are associated with a less negative elasticity of demand to the FOB price, especially among low-price firms. In Appendix B, we replicate the specifications of Irarrazabal et al. (2015) but we investigate how quality, rather than the FOB price, affects the elasticity of ϵ^{fob} with respect to per unit trade costs. We provide strong evidence that the predictions of equation (12) hold in our data. First, the elasticity of ϵ^{fob} with respect to distance is negative, but it increases with quality. Second, the demand for higher quality exports is more elastic to changes in the FOB price. We estimate that ϵ^{fob} is equal to -1.078 at the 5^{th} percentile of the quality distribution in our sample, and to -1.293 at the 95^{th} percentile. The finding that the demand for higher quality goods is more sensitive to changes in export prices is consistent with Goetz and Rodnyansky (2019) and Medina (2018).

3 Data and Descriptive Statistics

Our data set combines information from different sources: firm-level customs data, wine experts quality ratings, and macroeconomic indicators.

3.1 Customs Data

Firm-level exports are collected by the Argentinean customs and were purchased from a private vendor called Nosis (Chen and Juvenal, 2016, 2018). For each transaction we observe the name of the exporting firm, the destination country, the shipment date, the 12-digit HS classification code, the FOB value (in US dollars) and the volume (in liters) of each wine exported between 2002 and 2009.[24] The main advantage of our data set is its level of disaggregation as for each wine exported we observe its name, type (red, white, or rosé), grape (Malbec, Chardonnay, etc.), and vintage year.

As export prices are not available, as a proxy we compute FOB unit values by dividing the value by the volume exported at the firm-product-destination-time level. As we do not observe the currency of invoicing, we measure unit values in US dollars per liter (instead of Argentinean pesos). The Datamyne, a private vendor of international trade data, indeed reports that 88 percent of total Argentinean wine exports (HS 2204) between 2005 and 2008 were priced in US dollars. As unit values are defined for positive exports only, our analysis focuses on the intensive margin of adjustment (we deal with the extensive margin in Appendix C).

We argue that our unit values can plausibly be interpreted as prices. On the one hand, unit values are defined at the *individual* product level (we show in Section 6 that our results remain similar if we further control for the type of packaging used for shipping). This means that we can compare the unit values of a given wine exported by a given firm at a given point in time across destinations, holding

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[24] Due to confidentiality reasons, the customs cannot make the name of the exporter public. Therefore, Nosis uses its own market knowledge to identify a first, a second, and a third probable exporter. To identify the exporter's identity, we collected from the Instituto Nacional de Vitivinicultura the name of the producer and of the wholesaler/retailer authorized to export each wine, and compared them against the probable exporters reported by Nosis.

quality constant. This is clearly an advantage over other firm-level trade data sets where unit values are defined at the CN or HS levels, and therefore measure for each product category the *average* price of different varieties with potentially heterogeneous levels of quality (Bastos and Silva, 2010; Görg et al., 2017; Harrigan et al., 2015; Manova and Zhang, 2012; Martin, 2012). On the other hand, as the volume is only reported in liters, the unit of measurement of our unit values is homogeneous across products.

We clean up the raw data in several ways. We only keep the FOB flows, and we exclude the wines produced outside of Argentina. We only include wine producers in the sample such that each wine is exported by one firm only (wholesalers and retailers are excluded, but as we show in Section 6 our results remain robust to including intermediaries in the sample). We drop the shipments containing less than 4.5 liters (the latter corresponds to a carton of six 75cl bottles) to discard commercial samples exported for marketing and promotion. We omit a few observations where the vintage year reported is ahead of the shipment year, and the cases where the value of exports is positive, but the volume is reported as zero. We aggregate the data at quarterly frequency between 2002Q1 and 2009Q4. As we show in Section 6, our results remain robust to aggregating the data at annual frequency. Finally, to eliminate potential outliers, we calculate the median unit value charged by each exporter in each time period, and we drop the observations for which the unit value exceeds 100 times the median, or falls below the median divided by 100.

In studies of price discrimination, disentangling markups from marginal costs is a challenge. To identify variations in the markup, researchers using firm-level data regress unit values on firm-product fixed effects to control for firm-product marginal costs (Manova and Zhang, 2012; Martin, 2012). However, as unit values are generally measured at the CN or HS levels, variations in the markup at the individual product level cannot be identified. Instead, as we observe the unit values of individual products exported by a single firm at a given point in time, we can identify variations in the markup by including product-time fixed effects (which are also firm specific) to control for product-specific marginal costs (Chen and Juvenal, 2016, 2018).[25] In other words, we can measure price discrimination on the basis of variable markups as the product-time fixed effects ensure that marginal costs are not responsible for the variation in prices across markets.

3.2 Quality

As in Chen and Juvenal (2016, 2018), we measure quality using the time-invariant quality ratings published by the Wine Spectator and Robert Parker. The wines are assessed in blind tastings, and the ratings are given on a (50,100) scale according to the name of the wine, its grape, type, and vintage year. A larger score indicates a higher quality. Table 1 describes the two rating classifications.

When we match the wines from the customs data set with the quality ratings of the Wine Spectator by name, type, grape, and vintage year, we end up with 237 producers exporting 8,426 wines with 1,066

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[25] As each wine is produced in a single year, marginal costs are time-invariant and can be absorbed by including product fixed effects. The product-time fixed effects control for other time-varying costs such as storage costs.

Table 1: Quality Ratings

Wine Spectator (50,100)		**Robert Parker (50,100)**	
Great	95-100	Extraordinary	96-100
Outstanding	90-94	Outstanding	90-95
Very good	85-89	Above average/very good	80-89
Good	80-84	Average	70-79
Mediocre	75-79	Below average	60-69
Not recommended	50-74	Unacceptable	50-59

Notes: Both the Wine Spectator and Parker rating systems classify the quality scores into six different bins.

different names, three types, 24 grapes, and 22 vintage years (from 1977 to 2009). The lowest rated wine receives a score of 55, and the highest a score of 97. When matching with the Parker ratings, we only observe 2,985 wines exported by 151 firms (with 443 different names, three types, 21 grapes, and 20 vintage years), and the scores vary between 72 and 98 (i.e., we only observe four of the six bins listed in Table 1). The mean absolute difference between the Wine Spectator and Parker ratings is equal to 1.96, with a standard deviation of 3.19. Still, the two ratings are positively correlated as Pearson's correlation is equal to 0.53, and Kendall's correlation index of concordance is 0.36. We rely on the Wine Spectator for our main specifications because it has the largest coverage of Argentinean wines. The Parker ratings are used as a robustness check only.

3.3 Macroeconomic Data

Bilateral distances (in kilometers) are from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Bilateral ad valorem tariffs for wine (HS 2204), reported at annual frequency, are obtained from the United Nations Conference on Trade and Development TRAINS database. We use the effectively applied weighted average tariff rates expressed in percentage terms (our results are similar if we use the effectively applied simple average tariff rates). Annual PPP GDPs and GDPs per capita (in constant 2011 US dollars) are from the World Bank's World Development Indicators.

3.4 A First Glance at the Data

Our sample includes 237 exporters, 8,426 wines, and 95 destination countries between 2002Q1 and 2009Q4 (90,243 observations). It represents 70 percent of the total value of red, white, and rosé wine exported over the period. Table 2 summarizes our trade data by year, and shows that the number of exporters and of exported wines increased threefold between 2002 and 2009. A total of 936 wines were exported by 70 different firms in 2002, while 191 firms exported 2,687 different wines in 2009. The number of export markets rose from 62 in 2002 to 77 in 2009. The mean number of exported wines and of destinations per firm, and the mean number of destinations per wine also increased over time (the fall in the number of observations, firms, destinations, and in the mean number of destinations per firm and per wine in 2009 corresponds to the global financial crisis, see Chen and Juvenal, 2018).

Table 3 reports descriptive statistics by quality bin of the Wine Spectator. "Good" and "Very good" wines represent the largest share of the sample (in terms of number of observations, firms, wines,

Table 2: Summary Statistics

Year	Observations	Firms	Wines	Destinations	Wines per firm	Destinations per firm	Destinations per wine
2002	3,491	70	936	62	33.7	16.3	6.4
2003	5,999	94	1,222	61	35.4	18.0	8.1
2004	7,928	123	1,473	66	33.5	18.8	9.4
2005	10,865	143	1,801	67	35.9	20.9	11.0
2006	13,662	166	2,138	77	39.2	20.8	11.6
2007	15,828	179	2,404	78	40.2	22.5	12.8
2008	16,870	196	2,517	80	43.2	21.9	12.8
2009	15,600	191	2,687	77	46.2	20.4	10.8

Notes: For each year in the sample, the table reports the number of observations, exporters, wines, and destinations, and the mean number of wines per exporter, destinations per exporter, and destinations per wine.

destinations, and export share in the sample). Instead, "Great" wines, followed by "Not recommended" wines, have the smallest coverages. "Great" wines are exported to a smaller number of countries which are, on average, richer. Consistent with quality sorting and the Alchian and Allen (1964) conjecture, "Great" wines are also exported to more distant locations. Higher quality wines are on average more expensive, but the correlation between unit values and quality in our sample is only equal to 36 percent.

Table 3: Descriptive Statistics

	Observations	Firms	Wines	Export shares	Unit values	Destinations	Distance	PPP GDP per capita
Great	201	7	44	0.10%	27.98	30	9,511	33,782
Outstanding	12,845	79	1,284	16.54%	12.45	81	8,864	31,103
Very good	35,755	147	2,508	43.82%	4.75	91	8,975	30,108
Good	35,855	181	3,617	34.38%	4.30	90	8,992	30,828
Mediocre	5,160	97	911	4.38%	3.93	80	8,905	32,960
Not recommended	427	26	62	0.78%	3.89	52	8,405	29,195

Notes: For each quality bin of the Wine Spectator, the table reports the number of observations, firms, wines, exports as a share of total exports (in %), the mean unit value (in US dollars per liter), the number of destinations, the mean distance (in kilometers), and the mean income per capita of the destination countries (in PPP constant 2011 US dollars).

To explore the relationship between distance and prices, we regress (log) unit values on product-time and destination country dummy variables. As the country fixed effects capture the average price that firms charge for their exports in each destination, we plot in Figure 2 the country fixed effects against (log) distance. The positive relationship indicates that, on average, firms set higher prices on exports to more distant countries.[26] The slope is equal to 0.02 (significant at the five percent level). If distance doubles, FOB prices increase by 1.4 percent on average ($2^{0.02} - 1$). The average price is the highest for exports to Luxembourg (LUX) which is a distant country (and has a high GDP per capita). There are some outliers, however, including Saint Lucia (LCA) and Belarus (BLR) which are both charged low average prices despite being relatively far away from Argentina (but they also have a low GDP per capita).

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[26] As we include product-time fixed effects, Figure 2 also shows that firms set higher markups in more distant countries.

