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Market Size, Trade and Quality: Evidence from French Exporters

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Highlights

- Because it affects the toughness of competition, market size is important in explaining variation in industry performance across markets.
- This paper shows that high quality firms perform disproportionately better in larger markets, thereby raising aggregate quality.
- The paper exploits a unique dataset which contains quality ratings at the firm level, allowing for the most direct test to date of this key mechanism for pro-competitive effects.

Abstract

This paper presents the most direct test to date of the key welfare mechanism put forward by Melitz and Ottaviano (2008): the best firms increase sales disproportionately when competing in larger markets. I test this prediction in a quality context where the best firms produce the highest quality. The empirical analysis is guided by a quality-augmentation of Melitz and Ottaviano (2008). I capture product quality empirically using a unique dataset containing firm-level quality ratings. The results are in line with the key prediction of the model. I also find a strong positive relationship between a proxy for consumer quality preference and demand for quality which is consistent with the theory.

Keywords

Heterogenous firms, Flexible mark-ups, Market size, Quality, Complementarities.

JEL

F12, F14, F15, F61, L11, L15.

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RESEARCH AND EXPERTISE
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Market Size, Trade and Quality: Evidence from French Exporters[1]

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1. Introduction

Because it affects the toughness of competition, market size is important in explaining variation in industry performance across markets. In a heterogeneous firms setting, this variation can arise from market-size induced adjustments in industry composition on the intensive or extensive margins. Firm heterogeneity in the present paper manifests itself in differences in product quality. Using a unique dataset containing firm-level quality ratings, this paper shows that high quality firms perform disproportionately better in larger markets, thereby raising aggregate welfare.

The literature to date has offered two competing explanations for the observed positive relationship between market size and aggregate industry outcomes: agglomeration economies and competition-driven composition effects.[2] Key empirical contributions have considered the relationship between market size and aggregate productivity in a regional or city-level market setting where production and consumption take place in the same market.[3] Differences in productivity can therefore arise either from agglomeration economies or from asymmetric pro-competitive effects which drive the redistribution of market share towards the best firms. This makes the mechanisms difficult to disentangle empirically. By excluding variation in the location and structure of production and thus variation in agglomeration forces, this paper is able to identify market size effects that arise purely from demand side factors.

In order to guide the empirical analysis, I present the key mechanism in the framework of

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[2]The latter can include both selection of firms and sorting of workers - see Behrens, Duranton, Robert-Nicoud, 2014.

[3]Syverson, 2004; Campbell and Hopenhayn, 2005; Combes, Duranton, Gobillon, Puga, Roux, 2012.

a quality-augmented Melitz and Ottaviano (2008) model which builds on Antoniades (2015). Market size effects in the setting considered here arise from changes in the number of consumers, while per capita income is held fixed. More generally, the market size effects studied arise when mark-ups are flexible in a monopolistically competitive setting, firms are heterogeneous and optimized profits are supermodular in market size and firm productivity. With flexible mark-ups and monopolistic competition among symmetric firms, globalization generally implies downward pressure on prices;[4] when firms are at the same time heterogeneous in their productivity, mark-up reductions are skewed in such a way that sales expand relatively more for higher productivity firms. The evidence presented in this paper supports this mechanism for a set-up, where higher productivity firms produce higher quality.

The present paper identifies this mechanism in the context of the champagne industry. I use a dataset constructed by Crozet, Head and Mayer (2012), which is unique in containing a direct measure of firm-level quality. The authors combine confidential French firm-destination level export data with producer-level star ratings taken from the world's most comprehensive champagne guide by Juhlin (2008). The key idea underlying the empirical strategy in the present paper is that the relative impact of export market size on firm-level export sales should be increasing in firm quality. I identify my parameters of interest by relying on within-firm variation in export sales across French export destinations with exogenously varying market sizes.[5] I capture market size using GDP in my main specifications. In addition, I use champagne absorption (total destination champagne exports) as an alternative proxy for the relevant market size. I subsequently decompose the export revenue effects into their quantity and price components.

Consistent with the theoretical set-up, all specifications control for GDP per capita. The preference structure underlying the empirical analysis is quasi-linear, such that all income effects are absorbed by the numeraire good. Controlling for per capita GDP allows to fully isolate the competition effect induced by a larger market, which is driving the welfare gains. In addition, controlling for per capita GDP addresses an issue which is particular to the quality setting considered here. Consumers' taste for quality may change as they become richer (Hallak, 2006), giving high quality firms an advantage in richer markets. I derive a formal prediction for the differential effect of quality preference on firms with different quality ratings and test it using GDP per capita as a proxy for quality preference.

I find strong support of the market size hypothesis in the data. Initially, I run an OLS regression of export sales on interactions of market size with quality ratings. However, the champagne trade matrix contains many zeroes: of the 40,586 observations in the dataset, approximately 7.5% correspond to positive export flows. This makes selection into export markets an important issue

[4] See Parenti, Ushchev and Thisse, 2014, for necessary and sufficient conditions.

[5] An alternative strategy would be to consider trade liberalization episodes, using variation in the trade environment over time. Iacovone and Javorcik (2012) and Verhoogen (2008) for example rely on this strategy in their studies on quality upgrading by Mexican firms in the context of Mexico's NAFTA entry (though they do not consider market size effects per se). However, France has not had liberalization episodes recently which are suitable to capture exogenous changes in market size.

which needs to be addressed econometrically. I thus estimate a Tobit model as my preferred specification. Market size effects remain strong after selection is controlled for. Furthermore, coefficient estimates on the income variable are consistent with the quality preference mechanism put forward in this paper: higher quality firms sell disproportionately more in richer markets.

I then re-estimate the model using firm-destination export quantities as the dependent variable and show that revenue effects are to a large extent driven by quantity adjustments. I further provide evidence for within-firm price discrimination across export markets using a price decomposition (as discussed in Harrigan, Ma and Shlychkov, 2012) and subsequently examine the importance of market size in explaining this variation. I find evidence that the highest quality firms apply a different pricing strategy relative to the other firms, charging relatively lower prices in larger markets.

The analysis confirms the key prediction of market-size induced industry polarization in Melitz and Ottaviano (2008), representing the most direct test of this mechanism to date. More generally, results support the assumption of flexible mark-ups over CES preferences. This is important in light of the fact that the nature of preferences has been shown to matter greatly for the efficiency of the market outcome and welfare.[6]

The present paper contributes to three important strands of the trade and IO literature: (i) the strand exploring the pro-competitive effects which can accompany trade integration; (ii) contributions from the trade and IO literature which investigate the consequences of complementarities in firms' production functions (supermodularity); (iii) a strand of the recent trade literature which establishes a systematic relationship between product quality and characteristics of the trade environment, in particular destination market size.

Market Size Effects Some, but not yet many, contributions have presented evidence consistent with the assumption of endogenous mark-ups in combination with firm heterogeneity: Syverson (2004) and Campbell and Hopenhayn (2005) consider regional US markets and find that a larger market size is associated with larger firm size on average.[7] Bellone, Musso, Nesta and Warzynski (2014) show that firms' mark-ups are increasing in firm productivity and on average are decreasing in the toughness of competition in local markets. Rather than relying on averages, here I make use of a productivity proxy at the firm level which allows for a more direct test of the market size mechanism in terms of which firms are gaining.

Further evidence of market size effects can be found in the multi-product firms literature. Iacovone and Javorcik (2010) show that firms concentrate increasingly on their core products

[6] Dixit and Stiglitz, 1977; Mrázová and Neary, 2013.

[7] Both also find a relationship between market size and productivity dispersion; the sign for the latter differs, however: while Campbell and Hopenhayn (2005) find that the distribution is more disperse in a larger market, Syverson (2004) presents evidence in line with tougher selection, i.e. the distribution is less disperse.

as competition gets tougher (in their case, as Mexican firms are exposed to more competition post-NAFTA accession). Mayer, Melitz and Ottaviano (2014) establish that the size of the destination market is an important determinant of the export behaviour of multi-product firms in terms of their exported product mix; like Iacovone and Javorcik (2010), they find strong evidence that in markets with tougher competition, multi-product firms skew their exports towards their best performing products. The present paper adds to this literature by providing novel empirical evidence on this skewing of export sales across rather than within firms.

Augmenting Melitz and Ottaviano (2008) by a quality dimension, Antoniades (2015) theoretically considers firm-level quality responses to market size.

Supermodularity Mathematically, the key concept studied here is that of supermodularity or what Mrázová and Neary (2011) call the "Matthew Effect". The best firms benefit the most from trade integration, or as Mrázová and Neary (2011, p.6) put it: "to those who have, more shall be given". The market size effect studied in the present paper arises from complementarities between firm characteristics and market characteristics which play out as a consequence of changes in the trade environment.[8] The case I consider here is characterised by a complementarity between market size and firm productivity by which firms gain more from an increase in market size the more favourable their productivity draw. Here, these are also the highest quality firms.