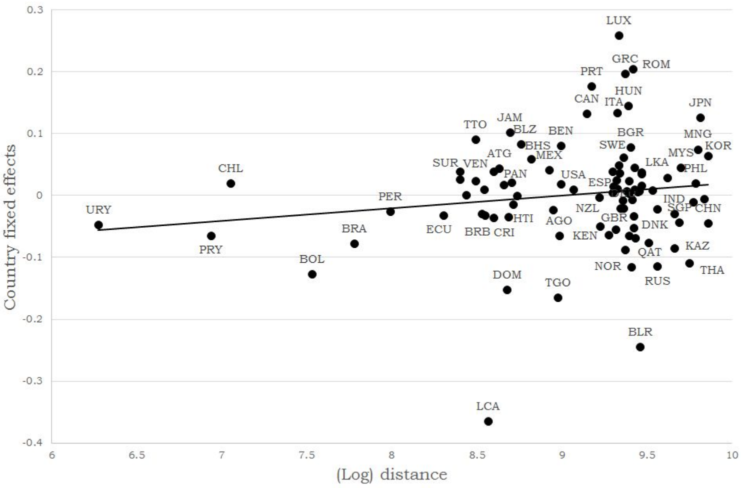

Figure 2: Destination-specific average prices against (log) distance.

4 Empirical Analysis

To test the predictions of our model, and therefore establish how exporters set their prices according to bilateral distance, tariffs, and the quality of their exports, we estimate the following reduced-form regression:

$$\begin{aligned} \ln uv_{ijk,t} \quad = \quad & \alpha_1 \ln dist_j + \alpha_2 \ln dist_j \times quality_k + \alpha_3 \ln tar_{j,t} + \alpha_4 \ln tar_{j,t} \times quality_k \\ & + \alpha_5 z_{j,t} + D_{k,t} + \varepsilon_{ijk,t}, \end{aligned} \tag{13}$$

where $uv_{ijk,t}$ is the FOB unit value of wine k exported by firm i to country j in quarter t (in US dollars per liter). The quality of wine k, denoted by $quality_k$, is measured using the Wine Spectator ratings. The bilateral distance $dist_j$ between Argentina and destination j, and the (annual) tariff $tar_{j,t}$ imposed by country j on wine imports from Argentina in quarter t are both interacted with quality (we use the logarithm of one plus the bilateral tariff rate). As our model predicts that prices increase with distance and fall with tariffs, but by less for higher quality exports, we expect $\alpha_1 + (\alpha_2 \times quality_k) > 0$ with $\alpha_2 < 0$ (Prediction 1), and $\alpha_3 + (\alpha_4 \times quality_k) < 0$ with $\alpha_4 > 0$ (Prediction 2).

We also control for destination-specific characteristics $z_{j,t}$ including (log) GDP, GDP per capita, and remoteness, measured at annual frequency. We expect GDP per capita to be associated with higher prices, reflecting that wealthier countries have a stronger preference for quality (Bastos and Silva, 2010; Görg et al., 2017; Hummels and Skiba, 2004; Lugovskyy and Skiba, 2015; Manova and Zhang, 2012; Martin, 2012). As unit values depend on average prices in each export market, they should also be higher in remote locations which are less competitive and have higher prices.[27] They should instead

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[27] A country is remote in economic terms if it is geographically isolated from other countries or is close to small countries but far away from large economies. Remoteness is calculated as $\sum_j (GDP_j/dist_j)^{-1}$ (Baldwin and Harrigan, 2011). Baldwin and Harrigan (2011), Harrigan et al. (2015), and Manova and Zhang (2012) find that export unit values are lower in remote countries where there is less competition. Instead, Martin (2012) finds that firms reduce their prices

be lower in larger countries where there is tougher competition (Baldwin and Harrigan, 2011; Görg et al., 2017; Harrigan et al., 2015; Martin, 2012).[28,29]

We perform within estimations and include product-time fixed effects $D_{k,t}$ (which are also firm specific).[30] The direct effect of quality therefore drops out from the regression. As explained earlier, the product-time fixed effects control for product-specific marginal costs such that a change in the price corresponds to a change in the markup. Robust standard errors are adjusted for clustering at the destination-time level (our results remain robust to multi-level clustering, for instance by destination and firm).

We then estimate a more stringent specification:

$$\ln uv_{ijk,t} = \phi_1 \ln dist_j \times quality_k + \phi_2 \ln tar_{j,t} \times quality_k + D_{k,t} + D_{ij,t} + v_{ijk,t}, \tag{14}$$

where the firm-destination-time fixed effects $D_{ij,t}$ control for factors such as the time-varying demand or taste of a country for a firm's exports, or the existence of long-term contracts for some exporters in some destination countries. They also absorb all destination-specific factors including distance, tariffs, GDP, GDP per capita, and remoteness. As a result, only the two interaction terms with quality can be estimated.

Our empirical analysis proceeds in three steps. In Section 4.1 we first revisit evidence from the prior literature that firms set on average higher prices on exports to more distant countries (and lower prices in high-tariff destinations). We then turn to our first contribution and show that variable markups matter in explaining the behavior of unit values across destinations. Our second contribution in Section 4.2 is to establish that the effects of distance and tariffs on prices and markups are smaller in magnitude for higher quality exports.

4.1 Homogeneous Trade Cost Effects

We start by estimating equation (13) but we omit the two interaction terms with quality to examine the homogeneous effects of bilateral distance and tariffs on unit values. Also, we replace the product-time fixed effects by firm-time dummy variables, and we control for product characteristics by including grape, type, vintage year, HS-level, and province of origin of the grapes fixed effects. Fixed effects for the wine names are not included as they are collinear with the firm fixed effects (as each wine is exported by one producer only). The firm-time fixed effects control for time-varying characteristics of the exporters such as productivity, firm size, or credit constraints. They also imply that our coefficients identify the variation in unit values across products and destinations for a given exporter at a given

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in highly competitive markets where average prices are lower.

[28] Instead, Bastos and Silva (2010) and Manova and Zhang (2012) find that unit values increase with the destination's GDP, while Baldwin and Harrigan (2011) show that unit values fall with the destination's income per capita. All our results remain robust to measuring real GDP, GDP per capita, and remoteness without any adjustment for PPP.

[29] Our results remain similar if we further include a dummy variable for the members of Mercosur (Brazil, Paraguay, Uruguay, and Venezuela) and its associate members (Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, and Suriname).

[30] Unless stated otherwise, throughout the paper the time dimension refers to quarters.

point in time. The effects of distance and tariffs on unit values can therefore be driven by selection across products within firms, Alchian and Allen (1964) effects, and/or variable markups.

Column (1) of Table 4 only includes bilateral distance, remoteness, GDP, and GDP per capita as regressors (i.e., we omit tariffs from the regression). Consistent with equation (8), export unit values increase with bilateral distance. If distance doubles, an exporter increases its FOB prices by 3.4 percent on average ($2^{0.049}-1$), which is similar in magnitude to the effects found by Bastos and Silva (2010), Görg et al. (2017), and Martin (2012) for Portuguese, Hungarian, and French exporters, respectively. Exporters charge higher prices in richer and remote destinations, and lower prices in larger markets.

Table 4: Homogeneous Trade Cost Effects

	(1)	(2)	(3)	(4)	(5)
$\ln distance$	0.049^a (0.007)	0.055^a (0.008)	0.053^a (0.008)	0.033^a (0.007)	–
$2,900 < distance < 7,700$	–	–	–	–	0.041^a (0.009)
$7,700 < distance < 14,200$	–	–	–	–	0.070^a (0.015)
$distance > 14,200$	–	–	–	–	0.079^a (0.019)
$quality$	–	–	0.032^a (0.001)	–	–
$\ln tariff$	–	-0.166^a (0.046)	-0.163^a (0.046)	-0.138^a (0.039)	-0.134^a (0.033)
$\ln remoteness$	0.098^a (0.017)	0.067^a (0.015)	0.067^a (0.015)	0.045^a (0.012)	0.040^a (0.012)
$\ln GDP$	-0.025^a (0.003)	-0.026^a (0.003)	-0.026^a (0.003)	-0.018^a (0.002)	-0.016^a (0.002)
$\ln GDP/cap$	0.036^a (0.007)	0.022^a (0.007)	0.024^a (0.007)	0.019^a (0.006)	0.013^b (0.006)
R-squared	0.567	0.567	0.579	0.782	0.782
Observations	89,740	89,740	89,740	74,315	74,315
Firm-time fixed effects	Yes	Yes	Yes	No	No
Product characteristics fixed effects	Yes	Yes	Yes	No	No
Product-time fixed effects	No	No	No	Yes	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels.

Column (2) includes tariffs as an additional regressor. Consistent with equation (10), higher tariffs reduce unit values (Görg et al., 2017; Hummels and Skiba, 2004; Lugovskyy and Skiba, 2016). The finding that export prices increase with distance and fall with tariffs is therefore consistent with the predictions of our theoretical framework which relies crucially on the assumption that trade costs have a per unit component (Hummels and Skiba, 2004; Martin, 2012). As we show in Appendix A, per unit trade costs are indeed pervasive in our data. Column (3) further controls for quality. Higher quality wines are exported at a higher price, as in equation (6). And for a given quality, exporters set higher prices on exports to more distant countries, and lower prices in markets with higher tariffs.

Column (4) includes product-time fixed effects and quality drops out from the regression. Importantly, the coefficient on distance remains positive while the coefficient on tariffs continues to be negative. As the coefficients are now purely identified from the variation in unit values across destinations for a given exporter and a given product at each point in time, this specification controls for selection and for Alchian and Allen (1964) effects across products within firms. Moreover, it absorbs the variation in product-specific marginal costs such that the coefficients on distance and tariffs capture the effects on variable markups.[31] A given wine is therefore sold at a higher price in more distant locations because the markup is larger. In contrast, a given wine is sold at a lower price in countries with higher tariffs because of a reduced markup.

Compared to a value of 0.053 in column (3), the distance coefficient falls to 0.033 in column (4). Around two-thirds of the impact of distance on the variation in within firm prices across destinations is therefore due to variable markups, while one-third is due to selection or to composition effects across products within firms.[32] Similarly, as the magnitude of the coefficient on tariffs falls from -0.163 to -0.138, variable markups explain around 85 percent of the effect of tariffs on the variation in within firm unit values across destinations, the rest being due to selection or to composition effects across products within firms.[33]

Column (5) reports non-parametric estimates and regresses unit values on distance interval dummy variables (the dummy for the first interval below 2,900 kilometers is omitted).[34] Again, the results indicate that markups, and therefore prices, rise with distance. Exporting to Latin American countries not sharing a common land border with Argentina (between 2,900 and 7,700 kilometers) increases markups by 4.1 log points, on average. The effect is equal to 7.0 log points for the countries located between 7,700 and 14,200 kilometers away from Argentina, and to 7.9 log points for the most distant destinations (above 14,200 kilometers). Higher tariffs continue to reduce markups across destinations.[35]

4.2 Heterogeneous Trade Cost Effects

We now explore the heterogeneous effects of distance and tariffs on unit values and markups differentiated by quality. Column (1) of Table 5 includes an interaction term between distance and quality, while column (2) further interacts tariffs with quality. Consistent with Predictions 1 and 2, the interaction between distance and quality is negative, while the interaction between tariffs and quality is

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[31] The selection and composition effects imply that prices rise with distance because different wines are sold in different markets. The effect of distance on prices conditional on observing positive exports for the same wine across destinations instead reflects price discrimination. Column (4) also rules out that firms upgrade their quality for more distant markets.

[32] The number of observations falls from 89,740 in column (3) to 74,315 in column (4) because the observations perfectly predicted by the product-time fixed effects (singletons) are dropped. As these correspond to wines exported by a given firm in a given quarter to a single country, they capture selection or composition effects across products within firms.