Quality and Market Size In addition, the paper contributes to the literature on the relationship between market size and aggregate quality. In a quality-augmented heterogeneous firms model with flexible mark-ups as the one presented below, three specific mechanisms are at play: aggregate quality can change via (i) asymmetric pro-competitive effects on the intensive margins; (ii) the extensive margin via selection; and (iii) quality upgrading by the most productive firms.[9]

At the *product level*, the three adjustment mechanisms cannot be distinguished. Studies working at the product level have taken the average unit value of exports as a proxy for the embedded quality. Results on the market size-quality relationship at the product level are not consistently of the same sign (see Table 1). Only recently have researchers started looking at *firm-level* pricing behaviour across export markets, making it possible to identify quality upgrading effects. Within-firm prices vary considerably across destination markets and several studies have found a positive significant relationship with export market size. These studies include Manova and

[8]These types of complementarities have been studied widely outside the trade context, in particular in the industrial organization literature. For example, Milgrom and Roberts (1990) study these mechanisms in modern manufacturing processes. Topkis (1978) is the seminal paper which formulates the idea that the property of supermodularity implies monotone comparative statics for firm-level decisions. Mrázová and Neary (2011) theoretically study complementarities between variable trade costs and inverse productivity.

[9]The latter effect is only present if quality investment is subject to scale effects.

Authors	Margins	Quality - Mkt Size	Dep Var
Kneller-Yu (2008)	ext+int+upgr	+/-	product unit value
Baldwin-Harrigan (2011)	ext+int+upgr	-	product unit value
Manova-Zhang (2012)	ext+int+upgr	-/0	product unit value
Bastos-Silva (2010)	upgrading	+	firm-product unit value
Iacovone-Javorcik (2012)	upgrading	+	firm-product unit value
Manova-Zhang (2012)	upgrading	+	firm-product unit value
Martin (2012)	upgrading	0	firm-product unit value
Harrigan et al (2012)	upgrading	(+)	firm-product unit value
Görg et al (2010)	upgrading	+	firm-product unit value
this paper	intensive margin	+	firm-product revenue

Table 1 – Quality-Market Size Relationship in the Literature

Zhang (2012) for Chinese exporters, Bastos and Silva (2010) for Portugal, and Görg, Halpern and Murakozy (2010) for Hungary. Results in Harrigan, Ma and Shlychkov (2012) point to a weakly positive relationship in the US export data. The overall evidence is thus consistent with the quality discrimination hypothesis by which firms on average export a higher level of quality to larger markets.

Overall, the evidence suggests that aggregate quality is increasing in market size thanks to quality upgrading and - as shown in this paper - more than proportionate increases in sales for high quality firms, while some of this effect may be offset by the entry of lower quality firms.[10] The overall direction and size of the market size effect on aggregate quality is relevant from a welfare perspective. Changes in relative sales of high quality and low quality firms in favour of the high quality suppliers will have a positive effect on average quality, which in turn positively affects overall welfare.

The paper proceeds as follows: Section 2 presents the theoretical mechanism that will guide the analysis and lays out the baseline specification. Section 3 discusses the data. Section 4 presents results and Section 5 concludes.

2. Theoretical Background & Baseline

2.1. Key Mechanism

The empirical analysis in the present paper is guided by a key theoretical mechanism for the aggregate quality impact of globalization: a larger market is associated with a disproportionate increase in sales on the intensive margin for high productivity firms. With optimally chosen product quality monotonically increasing in firm productivity, the intensive margin effect translates

[10] Evidence on the behaviour of the extensive quality margin is sparse so far. Theoretically, an increase in market size has conflicting effects on the extensive margin through a demand and a competition channel, which can imply either tougher or laxer selection depending on the relative strength of the two effects.

to the quality dimension. It is therefore possible to capture this effect in the quality context as I do in the present paper.

The effect is due to an underlying complementarity in firms' optimized profit and revenue functions. Mrázová and Neary (2011) introduce the term "Matthew Effect" to the trade literature, to capture the phenomenon by which the best firms benefit the most from a trade liberalization.[11,12] As opposed to Mrázová and Neary (2011), who consider complementarities between firm productivity and variable trade cost, the key mechanism driving the intensive margin effect in the present paper arises from a complementarity between firm productivity and market size.

In order to generate the intensive margin effect related to market size, the optimized revenue function needs to be twice differentiable and multiplicative in market size and the inverse of firms' cost draws. Furthermore, it needs to be sub-modular with respect to market size and cost (supermodular with respect to market size and inverse cost): firm-level revenues need to be increasing in market size while the rate at which this happens is decreasing in a firm's cost draw, i.e. the revenue "gap" between high and low cost firms is getting larger as market size increases. More formally, the intensive margin effect in the current context is given by $\frac{\partial^2 r}{\partial L \partial c} < 0$, where r are firm-level revenues, L is market size and c is a firm's cost draw; we can capture this effect in the quality dimension if firm-level quality is monotonically related to firms' productivity draws, i.e. $\frac{\partial z}{\partial c} < 0$. Below, I give an example of a model which generates this comparative static, validating the use of observed product quality as a proxy for unobservable productivity.[13]

In the subsequent empirical analysis, I identify parameters of interest by relying on exogenous variation in market size across French export markets. The identification strategy thus requires that the effect also hold in an open economy set-up for within-firm variation in export revenues across export markets. In the next section, I show that this is indeed the case in my model. I discuss econometric issues related to selection of firms into export markets below. In a Melitz-Ottaviano (2008) framework, we should expect exporting to become tougher for lower quality firms as market size increases.

Below I test for the existence of the intensive margin effect, using an empirical quality measure, Z, which is firm-specific and fixed across export markets, as a proxy for productivity. Any quality upgrading that might also be happening in a larger market is not reflected in a change in the empirical quality measure used in this paper. This is valid as long as the ranking of producers stays the same across markets, which theory suggests it does. I thus test whether export

[11]The term Matthew Effect was originally coined by the Sociologist Robert Merton (1968) in reference to the Gospel of Matthew: "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken even that which he hath." (Matthew, 25:29, King James Bible)

[12]Mrázová and Neary (2011) consider a different type of complementarity, namely that between inverse firm productivity and variable trade costs; they do so in the context of a heterogeneous firms trade model with general preferences: here, a reduction in per unit trade costs will bring the largest benefits to the firms selling the most units, which in Melitz (2003) type models are the firms with the highest productivities.

[13]Here, I show this under the assumption that quality incurs a fixed cost; in Baller (2013), I show that the result holds also for the case of variable cost of quality.

revenues of a firm located in l and exporting to h, r_X^{lh}, are increasing in destination market size L^h and more so for firms producing higher quality Z: $\frac{\partial^2(r_X^{lh})}{\partial L^h \partial Z} > 0$.

2.2. The Market Size Effect with Quadratic Preferences

In this section, I derive an explicit expression for $\frac{\partial^2(r_X^{lh})}{\partial L^h \partial Z} > 0$ for a commonly used preference and cost structure. On the demand side, I adapt the preference specification from Eckel, Iacovone, Javorcik and Neary (2015) as in Baller (2012). This specification improves on a direct quality-augmentenation of Melitz-Ottaviano (2008) preferences, by having only one parameter associated with quality and thus allowing for a clean isolation of the quality dimension. The parameter further has a clear interpretation as the weight which consumers place on product quality. The supply side of the model is as in Antoniades (2015) with the exception that here I drop the country-specific shifter of the cost distribution as well as the variable cost of quality for reasons of parsimony. Detailed derivations are given in the Appendix.

2.2.1. Consumers

There are L consumers in the economy, who each supply one unit of labour, and consume varieties i from a set $\widetilde{\Omega}$ of a differentiated product; Ω will denote the endogenous subset which is actually consumed. Consumers in this model have identical tastes. I assume quasi-linear preferences (q_0 being the numeraire good), which are quadratic in the differentiated varieties, and exhibit love of variety and a preference for quality of the following form:

$$U = q_0 + u_1 + \beta u_2, \tag{1}$$

where

$$u_1 = \alpha Q - \frac{1}{2} b \left[(1-e) \int_{i \epsilon \widetilde{\Omega}} q_i^2 di + eQ^2 \right] \tag{2}$$

$$u_2 = b(1-e) \int_{i \epsilon \widetilde{\Omega}} q_i z_i di. \tag{3}$$

Here, q_i is the quantity consumed of variety i, and $Q \equiv \int_{i \epsilon \widetilde{\Omega}} q_i \mathrm{d}i$. The level of product quality embedded in variety i is z_i. The parameter e, where $0 < e < 1$, reflects the degree of product differentiation between varieties; as $e \to 1$ varieties become perfect substitutes. Importantly, β can be interpreted as consumers' preference for quality. Setting $\beta = 0$ reduces the model to the no-quality benchmark in Melitz and Ottaviano (2008). I think of β as country-specific.