[33] Using US firm-level exports data, Harrigan et al. (2015) show that the ratio between the 90^{th} and 10^{th} percentiles of the within firm-product unit values distribution is equal to 3.1. If this variation in unit values across export markets was due to variable markups only, then the differences in demand elasticities for the same product across countries would need to be unrealistically large. These authors thus conclude that the variation in unit values across markets cannot be explained by price discrimination alone and that composition and selection effects need to play a role.

[34] The first group (below 2,900 kilometers) includes the countries sharing a common land border with Argentina (Bolivia, Brazil, Chile, Paraguay, and Uruguay). The second group (2,900–7,700 kilometers) consists of all other Latin American countries. The third group (7,700–14,200 kilometers) contains the US, Canada, Australia, New Zealand, Africa, Europe, and the Middle East. The last group (above 14,200 kilometers) comprises Asian countries.

[35] Our results also remain robust to letting the coefficient on distance vary across continents (South America, North America, Africa, Europe, and Asia).

positive. The elasticities of unit values and markups with respect to trade costs are therefore smaller in magnitude for the wines of higher quality.[36]

Table 5: Heterogeneous Trade Cost Effects

	(1)	(2)	(3)
$\ln distance$	0.379^{a} (0.064)	0.468^{a} (0.068)	–
$\ln distance \times quality$	-0.004^{a} (0.001)	-0.005^{a} (0.001)	-0.004^{a} (0.001)
$\ln tariff$	-0.139^{a} (0.039)	-1.325^{a} (0.449)	–
$\ln tariff \times quality$	–	0.014^{a} (0.005)	0.022^{a} (0.005)
$\ln remoteness$	0.045^{a} (0.012)	0.044^{a} (0.012)	–
$\ln GDP$	-0.017^{a} (0.002)	-0.017^{a} (0.002)	–
$\ln GDP/cap$	0.018^{a} (0.006)	0.018^{a} (0.006)	–
R-squared	0.782	0.782	0.909
Observations	74,315	74,315	69,219
Product-time fixed effects	Yes	Yes	Yes
Firm–destination-time fixed effects	No	No	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} indicates significance at the one percent level.

How large are the heterogeneous effects of trade costs? According to the estimates reported in column (2), at the mean value of quality (equal to 85) the distance elasticity is equal to 0.035 (significant at the one percent level). It is equal to 0.065 (significant at the one percent level) for a wine at the 5^{th} percentile of the quality distribution (i.e., a "Mediocre" wine with a quality of 79), and falls to 0.004 (which is insignificant) for a wine at the 95^{th} percentile (i.e., an "Outstanding" wine with a quality of 91). Similarly, the tariff elasticity is equal to -0.143 at the mean value of quality (significant at the one percent level). It is equal to -0.227 for a wine at the 5^{th} percentile of the quality distribution (significant at the one percent level), and falls in magnitude to -0.060 at the 95^{th} percentile (but is not significant). The distance and tariff elasticities are, therefore, on average 14.4 and 3.8 times smaller in magnitude at the 95^{th} than at the 5^{th} percentile of the quality distribution. According to our model, this heterogeneity in the magnitude of the distance and tariff elasticities arises because a higher quality makes the demand faced by exporters more elastic to changes in the FOB price (see Appendix B for evidence that the FOB elasticity is larger in magnitude for higher quality exports).

Based on the estimates reported in column (2), Panels (a) and (b) of Figure 3 plot the distance and tariff elasticities at each quality level in our sample (between 55 and 97) and their corresponding confidence intervals. The distance elasticity is the largest at 0.188 (significant at the one percent level) for a quality of 55, and falls to 0.01 for a rating of 89 (significant at the five percent level). The magnitude of the tariff elasticity is the largest at -0.560 (significant at the one percent level) for a

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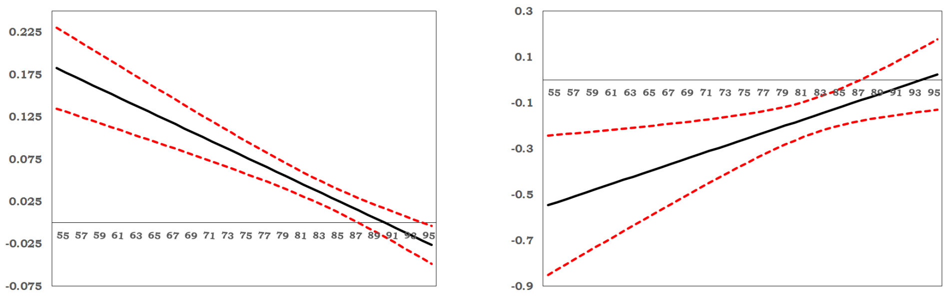
[36] Görg et al. (2017) find that the positive effect of distance on unit values falls with the potential for vertical differentiation, as proxied by Khandelwal's (2010) measure of quality "ladders." These authors interpret this finding as evidence against the Alchian and Allen (1964) mechanism.

quality of 55, and decreases to -0.088 (significant at the ten percent level) for a rating of 89. For quality levels above 89, both the distance and tariff elasticities become insignificant.



(a) Distance

(b) Tariffs

Figure 3: Bilateral distance and tariff elasticities by quality level (based on the estimates reported in column 2 of Table 5). 95 percent confidence intervals reported as dashed lines.

Column (3) reports the results of our more stringent specification (14). As we include product-time and firm-destination-time fixed effects, we can only identify the coefficients on the interaction terms. The interaction between distance and quality remains negative, while the interaction between tariffs and quality is positive.

As we only observe unit values when a firm exports to a destination country, our regressions do not control for the possibility that firms decide to export to some markets but not to others, leading to a selection bias across firms. By implementing the three-step estimator of Harrigan et al. (2015), we show in Appendix C that our results remain robust to controlling for selection bias across firms.[37] We explain export values using a two-step Heckman estimator and include the residuals as a selection control in the unit values regression.

Overall, our results provide strong evidence that variable markups matter in explaining the positive effect of distance, and the negative effect of tariffs on export unit values. Also, the effects of distance and tariffs on export unit values and markups are strongly heterogeneous across quality levels.

5 Extensions

This section discusses extensions to our main specifications. First, we investigate whether our results vary with the destination country's income per capita. Second, we explore whether our findings vary across firms depending on their average quality, size, and export market shares. Third, we extend our analysis for export prices to manufacturing industries other than wine. Finally, we derive and test the predictions of our model for export volumes.

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[37] While the introduction of product-time fixed effects in our regressions eliminates selection across products within firms, the exercise we implement in Appendix C removes selection bias across firms.

5.1 Income Heterogeneity across Destinations

Evidence suggests that consumer preferences for quality vary from one country to the other as preferences are affected by per capita income. In particular, consumers in richer countries are assumed to have a stronger preference for higher quality goods.[38] To check if our results are affected by per capita income, we classify countries as relatively rich or poor based on whether their income per capita is above or below the sample median, respectively. We estimate equation (13) and we interact the distance and tariff variables with a dummy for the richer destinations.[39]

Table 6: Income Heterogeneity across Destinations

	(1)	(2)	(3)	(4)
$\ln distance$	0.312^{a} (0.088)	–	0.395^{a} (0.079)	–
$\ln distance \times quality$	-0.003^{a} (0.001)	-0.003^{a} (0.001)	-0.004^{a} (0.001)	-0.003^{a} (0.001)
$\ln distance \times rich$	0.052^{a} (0.018)	–	0.050^{b} (0.022)	–
$\ln distance \times quality \times rich$	-0.001^{a} (0.000)	-0.000^{c} (0.000)	-0.001^{b} (0.000)	-0.000^{c} (0.000)
$\ln tariff$	0.010 (0.530)	–	0.407 (0.727)	–
$\ln tariff \times quality$	−0.001 (0.006)	0.008 (0.006)	−0.006 (0.009)	−0.012 (0.010)
$\ln tariff \times rich$	-2.080^{b} (0.851)	–	-1.906^{b} (0.845)	–
$\ln tariff \times quality \times rich$	0.022^{b} (0.010)	0.024^{b} (0.010)	0.022^{b} (0.010)	0.038^{a} (0.011)
$\ln remoteness$	0.026^{b} (0.012)	–	0.044^{a} (0.013)	–
$\ln GDP$	-0.018^{a} (0.002)	–	-0.017^{a} (0.002)	–
$\ln GDP/cap$	0.022^{a} (0.008)	–	0.021^{a} (0.007)	–
Rich versus poor distinction	Median GDP/cap	Median GDP/cap	World Bank GNI	World Bank GNI
R-squared	0.783	0.909	0.782	0.909
Observations	74,315	69,219	74,315	69,219
Product-time fixed effects	Yes	Yes	Yes	Yes
Firm-destination-time fixed effects	No	Yes	No	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a}, ^{b}, and ^{c} indicate significance at the one, five, and ten percent levels.

The results are presented in column (1) of Table 6. The coefficients on distance and on its interaction with quality are significant for the two groups of countries, but they are both larger in magnitude for the richer destinations. Instead, the effect of tariffs is significant and heterogeneous for the richer markets only. Column (2) further includes firm-destination-time fixed effects, and the coefficients on the two interaction terms are again significantly larger in magnitude for the richer countries. The heterogeneous effects of trade costs on prices and markups are thus stronger for exports to richer destinations.

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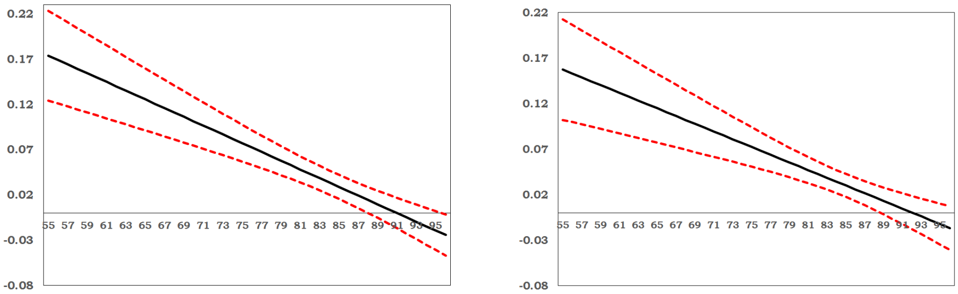
[38] Hallak (2006) finds that rich countries import more from countries producing higher quality goods. In Fajgelbaum et al. (2011), the share of consumers who buy higher quality goods rises with income. Also, see Chen and Juvenal (2016, 2018), Crinò and Epifani (2012), Feenstra and Romalis (2014), Manova and Zhang (2012), Simonovska (2015), and Verhoogen (2008).

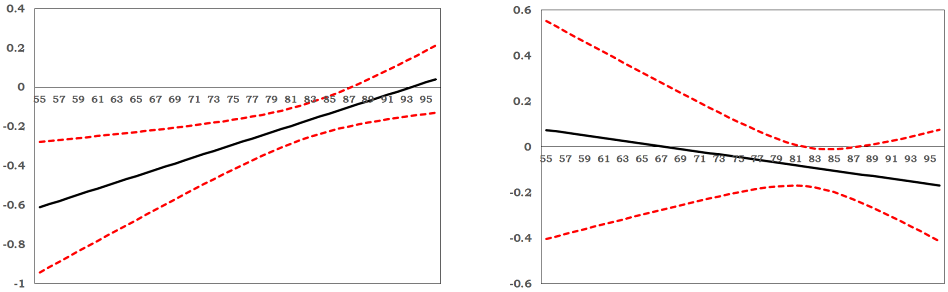
[39] Argentina's higher income export destinations such as the US and the EU also tend to be farther away. In our sample, the correlation between income per capita and bilateral distance is equal to 60 percent.

Another way to investigate the effect of income per capita is to split our sample using the World Bank's classification of high and low income countries (the threshold is a GNI per capita of 4,035 US dollars in 2011). The results, reported in columns (3) and (4), remain similar, however.[40]



(a) Distance, rich countries

(b) Distance, poor countries



(c) Tariffs, rich countries

(d) Tariffs, poor countries

Figure 4: Bilateral distance and tariff elasticities for the rich and poor destinations by quality level (based on the estimates reported in column 3 of Table 6). 95 percent confidence intervals reported as dashed lines.

Based on the estimates of column (3), Panels (a) to (d) of Figure 4 plot, for both groups of countries, the distance and tariff elasticities by quality level as well as their corresponding confidence intervals. The distance elasticities vary significantly with quality for both higher and lower income countries, but the relationship is slightly steeper for the richer destinations, reflecting stronger heterogeneous effects. Instead, the tariff elasticities vary strongly with quality for the richer countries only.

5.2 Firm Characteristics

We explore whether our results vary between different types of exporters. We focus on firm-level quality, firm size, and export market shares in each destination country. We find that the heterogeneous effects of distance and tariffs on unit values and markups are mainly driven by the high performance firms.

First, we compare higher and lower quality exporters by dividing our sample at the median of average firm-level quality. Quality ranges between 55 and 97 for the higher quality exporters (mean quality is 87), and between 55 and 93 for the lower quality firms (mean quality is 83). We estimate

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[40] If we instead estimate a specification with a full set of interactions, the interaction between tariffs, quality, and income per capita is positive, while the interaction between distance, quality, and income per capita is negative but insignificant.

Table 7: Firm Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	Exporter quality		**Exporter size**		**Export market shares**	
ln *distance*	0.084 (0.089)	–	0.409^a (0.097)	–	0.451^a (0.070)	–
ln *distance* × *quality*	0.000 (0.001)	−0.001 (0.001)	−0.005^a (0.001)	0.000 (0.001)	−0.005^a (0.001)	−0.004^a (0.001)
ln *distance* × *large*	0.558^a (0.136)	–	0.170 (0.131)	–	0.009 (0.017)	–
ln *distance* × *quality* × *large*	−0.007^a (0.002)	−0.006^a (0.001)	−0.001 (0.002)	−0.006^a (0.001)	0.000 (0.000)	0.000 (0.000)
ln *tariff*	−0.036 (0.523)	–	−0.384 (0.671)	–	−0.373 (0.789)	–
ln *tariff* × *quality*	−0.001 (0.006)	0.010^c (0.005)	0.003 (0.008)	0.004 (0.008)	0.000 (0.010)	0.000 (0.008)
ln *tariff* × *large*	−3.216^a (0.857)	–	−1.658^b (0.796)	–	−1.500^c (0.904)	–
ln *tariff* × *quality* × *large*	0.037^a (0.010)	0.022^b (0.010)	0.019^b (0.009)	0.025^b (0.010)	0.021^c (0.011)	0.031^a (0.010)
ln *remoteness*	0.044^a (0.012)	–	0.044^a (0.012)	–	0.027^b (0.011)	–
ln *GDP*	−0.017^a (0.002)	–	−0.018^a (0.002)	–	−0.017^a (0.002)	–
ln *GDP/cap*	0.018^a (0.006)	–	0.019^a (0.006)	–	0.016^a (0.006)	–
R-squared	0.783	0.909	0.783	0.909	0.783	0.909
Observations	74,315	69,219	74,315	69,219	74,315	69,219
Product-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-destination-time fixed effects	No	Yes	No	Yes	No	Yes

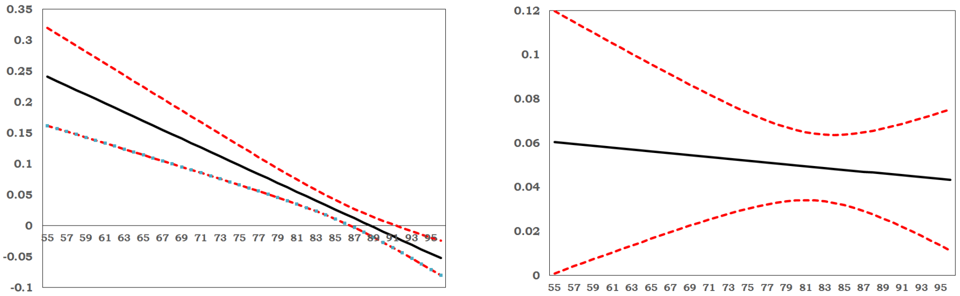
Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a}, ^{b}, and ^{c} indicate significance at the one, five, and ten percent levels. The *large* dummy variable captures whether average firm-level quality, firm size, or firm export market shares are above the sample median, respectively.

equation (13) and interact distance, tariffs, and their interaction with quality with a dummy for the higher quality firms. In column (1) of Table 7, the effects of distance and tariffs are only significant and heterogeneous for the higher quality firms. These findings are illustrated in Panels (a) to (d) of Figure 5 which plot for both types of firms the distance and tariff elasticities by quality level. The distance and tariff elasticities vary strongly with quality for the higher quality exporters, while these relationships are flatter (and the confidence intervals are larger) for the lower quality firms.

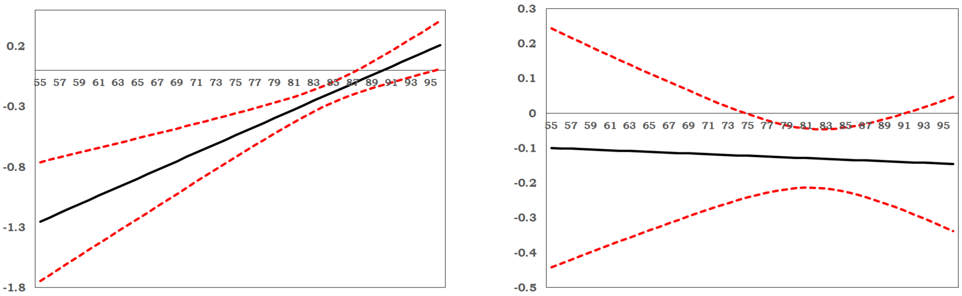
We further control for firm-destination-time fixed effects in column (2) and the coefficient on tariffs interacted with quality becomes positive (at the ten percent level) for the lower quality firms. Still, the coefficients on the interactions of distance and tariffs with quality are significantly larger in magnitude for the higher quality exporters. Heterogeneity in the impact of trade costs on prices and markups is therefore stronger for the higher quality firms.

Second, we ask whether our results vary with firm-level productivity. As more productive firms tend to charge higher markups (Bellone, Musso, Nesta, and Warzynski, 2014; Berman et al., 2012; Melitz and Ottaviano, 2008), we expect those firms to be better able to adjust their markups in response to changes in trade costs. Harrigan et al. (2015) find that the positive effect of distance on unit values is mainly due to the behavior of high-TFP firms, while Bastos and Silva (2010) show that it is larger for more productive exporters. Missing any data on firm-level value-added or employment which are required to calculate productivity, we instead rely on a measure of firm size as the latter is known to correlate strongly with productivity (Bernard, Eaton, Jensen, and Kortum, 2003). We calculate the total volume (in liters) of exports for each firm in each year, and divide our sample between large and small firms based on whether their total yearly exports are above or below the sample median.

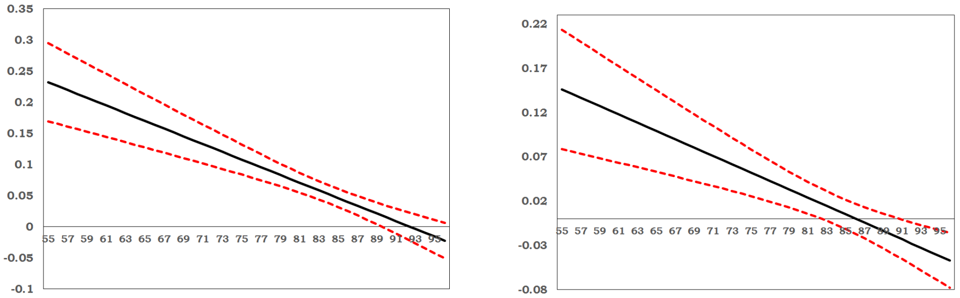
Column (3) reports the results of estimating equation (13) where we interact the distance and tariff variables with a dummy for the large firms. The effect of distance is significant and heterogeneous for the large and small firms, while the effect of tariffs is significant and heterogeneous for the large firms only (these relationships are graphically represented in Panels e to h of Figure 5). Once we control for firm-destination-time fixed effects in column (4), distance interacted with quality turns insignificant for the small firms. The heterogeneous effects of distance and tariffs on prices and markups are therefore mainly driven by the large firms.



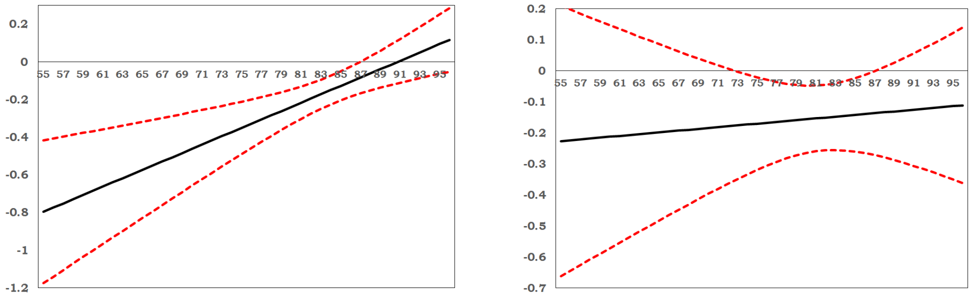
(a) Distance, high quality firms (b) Distance, low quality firms



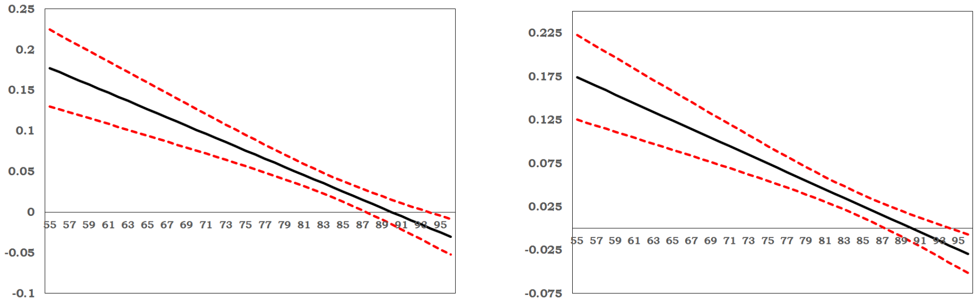
(c) Tariffs, high quality firms (d) Tariffs, low quality firms



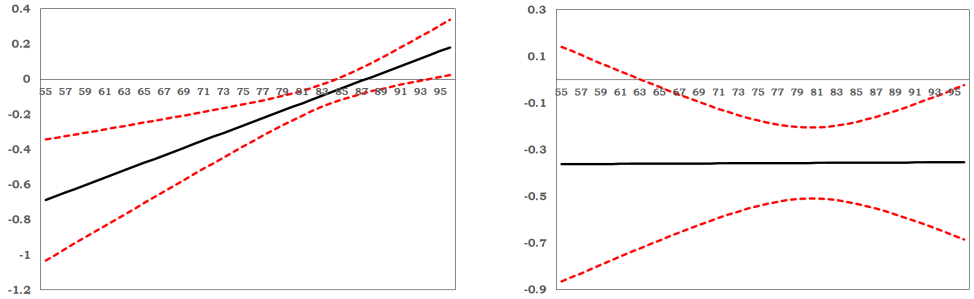
(e) Distance, large firms (f) Distance, small firms



(g) Tariffs, large firms (h) Tariffs, small firms



(i) Distance, high market share firms (j) Distance, low market share firms



(k) Tariffs, high market share firms (l) Tariffs, low market share firms

Figure 5: Bilateral distance and tariff elasticities for high/low quality firms, large/small firms, and exporters with large/small export market shares by quality level (based on the estimates reported in columns 1, 3, and 5 of Table 7). 95 percent confidence intervals reported as dashed lines.

Lastly, we compare firms based on their export market shares. According to Amiti, Itskhoki, and Konings (2014) and Atkeson and Burstein (2008), exporters have higher markups in the countries where they own a large share of the market, making it easier to adjust their markups. We thus expect the effects of trade costs on prices and markups to be more strongly heterogeneous for the high market share firms.

We construct the market share of each firm as the share of its total exports in the total value exported by all firms by destination in each year. Relative to the median market share, we split the sample between high and low market share firms. We regress equation (13) and interact the distance and tariff variables with a dummy for the high market share firms. Column (5) shows that the effect of distance is significant and heterogeneous for the two groups of firms. Instead, tariffs only have heterogeneous effects for the high market share firms (these relationships are depicted in Panels i to l of Figure 5). The results are similar in column (6) once we include firm-destination-time fixed effects. The impact of tariffs on prices and markups is therefore heterogeneous for the high market share firms only, while the effect of distance is equally heterogeneous for the two groups of exporters.

5.3 Manufacturing Industries

To demonstrate that our results for export prices generalize to industries other than wine, we rely on the universe of Argentinean firm-level exports (from Nosis). We observe the name of the exporter, the destination country, the transaction date, the 12-digit HS code, the FOB value (in US dollars) and the mass (in kilograms) of exports between 2002 and 2009. We focus on manufacturing industries (HS 16 to 97), and we define a product at the 8-digit HS level. We aggregate the data at quarterly frequency, and we compute unit values in US dollars per kilogram.[41] As quality is unobserved, we follow Bernini and Tomasi (2015) who adapt the Khandelwal (2010) procedure to estimate the quality of exports at the firm-product-destination-time level (Chen and Juvenal, 2018). See Appendix D for details. Our sample includes 11,726 exporters, 4,435 products, and 81 destination countries (605,225 observations). We estimate different versions of equation (13), but as each product can be exported by more than one firm we now control for firm-time and firm-product fixed effects.

Table 8: Manufacturing Industries

	(1)	(2)	(3)	(4)
$\ln distance$	0.030^{a} (0.002)	0.031^{a} (0.002)	0.031^{a} (0.002)	–
$quality$	–	0.016^{a} (0.001)	0.054^{a} (0.004)	0.062^{a} (0.005)
$\ln distance \times quality$	–	–	-0.005^{a} (0.001)	-0.006^{a} (0.001)
$\ln tariff$	-0.055^{b} (0.025)	-0.054^{b} (0.025)	-0.054^{b} (0.025)	–
$\ln tariff \times quality$	–	–	0.011^{c} (0.006)	0.019^{a} (0.007)
$\ln remoteness$	0.020^{b} (0.008)	0.023^{a} (0.008)	0.023^{a} (0.008)	–
$\ln GDP$	-0.020^{a} (0.002)	-0.020^{a} (0.001)	-0.020^{a} (0.001)	–
$\ln GDP/cap$	0.032^{a} (0.004)	0.030^{a} (0.004)	0.030^{a} (0.004)	–
R-squared	0.917	0.917	0.917	0.934
Observations	556,786	556,786	556,786	473,097
Firm-time fixed effects	Yes	Yes	Yes	No
Firm-product fixed effects	Yes	Yes	Yes	Yes
Firm-destination-time fixed effects	No	No	No	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per kilogram). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a}, ^{b}, and ^{c} indicate significance at the one, five, and ten percent levels.

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[41] The BACI data set that we use to estimate quality only starts in 2003 (see Appendix D). In the customs data, we identify the exporter as the first probable exporter reported by Nosis. We drop the observations for which the unit value exceeds 100 times the median unit value per firm-product-time, or falls below the median divided by 100.

Overall, the results presented in Table 8 provide strong evidence that our findings for export prices hold more generally for manufacturing industries other than wine. The only drawback is that the level of disaggregation of the data (at the HS level) prevents us from identifying variations in the markup. Still, the results show that export unit values increase with bilateral distance, income per capita, and remoteness, and fall with a country's size and tariffs (column 1). Higher quality goods are exported at a higher price (column 2). The magnitude of the effects of distance and tariffs on export unit values is smaller for higher quality exports (column 3), and this finding remains robust to controlling for firm-destination-time fixed effects (column 4).

5.4 Export Volumes

Our model also holds predictions for the effects of distance and tariffs on exports across quality levels. Using equations (4) and (5), the elasticities of export quantities q_{ij} with respect to T_{ij}/τ_{ij} and τ_{ij} are given by:

$$\epsilon^{q}_{T/\tau} = \frac{-\sigma}{\left(1 + \frac{c_i(\theta)}{T_{ij}/\tau_{ij}}\right)} < 0, \tag{15}$$

$$\epsilon^{q}_{\tau} = \frac{-\sigma}{\left(1 + \frac{T_{ij}/\tau_{ij}}{c_i(\theta)}\right)} < 0. \tag{16}$$

Export quantities fall with T_{ij}/τ_{ij} (and therefore with distance) but by less for higher quality products. Instead, quantities fall with ad valorem costs τ_{ij} (such as tariffs) but by more for higher quality exports.[42] To investigate those predictions, we estimate the following reduced-form regression:

$$\begin{aligned} \ln q_{ijk,t} &= \xi_1 \ln dist_j + \xi_2 \ln dist_j \times quality_k + \xi_3 \ln tar_{j,t} + \xi_4 \ln tar_{j,t} \times quality_k \\ &\quad + \xi_5 z_{j,t} + D_{k,t} + \nu_{ijk,t}, \end{aligned} \tag{17}$$

where $q_{ijk,t}$ is the export volume (in liters), and we expect $\xi_1 + (\xi_2 \times quality_k) < 0$ with $\xi_2 > 0$, and $\xi_3 + (\xi_4 \times quality_k) < 0$ with $\xi_4 < 0$. Equation (17) can be estimated by OLS. However, as estimations that include positive trade flows only suffer from a selection bias (Crozet et al., 2012), we also regress $q_{ijk,t}$ by Poisson Pseudo-Maximum Likelihood (Head and Mayer, 2014; Santos Silva and Tenreyro, 2006). To do so, we construct a balanced sample of all possible firm-product-destination-time combinations that includes positive and zero trade observations. With 8,426 wines, 95 destination countries, and eight years at a quarterly frequency, this sample includes 25,615,040 observations. As each wine can only be exported after it has been produced, we then drop for each wine the years prior to its vintage year. This reduces our sample to 15,986,517 observations.[43]

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[42] For a given quality, exports fall with the CIF price (equation 4) and therefore with distance and tariffs (using equation 5 we can show that the CIF price increases with T_{ij}/τ_{ij} and τ_{ij}). A longer distance therefore increases the CIF price directly but also indirectly through the FOB price. As the increase in the FOB price (and thus in the CIF price) is smaller for higher quality goods, their exports fall less compared to lower quality exports. Higher tariffs increase the CIF price directly, but also reduce it by lowering the FOB price. As the FOB price falls less (and the CIF price therefore rises more) for higher quality goods, their exports fall to a larger extent compared to lower quality exports.

[43] Due to the fixed effects, the number of observations used in each regression is actually much smaller.

Table 9: Export Volumes

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln distance$	-1.036^a (0.069)	-2.399^a (0.372)	–	-0.272^a (0.040)	-0.858^a (0.269)	–
$\ln distance \times quality$	–	0.016^a (0.004)	0.018^a (0.006)	–	0.007^b (0.003)	-0.003 (0.003)
$\ln tariff$	-2.346^a (0.245)	8.098^a (2.329)	–	-0.570^a (0.201)	10.683^a (1.771)	–
$\ln tariff \times quality$	–	-0.124^a (0.028)	-0.219^a (0.028)	–	-0.132^a (0.021)	-0.079^a (0.017)
$\ln remoteness$	-0.713^a (0.109)	-0.713^a (0.109)	–	0.067 (0.071)	0.071 (0.070)	–
$\ln GDP$	0.737^a (0.019)	0.737^a (0.019)	–	0.262^a (0.012)	0.263^a (0.012)	–
$\ln GDP/cap$	0.942^a (0.062)	0.942^a (0.061)	–	0.444^a (0.036)	0.444^a (0.036)	–
R-squared	–	–	–	0.471	0.472	0.768
Observations	2,472,069	2,472,069	421,691	74,315	74,315	69,219
Estimation	PPML	PPML	PPML	OLS	OLS	OLS
Zero observations included	Yes	Yes	Yes	No	No	No
Product-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm–destination-time fixed effects	No	No	Yes	No	No	Yes

Notes: The dependent variable is the FOB export volume (in liters) in (1) to (3), and the log FOB export volume in (4) to (6). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels.

Columns (1) to (3) of Table 9 report PPML estimates. Export volumes fall with distance and tariffs (column 1). The magnitude of the distance elasticity falls with quality, while the magnitude of the tariff elasticity increases with quality (column 2).[44] This heterogeneity across quality levels remains robust to the inclusion of firm-destination-time fixed effects (column 3). Besides, firms export more to richer and larger markets, and less to remote destinations. Columns (4) to (6) report OLS estimates. The results remain similar, except that remoteness in columns (4) and (5) and the interaction between distance and quality in column (6) become insignificant.

According to the PPML estimates of column (2), the distance elasticity is equal to -1.040 at the mean value of quality (equal to 84). At the 5^{th} and 95^{th} percentiles of the quality distribution (equal to 78 and 91, respectively), it is equal to -1.142 and -0.932 (all three elasticities are significant at the one percent level). At the mean, 5^{th}, and 95^{th} percentiles, the tariff elasticity is equal to -2.314, -1.540, and -3.147, respectively (all significant at the one percent level).[45]

6 Robustness

We report a number of robustness exercises on the estimation of equation (14). Overall, the patterns we find are supportive of our main conclusions.

Using the same data as in this paper, Chen and Juvenal (2016, 2018) show that the markups of

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[44] When explaining export values, Crozet et al. (2012) find that the interaction between distance and quality is positive.

[45] Although the coefficient on tariffs is positive in columns (2) and (5), the elasticity of export volumes with respect to tariffs is negative for all quality levels in our sample (between 55 and 97).

higher quality exports are more sensitive to changes in real exchange rates and to changes in foreign income. To ensure that our results continue to hold once we control for these two mechanisms, in column (1) of Table E1 in Appendix E we further include the exchange rate between the US dollar and the destination country's currency (an increase indicates an appreciation of the US dollar) interacted with quality. In column (2), we instead control for foreign real GDP per capita interacted with quality.[46] In both columns, the coefficient on these interaction terms is positive and significant. In column (3), we include the two interaction terms simultaneously and only the coefficient on the exchange rate interaction remains positive and significant. Most importantly, in all columns our main conclusions continue to hold as the interaction between distance and quality is negative, while the interaction between tariffs and quality is positive. Notice that Hummels and Skiba (2004) also rule out pricing-to-market as an explanation for the positive effect of distance on export prices. Martin (2012) reaches a similar conclusion by showing that the effect of distance on export unit values remains positive once he restricts his sample to the euro area where exchange rates are fixed.

One factor that may affect the prices of Argentinean wine exports is the degree of competition faced in foreign markets. Without any data on the supply of non-Argentinean wines by quality level in each destination country, we are unable to measure the intensity of competition by quality segment in each export market, resulting in potential omitted variables bias. We address this concern by controlling for each country's share of wine imports from Argentina, interacted with quality.[47] In the countries with a large import share, Argentinean exporters should be able to charge higher prices as they are less exposed to competition from other countries. As shown in column (1) of Table E2, the coefficient on the import share is indeed positive, while the coefficient on its interaction with quality is negative. Firms therefore set higher markups and higher prices in the countries with a larger share of Argentinean wine imports, especially for lower quality wines. But crucially, our results on the effects of distance and tariffs on export prices and markups continue to hold. In column (2) we further control for firm-destination-time fixed effects, and the coefficients on the three interaction terms remain significant. We therefore conclude that our results are not driven by the extent of competition in foreign countries.

Our data set provides us with information on the type of packaging used for shipping. Wines are predominantly exported in boxes or bottles (accounting for 97 percent of transaction counts), but they are also shipped in wooden barrels, glass, tin, or tetra pak containers. As prices and markups may vary with the type of packaging used, we construct a new sample and define a wine product according to its name, grape, type, vintage year, and container type. Column (1) of Table E3 shows that accounting for packaging leaves our results unchanged.[48]

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[46] The quarterly nominal exchange rates are from the International Financial Statistics of the International Monetary Fund. Chen and Juvenal (2016) instead regress unit values in Argentinean pesos on the real exchange rate between Argentina and the importing country.

[47] A country's import share is defined as the volume of wine imports from Argentina divided by the volume of total wine imports (in liters). Bilateral wine import volumes (HS 2204) at annual frequency are from the BACI data set.

[48] Compared to our benchmark data set, this sample is slightly larger with 91,859 observations, but it also includes a greater proportion of wine products being exported to a single destination in each time period. The inclusion of product-time fixed effects therefore reduces our estimation sample to 66,993 observations.

In many countries, wholesalers and retailers, which are excluded from our sample, account for a large share of exports as they assist less productive firms in overcoming barriers to foreign markets. In Argentina, a very small share of wine exports is, however, handled by intermediaries. In our raw data set, this share is equal to 4.80 percent in 2002, and to 5.33 percent in 2009. Column (2) shows that our results continue to hold once we include wholesalers and retailers in the sample.[49]

Column (3) restricts our sample to the firms exporting to more than ten destinations, while column (4) only includes the wines exported to more than ten foreign markets. In column (5), we compute unit values at annual frequency as combining quarterly data for export prices with annual data on tariffs may downward bias the standard errors (Manova and Zhang, 2012). In column (6), we include the shipments smaller than 4.5 liters in the sample.

Table E4 addresses the measurement of quality. In column (1), quality is measured using the Parker ratings. In column (2), quality is rescaled to vary between one and six, where each value corresponds to one the Wine Spectator bins (Table 1) and a larger value indicates a higher quality. Column (3) excludes "Great" wines from the sample. Column (4) excludes the US from the sample because the Wine Spectator (and Parker) is a US-based rating and may therefore not capture taste preferences for quality in other countries. Besides, as endogeneity could arise due to measurement error in the quality ratings (Ashenfelter and Quandt, 1999), in column (5) we use the Parker scores to instrument the Wine Spectator ratings (both interacted with distance and tariffs) under the assumption that their measurement errors are uncorrelated. The Kleibergen-Paap F statistic (equal to 404, Stock and Yogo, 2005) rejects the null of weak correlation between the instruments and the endogenous regressors.

We also estimate the quality of wine exports using the Khandelwal (2010) methodology. As the data we use to calculate the outside variety share are measured at the 6-digit HS level (see Appendix D), we estimate quality for each 12-digit HS-level wine product exported by each firm to each destination country in each time period. Our data coverage more than doubles as all unrated wines can be included in the sample. As shown in column (6), our results continue to hold.

To ensure that our results hold individually for lower and for higher quality wines, in column (7) we classify the "Very good," "Outstanding," and "Great" wines as high quality, and the "Not recommended," "Mediocre," and "Good" ones as low quality. We then let the coefficients on the interaction terms vary between the lower and the higher quality wines. Our results hold for both categories of goods.

Finally, to address the possibility that the relationship between export prices, quality, and trade costs may vary over time, in Table E5 we estimate the cross-sectional variation of our coefficients by multiplying the interactions of distance and tariffs with year dummy variables. The interaction between distance and quality is negative in the most recent period 2007 to 2009, while the interaction between tariffs and quality is positive in nearly all years (except in 2002–2003 and in 2009).

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[49] As each wine can be exported by more than one firm, we also included firm-product-time fixed effects but our results remain unchanged.

7 Concluding Remarks

Guided by the predictions of a model that features endogenous markups and per unit trade costs, our paper is the first to provide robust empirical evidence that the effects of trade costs (i.e., distance and tariffs) on export prices are largely driven by variable markups. Moreover, we show that the effects of trade costs on export prices and markups are heterogeneous and are smaller in magnitude for higher quality exports. This heterogeneity is stronger for exports to richer countries, and it is predominantly driven by the higher quality firms, the larger firms, and the exporters with large export market shares.

Our results are important because they shed light on how the export prices of traded goods differentiated by quality are impacted by trade costs across international markets. They show that due to market power, firms price discriminate across destinations by varying their markups, but the way and the extent to which they do so depends on the size and on the nature of trade costs (i.e., per unit versus ad valorem), and on the quality they export. Trade costs therefore play a key role in generating deviations from the Law of One Price, and they thus matter in explaining the degree of international market segmentation. Moreover, as they are mainly driven by the high performance firms that contribute to the bulk of aggregate exports, we expect our results to matter quantitatively in explaining aggregate export prices and markups.

Overall, our findings suggest that trade models featuring markups that are invariant to country-level characteristics lack a key channel to explain the pricing strategies of exporters across international markets. Our results therefore militate in favor of trade models with variable markups that depend on trade costs. Our findings also emphasize the importance of modelling trade costs more flexibly, and in particular that accounting for per unit trade costs enables us to explain strong patterns observed in the data. We believe that understanding the welfare implications of our results would be an important topic for future research.[50]

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[50] Irarrazabal et al. (2015), Lashkaripour (2017), and Sørensen (2014) argue that the welfare gains from trade are larger in models with per unit trade costs. Fan, Li, Xu, and Yeaple (2017) show that the gains from trade are lower in models with variable markups and endogenous quality due to per unit trade costs than in models without per unit costs or without per unit costs and variable markups.

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A Per Unit Trade Costs

In this appendix we provide evidence that both per unit and ad valorem trade costs are pervasive in our data. Also, trade costs become more per unit than ad valorem as distance increases.

First, to identify the nature of trade costs in our data, we estimate the following reduced-form regression (Hummels and Skiba, 2004; Lashkaripour, 2017; Lugovskyy and Skiba, 2015):

$$\ln f_{ijk,t} = \psi_1 \ln uv_{ijk,t} + \psi_2 \ln dist_j + \psi_3 \ln q_{ijk,t} + D_{k,t} + \mu_{ijk,t}, \tag{A1}$$

where for each wine k exported by firm i to country j in quarter t, $f_{ijk,t}$ are freight charges divided by the volume exported (in US dollars per liter), $uv_{ijk,t}$ is the export unit value (in US dollars per liter), $dist_j$ is the bilateral distance between Argentina and country j, and $q_{ijk,t}$ is shipment size (in liters). We expect freight costs to rise with bilateral distance, but also with export prices because more expensive goods may require heavier packaging, more careful and costly handling, and higher insurance fees (Hummels and Skiba, 2004). Instead, freight costs should fall with shipment size if there are scale economies in transportation (i.e., it should be less costly to export a large shipment at once than many small shipments at different times). We include product-time fixed effects $D_{k,t}$, and robust standard errors are adjusted for clustering by destination-time.

The coefficient of interest is ψ_1, the elasticity of freight costs with respect to unit values, as it captures the extent to which transport costs are ad valorem or per unit. If shipping costs are ad valorem only, they vary proportionally with export prices such that $\psi_1 = 1$. If they are per unit only, they do not depend on export prices such that $\psi_1 = 0$. An elasticity ψ_1 between zero and unity in turn indicates that transport costs are both per unit and ad valorem, and the smaller the elasticity, the larger the per unit component of shipping costs.

One issue is that unit values and shipment size are endogenous to freight costs. Freight costs rise with prices because of higher insurance or handling requirements, but prices increase with freight costs if they have a per unit component (see equation 6), resulting in a positive endogeneity bias. We therefore instrument, in each time period, the unit value of each wine exported to a given country with its mean unit value on exports to other destinations. The mean unit value is exogenous by construction as it excludes the unit value to be instrumented. Besides, as the dependent variable divides freight charges by the volume exported, it is negatively correlated with shipment size. We use the destination country's GDP and GDP per capita to instrument export volumes (Hummels and Skiba, 2004).

Our data set reports freight charges (in US dollars) at the firm-product-destination-time level. As the coverage is, however, very incomplete, the sample we use to estimate equation (A1) only includes 107 firms, 1,442 wines, and 82 export markets between 2005Q4 and 2009Q4 (6,748 observations).

Column (1) of Table A1 estimates equation (A1) by OLS. As expected, transport costs rise with bilateral distance and decrease with export volumes. Higher unit values are associated with higher shipping costs, and the elasticity is equal to 0.601 (significantly lower than unity at the one percent level). Column (2) instruments unit values and the elasticity falls to 0.591 (the OLS estimate in column 1 is therefore upward biased). Column (3) further instruments shipment size, and the unit value elasticity falls to 0.571.[51] Transport costs are therefore both per unit and ad valorem.

Table A1: Per Unit Trade Costs

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln$ *unit value*	0.601^a (0.070)	0.591^a (0.085)	0.571^a (0.087)	1.670^a (0.446)	2.294^a (0.440)	2.155^a (0.451)
$\ln$ *distance*	0.074^b (0.036)	0.074^b (0.036)	0.076^b (0.036)	0.256^a (0.081)	0.365^a (0.079)	0.346^a (0.080)
$\ln$ *unit value* × $\ln$ *distance*	–	–	–	−0.118^b (0.052)	−0.189^a (0.049)	−0.176^a (0.050)
$\ln$ *export volume*	−0.142^a (0.013)	−0.142^a (0.014)	−0.178^a (0.021)	−0.140^a (0.013)	−0.139^a (0.014)	−0.175^a (0.021)
Unit value elasticities						
Mean	–	–	–	0.616^a (0.074)	0.608^a (0.090)	0.585^a (0.093)
5th percentile	–	–	–	0.725^a (0.076)	0.783^a (0.100)	0.747^a (0.103)
95th percentile	–	–	–	0.509^a (0.098)	0.438^a (0.101)	0.426^a (0.104)
Estimation	OLS	IV	IV	OLS	IV	IV
Kleibergen-Paap F	–	105.01	161.17	–	50.38	109.91
R-squared	0.638	0.638	0.636	0.640	0.639	0.637
Observations	4,478	4,478	4,478	4,478	4,478	4,478
Product-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log freight cost per liter exported (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. In (2), (3), (5), and (6), unit values are instrumented with mean unit values. In (5) and (6), the interaction term is instrumented with mean unit values interacted with distance. In (3) and (6), shipment size is instrumented with the destination's GDP and GDP per capita.

Next, to determine how per unit and ad valorem trade costs vary with bilateral distance, we follow Lugovskyy and Skiba (2015) and we add to equation (A1) an interaction term between unit values and bilateral distance. If transport costs become more per unit than ad valorem at longer distances, as we assume in our model, the coefficient on the interaction term should be negative.

Column (4) reports OLS results, and the coefficient on the interaction term is negative and significant (at the five percent level). It remains negative and significant (at the one percent level) once we instrument unit values and the interaction term with mean unit values and their interaction with distance (column 5), and when we further instrument shipment size (column 6). Therefore, transport costs become more per unit than ad valorem at longer distances. At the mean value of distance the unit value elasticity in column (6) is equal to 0.585. It is equal to 0.747 at the 5th percentile of the distance distribution, and falls to 0.426 at the 95th percentile (all elasticities are significantly lower than unity at the one percent level). Based on the Kleibergen-Paap F statistic, we can reject in columns (5) and (6) the null of weak correlation between the instruments and the endogenous regressors.

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[51] Unit values are positively correlated with mean unit values while shipment size increases with GDP and GDP per capita. The R-squared for the unit values and shipment size first-stage regressions are equal to 0.935 and 0.629. The Kleibergen-Paap F statistic rejects the null of weak correlation between the instruments and the endogenous regressors.

B Elasticity of Demand

Irarrazabal et al. (2015) provide evidence that the elasticity of ϵ^{fob} with respect to per unit trade costs is negative, and it increases with the FOB price. Similarly, equation (12) predicts that the elasticity of ϵ^{fob} with respect to per unit trade costs is negative, but it increases not only with the FOB price but also with quality. To demonstrate that this mechanism holds in our data, we replicate the specifications of Irarrazabal et al. (2015) but we investigate how quality, rather than the FOB price, impacts the elasticity of ϵ^{fob} with respect to per unit trade costs. We estimate:

$$\ln q_{ijk,t} = \Psi \left[\ln uv_{ijk,t} \times \ln dist_j \times quality_k\right] + D_{ij,t} + \varpi_{ijk,t}, \tag{B1}$$

where $q_{ijk,t}$ is the export volume (in liters) of each wine k exported by firm i to country j in quarter t.[52] We include a full set of interactions between the FOB unit value, bilateral distance as a proxy for per unit trade costs, and quality, and Ψ is the vector of estimated coefficients. We control for firm-destination-time fixed effects $D_{ij,t}$, and standard errors are adjusted for clustering at the destination-time level. The demand elasticity ϵ^{fob} can be calculated as:

$$\epsilon^{fob} = \frac{\partial \ln q_{ijk,t}}{\partial \ln uv_{ijk,t}} = \Psi_1 + \Psi_2 \ln dist_j + \Psi_3 quality_k + \Psi_4 \ln dist_j \times quality_k, \tag{B2}$$

and it depends on bilateral distance and quality. We expect $\Psi_2 > 0$, reflecting that distance increases the negative ϵ^{fob} (i.e., ϵ^{fob} approaches zero). We also expect $\Psi_4 < 0$, showing that the effect of distance on ϵ^{fob} is smaller for higher quality exports.

To address the endogeneity of unit values in equation (B1) we instrument, in each time period, the unit value of each wine exported to a given country with its mean unit value on exports to other destinations (see Irarrazabal et al., 2015, and Appendix A). The mean unit value is exogenous by construction as it excludes the unit value to be instrumented. We also instrument the interactions of unit values with the interactions of mean unit values.

The results are reported in Table B1. Column (1) reports OLS estimates, while in column (2) we instrument unit values and their interactions. In both cases, the coefficient Ψ_2 on the interaction between unit values and distance is positive, while the coefficient Ψ_4 on the triple interaction between unit values, distance, and quality is negative. Our results therefore strongly support the theoretical predictions of equation (12): per unit trade costs reduce the magnitude of ϵ^{fob}, especially for lower quality exports.

Using equation (B2) we can calculate ϵ^{fob}, separately for lower and for higher quality exports. We measure quality at the 5^{th} and 95^{th} percentiles of the quality distribution in our sample (equal to 79 and 91, respectively), and we rely on the average (log) distance between Argentina and its export markets which is equal to 8.90 (about 7,319 kilometers). Based on the OLS estimates of column (1), ϵ^{fob} is

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[52] When estimating (B1), instead of quality Irarrazabal et al. (2015) include a dummy variable for the high-price firms.

Table B1: Elasticity of Demand

	(1)	(2)
$\ln unit\ value$	-11.222^{a} (4.326)	-10.991^{a} (2.983)
$quality$	-0.044 (0.074)	-0.156^{a} (0.057)
$\ln unit\ value \times quality$	0.110^{b} (0.048)	0.124^{a} (0.034)
$\ln unit\ value \times \ln distance$	1.437^{a} (0.494)	1.273^{a} (0.345)
$\ln distance \times quality$	0.008 (0.009)	0.022^{a} (0.007)
$\ln unit\ value \times \ln distance \times quality$	-0.015^{a} (0.005)	-0.016^{a} (0.004)
Estimation	OLS	IV
Kleibergen-Paap F	–	528.88
R-squared	0.601	0.065
Observations	69,861	69,861
Firm–destination-time fixed effects	Yes	Yes

Notes: The dependent variable is the FOB export volume (in liters). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. In (2), unit values (and their interactions) are instrumented with mean unit values (and their interactions).

equal to -0.555 at the 5^{th} percentile of the quality distribution, and to -0.878 at the 95^{th} percentile (both significant at the one percent level). Using the IV estimates of column (2), ϵ^{fob} is equal to -1.078 and -1.293 at the 5^{th} and 95^{th} percentiles (both significant at the one percent level). Consistent with the predictions of our model, the demand for higher quality wines is therefore more elastic to changes in the FOB price (Goetz and Rodnyansky, 2019; Medina, 2018).

Based on these estimates for ϵ^{fob}, for both higher and lower quality exports we can compute the elasticity of ϵ^{fob} with respect to distance as:

$$\frac{\partial \epsilon^{fob}}{\partial dist_j}\frac{dist_j}{\epsilon^{fob}} = \frac{1}{\epsilon^{fob}}\left(\Psi_2 + \Psi_4\right). \tag{B3}$$

Using OLS estimates, this elasticity is equal to -2.561 at the 5^{th} percentile of the quality distribution, and to –1.620 at the 95^{th} percentile (both significant at the one percent level). Based on the IV estimates, it is equal to -1.167 and -0.972 at the 5^{th} and 95^{th} percentiles (both significant at the one percent level). The elasticity of ϵ^{fob} with respect to per unit trade costs is therefore negative. Moreover, ϵ^{fob} falls less with per unit trade costs the higher the quality of exports. These findings are consistent with the patterns shown in Panel (a) of Figure 1.

To conclude, we provide evidence that the theoretical predictions of equation (12) hold in our data. First, the elasticity of ϵ^{fob} with respect to per unit trade costs (proxied by distance) is negative, and it increases with quality. Second, the demand for higher quality exports is more elastic to changes in the FOB price.

C Selection Bias

To remove selection bias across firms, we implement the three-step estimator of Harrigan et al. (2015). We construct a balanced sample of all possible firm-product-destination-time combinations that includes positive and zero trade observations. With 8,426 wines, 95 destination countries, and eight years at a quarterly frequency, this sample includes 25,615,040 observations. As each wine can only be exported after it has been produced, we then drop for each wine the years prior to its vintage year. This reduces our sample to 15,986,517 observations (see also Section 5.4).

In the first step we estimate the probability of entry using a reduced-form probit:

$$pr\left(x_{ijk,t} > 0\right) = \Phi\left(\delta_1 \ln Y_{j,t} + D_{k,t}\right), \tag{C1}$$

where $x_{ijk,t}$ is the export value, $Y_{j,t}$ includes distance, tariffs, GDP, GDP per capita, and remoteness (distance and tariffs can also be interacted with quality), and $D_{k,t}$ are product-time fixed effects. From equation (C1), we obtain the estimated inverse Mills ratio $\widehat{\lambda}_{ijk,t}$. In the second step, we estimate by OLS a regression for positive export values with $\widehat{\lambda}_{ijk,t}$ included as an additional regressor:

$$\ln x_{ijk,t} = \gamma_1 \ln Y_{j,t} + \gamma_2 \widehat{\lambda}_{ijk,t} + D_{k,t} + \epsilon_{ijk,t}, \tag{C2}$$

and we calculate the quasi-residuals $\widehat{\kappa}_{ijk,t} = \widehat{\gamma}_2 \widehat{\lambda}_{ijk,t} + \widehat{\epsilon}_{ijk,t} = \ln x_{ijk,t} - \widehat{\gamma}_1 \ln Y_{j,t} - \widehat{D}_{k,t}$. In the final step, we add $\widehat{\kappa}_{ijk,t}$ as a selection control in the unit value regression:

$$\ln uv_{ijk,t} = \zeta_1 \ln Y_{j,t} + \zeta_2 \widehat{\kappa}_{ijk,t} + D_{k,t} + \varrho_{ijk,t}. \tag{C3}$$

Equations (C1) and (C2) are estimated separately for each of the 8,426 wines (and, therefore, only include time fixed effects), while equation (C3) is regressed on the pooled sample including all wines.[53]

The results of the three-step selection correction procedure, with third-stage standard errors clustered by destination-time, are reported in Table C1.[54] The samples are marginally smaller compared to the ones of Tables 4 and 5 because some of the first-stage probit regressions do not converge.

In all columns, the positive coefficient on the selection control implies that the correlation between the errors of the export price and of the export value regressions is around four percent. As explained by Harrigan et al. (2015), a positive correlation suggests that destination-specific demand shocks are likely to be more important than supply shocks in explaining which markets firms decide to enter. But most importantly, controlling for selection yields results which are both economically and statistically similar to our benchmark findings. Whether we measure distance as a continuous variable or using interval dummy variables, export prices and markups increase with bilateral distance, remoteness, and

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[53] The estimates of the probit regressions (C1) may be biased due to the inclusion of time fixed effects. To address this issue we also estimated equations (C1) and (C2) separately for each wine in each quarter. Our results remain similar.

[54] Due to the firm-destination-time fixed effects, controlling for selection in equation (14) is computationally infeasible as this would require us to estimate the first-step probit using our full sample with more than 700,000 fixed effects included.

Table C1: Selection Bias

	(1)	(2)	(3)
$\ln distance$	0.033^a (0.006)	–	0.535^a (0.070)
$2,900 < distance < 7,700$	–	0.045^a (0.009)	–
$7,700 < distance < 14,200$	–	0.071^a (0.014)	–
$distance > 14,200$	–	0.080^a (0.017)	–
$\ln distance \times quality$	–	–	-0.006^a (0.001)
$\ln tariff$	-0.135^a (0.035)	-0.130^a (0.031)	-1.494^a (0.449)
$\ln tariff \times quality$	–	–	0.016^a (0.005)
$\ln remoteness$	0.046^a (0.011)	0.041^a (0.011)	0.046^a (0.011)
$\ln GDP$	-0.017^a (0.002)	-0.016^a (0.002)	-0.017^a (0.002)
$\ln GDP/cap$	0.019^a (0.006)	0.014^b (0.006)	0.019^a (0.006)
selection control	0.044^a (0.007)	0.043^a (0.008)	0.044^a (0.007)
R-squared	0.785	0.784	0.785
Observations	66,785	66,578	66,785
Product-time fixed effects	Yes	Yes	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. Estimates are obtained using the three-step procedure of Harrigan et al. (2015).

the destination's income per capita, and decrease with tariffs and country size (columns 1 and 2). In column (1), a doubling of distance induces an exporter to increase the markup of a given wine by 2.3 percent on average ($2^{0.033} - 1$), which is identical to the effect we find in column (4) of Table 4 when we do not control for selection across firms.[55]

Column (3) shows that the effects of distance and tariffs on unit values and markups are smaller in magnitude for higher quality exports. At the mean, 5^{th}, and 95^{th} percentiles of the quality distribution, the distance elasticity is equal to 0.035, 0.071 (significant at the one percent level), and 0.001 (which is insignificant), while the tariff elasticity is equal to -0.140, -0.238 (both significant at the one percent level), and -0.047 (which is not significant). Again, these elasticities are comparable in magnitude to the ones we report for column (2) in Table 5. Our results are therefore robust to controlling for selection bias across firms. Harrigan et al. (2015) find that removing selection bias leads to slightly smaller coefficients on distance, but they also conclude that the difference is negligible.

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[55] If we use the samples of Table C1 and estimate our regressions by OLS, the magnitude and significance of the estimated coefficients are undistinguishable from the ones reported in the table (available upon request).

D Estimation of Quality

We follow Bernini and Tomasi (2015) who adapt the Khandelwal (2010) procedure to estimate the quality of exports at the firm-product-destination-time level. The quality of an exported product is the part of its market share in a destination country that is not explained by its price (Berry, 1994; Khandelwal, 2010). We estimate:

$$\ln s_{ijk,t} - \ln s_{jK,t} = \beta_1 uv_{ijk,t} + \beta_2 \ln ns_{ijk,t} + D_{j,t} + D_{ik} + \eta_{ijk,t}, \tag{D1}$$

where $s_{ijk,t}$ is the market share of product k exported by firm i to country j in period t, $s_{jK,t}$ is the market share of an "outside variety" K, $ns_{ijk,t}$ is the "nest share," $uv_{ijk,t}$ is the export unit value, and $D_{j,t}$ and D_{ik} are destination-time and firm-product fixed effects. Robust standard errors are adjusted for clustering by destination-time.

We construct each variable as follows. First, we use the export value $x_{ijk,t}$ (in US dollars) and quantity $q_{ijk,t}$ (in kilograms) of each 8-digit HS-level product k exported by firm i to destination j in quarter t from 2002Q1 to 2009Q4 (from Nosis). The unit value $uv_{ijk,t}$ is in US dollars per kilogram. Second, we use annual frequency data between 2003 and 2009 from the BACI data set to calculate the outside variety share $s_{jK,t}$ as the share of non-Argentinean import quantities (in kilograms) in the total import quantities of country j in a 6-digit HS-level product category K (Bernini and Tomasi, 2015).[56] We match the outside variety share (measured at annual frequency) with the quarterly data from Nosis by year to calculate the market share $s_{ijk,t}$ and the nest share $ns_{ijk,t}$ as:

$$\begin{aligned} s_{ijk,t} &= \frac{q_{ijk,t}}{\sum_i q_{ijK,t} / \left(1 - s_{jK,t}\right)}, && \text{(D2)} \\ ns_{ijk,t} &= \frac{q_{ijk,t}}{\sum_i q_{ijk,t} / \left(1 - s_{jK,t}\right)}, && \text{(D3)} \end{aligned}$$

where $q_{ijk,t}$ and $q_{ijK,t}$ are defined at the 8-digit and 6-digit HS levels (the denominators of D2 and D3 are proxies for each HS-level market size).

To address the endogeneity of unit values and of the nest shares, we use the Nosis data to construct the same instruments as Bernini and Tomasi (2015). We instrument unit values by the mean unit value of each 8-digit HS-level product by destination-time, and the nest shares by the number of 8-digit HS-level products by firm-destination-time. Equation (D1) is estimated separately for each 2-digit HS-level product category, and the quality of product k exported by firm i to country j in period t is obtained as:

$$quality_{ijk,t} = \widehat{D}_{j,t} + \widehat{D}_{ik} + \widehat{\eta}_{ijk,t} = \left[\ln s_{ijk,t} - \ln s_{jK,t}\right] - \left[\widehat{\beta}_1 uv_{ijk,t} + \widehat{\beta}_2 \ln ns_{ijk,t}\right]. \tag{D4}$$

This procedure allows us to estimate the quality of each 8-digit HS-level product exported by each firm to each destination country between 2003Q1 and 2009Q4 which we use in Section 5.3. We also follow the same approach to estimate the quality of wine exports in Section 6.

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[56] The BACI data set reconciles the declarations of importers and exporters reported in UN Comtrade (Gaulier and Zignago, 2010). The exports data are only available from 2003 and are disaggregated at the 6-digit HS level.

E Robustness

Table E1: Exchange Rates and Foreign Demand

	(1)	(2)	(3)
$\ln distance \times quality$	-0.004^{a} (0.001)	-0.005^{a} (0.001)	-0.005^{a} (0.001)
$\ln tariff \times quality$	0.021^{a} (0.005)	0.024^{a} (0.005)	0.023^{a} (0.005)
$\ln GDP/cap \times quality$	–	0.002^{b} (0.001)	0.001 (0.001)
$\ln ER \times quality$	0.001^{a} (0.000)	–	0.001^{b} (0.000)
R-squared	0.909	0.909	0.909
Observations	69,219	69,219	69,219
Product-time fixed effects	Yes	Yes	Yes
Firm-destination-time fixed effects	Yes	Yes	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. An increase in the exchange rate ER indicates an appreciation of the US dollar.

Table E2: Foreign Competition

	(1)	(2)
$\ln distance$	0.745^{a} (0.125)	–
$\ln distance \times quality$	-0.008^{a} (0.002)	-0.009^{a} (0.001)
$\ln tariff$	-0.892^{b} (0.438)	–
$\ln tariff \times quality$	0.009^{c} (0.005)	0.011^{b} (0.005)
$\ln import\ share$	0.220^{a} (0.083)	–
$\ln import\ share \times quality$	-0.002^{b} (0.001)	-0.004^{a} (0.001)
$\ln remoteness$	0.023^{c} (0.012)	–
$\ln GDP$	-0.018^{a} (0.002)	–
$\ln GDP/cap$	0.021^{a} (0.006)	–
R-squared	0.783	0.909
Observations	74,312	69,217
Product-time fixed effects	Yes	Yes
Firm–destination-time fixed effects	No	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a}, ^{b}, and ^{c} indicate significance at the one, five, and ten percent levels.

Table E3: Robustness on Samples

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln \mathit{distance} \times \mathit{quality}$	-0.004^{a}	-0.004^{a}	-0.004^{a}	-0.003^{a}	-0.005^{a}	-0.003^{a}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\ln \mathit{tariff} \times \mathit{quality}$	0.028^{a}	0.022^{a}	0.022^{a}	0.020^{a}	0.017^{b}	0.014^{b}
	(0.004)	(0.005)	(0.005)	(0.006)	(0.008)	(0.005)
Sample	Packaging	Retailers	Dest/firm>10	Dest/wine>10	Annual	Less 4.5l
R-squared	0.921	0.909	0.904	0.900	0.860	0.902
Observations	66,993	69,424	66,590	42,918	48,232	74,307
Product-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-destination-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. In column (5), the time dimension for the fixed effects and the clustering is annual rather than quarterly.

Table E4: Robustness on Quality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln \mathit{distance} \times \mathit{quality}$	-0.006^{a}	-0.022^{a}	-0.004^{a}	-0.003^{a}	-0.009^{b}	-0.022^{a}	–
	(0.002)	(0.004)	(0.001)	(0.001)	(0.003)	(0.006)	
$\ln \mathit{tariff} \times \mathit{quality}$	0.034^{a}	0.088^{a}	0.022^{a}	0.017^{a}	0.047^{a}	0.155^{a}	–
	(0.012)	(0.022)	(0.005)	(0.005)	(0.017)	(0.042)	
$\mathit{quality}$	–	–	–	–	–	0.184^{a}	–
						(0.052)	
$\ln \mathit{distance} \times \mathit{low\ quality}$	–	–	–	–	–	–	-0.003^{b}
							(0.001)
$\ln \mathit{distance} \times \mathit{high\ quality}$	–	–	–	–	–	–	-0.003^{a}
							(0.001)
$\ln \mathit{tariff} \times \mathit{low\ quality}$	–	–	–	–	–	–	0.037^{a}
							(0.008)
$\ln \mathit{tariff} \times \mathit{high\ quality}$	–	–	–	–	–	–	0.036^{a}
							(0.007)
Sample	Full	Full	No "Great"	No US	Full	Full	Full
Quality	Parker	WS [1,6]	WS	WS	WS	Estimated	WS
Estimation	OLS	OLS	OLS	OLS	IV	OLS	OLS
R-squared	0.911	0.909	0.908	0.913	0.910	0.905	0.909
Observations	34,150	69,219	69,084	59,304	34,150	132,481	69,219
Product-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-destination-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels. "WS" refers to the Wine Spectator quality ratings. In column (6), quality is estimated using the Khandelwal (2010) methodology (see Appendix D).

Table E5: Cross-Sectional Estimates

	$\ln distance \times quality$	$\ln tariff \times quality$
Year 2002	-0.001 (0.004)	0.021 (0.019)
Year 2003	-0.003 (0.004)	0.017 (0.026)
Year 2004	-0.001 (0.002)	0.029^b (0.012)
Year 2005	-0.003 (0.002)	0.025^b (0.010)
Year 2006	-0.003 (0.002)	0.027^b (0.010)
Year 2007	-0.007^a (0.002)	0.022^b (0.011)
Year 2008	-0.004^a (0.001)	0.023^b (0.010)
Year 2009	-0.004^b (0.002)	0.014 (0.016)
R-squared	0.909	
Observations	69,219	
Product-time fixed effects	Yes	
Firm-destination-time fixed effects	Yes	

Notes: The dependent variable is the log FOB unit value of exports (in US dollars per liter). Robust standard errors adjusted for clustering by destination-time between parentheses. ^{a} and ^{b} indicate significance at the one and five percent levels.