Consumers maximise utility subject to the budget constraint $q_0 + \int_{i \epsilon \widetilde{\Omega}} p_i q_i di = I$. Individual inverse linear demand functions can then be aggregated over all consumers to give inverse market demand faced by firms for each variety. Given market clearing, $x_i = Lq_i$, we have:

$$p_i = a_i - \widetilde{b} \left[(1-e) x_i + eX \right], \tag{4}$$

where $\widetilde{b} \equiv \frac{b}{L}$ and $X \equiv \int_{i \epsilon \Omega} x_i di$. The intercept is $a_i = \alpha + \beta b (1-e) z_i$.

2.2.2. Firms

The model economy consists of two sectors, one producing a homogeneous numeraire good under perfect competition and constant returns to scale and the other made up of a continuum of monopolistically competitive firms producing differentiated varieties indexed by i. Labour is the only factor of production in the model and its supply is perfectly elastic. The labour market is assumed to be perfectly competitive and wage is unity.

Firms in the model have rational expectations. In the monopolistically competitive sector, a continuum of ex ante identical firms initially faces Melitz-type uncertainty about their productivity; the latter is represented by the inverse of their unit cost c. The total cost function of a firm consists of two components: a firm-specific variable cost, where x_i denotes output of firm i, and an endogenous fixed cost component associated with quality investment:

$$TC_i = c_i x_i + \frac{1}{2} {z_i}^2. \tag{5}$$

The sequencing of the model is as follows: firms pay the sunk entry cost f which gives them the right to draw their unit cost c_i. Firms whose productivity draw is too low to cover fixed costs withdraw. The remaining firms simultaneously choose the optimal level of quality and output, z_i and x_i. A firm's profit maximising price and output must satisfy:

$$p_i = \widetilde{b}\,(1-e)\,x_i + c_i, \tag{6}$$

and, its profit maximising level of quality is given by the first-order condition:

$$z_i = \beta b\,(1-e)\,x_i. \tag{7}$$

In equilibrium, a cost draw uniquely identifies a firm, such that subscripts can be dropped. It can be shown that the optimal level of quality z^* for a firm with cost draw c is given by:

$$z^* = \lambda\,(c_D - c)\,, \tag{8}$$

where $\lambda = \frac{\beta L}{2-\beta^2 b(1-e)L}$ which is positive by second order conditions. λ is the slope of the optimal quality-cost relationship and can be interpreted as a market level summary statistic of the degree of quality competition; c_D is the cost cut-off. Importantly for the empirical implementation, from equation (8) a firm's optimally chosen quality is monotonically decreasing in its cost draw.

Equilibrium revenues are given by:

$$r^* = \frac{\varepsilon_\lambda^2 L}{4b(1-e)}\,(c_D - c)^2 + \frac{\varepsilon_\lambda L}{2b(1-e)}\,(c_D - c)\,c,$$

where $\varepsilon_\lambda = 1 + B\lambda = 1 + \beta b(1-e)\frac{\beta L}{2-\beta^2 b(1-e)L}$ is the elasticity of λ with respect to market size. $B = \beta b(1-e)$ is a collection of demand side parameters.

Checking now for submodularity, we obtain the following expression:

$$\frac{\partial r^2}{\partial c \partial L} = -\frac{\varepsilon_\lambda^2}{2b(1-e)}\left[\frac{B\lambda}{L}\left(\frac{n+1}{n+2}c_D - c\right) + B\lambda(c_D - c) + c\right] \tag{9}$$

where $c < \frac{n+1}{n+2}c_D$ is sufficient for submodularity to obtain; n is the shape parameter of the Pareto distribution. Since $c_D > c$, this expression will hold unambiguously as n gets large. The expression thus shows that revenues are falling in firms' cost draws and these revenue gaps get bigger as market size increases. Combining this with the fact that quality is falling in cost draws, we have the prediction that revenue gaps between high quality and low quality firms are increasing to the advantage of the high quality firms as market size increases.

2.2.3. Open Economy

Market Size The empirical test below is implemented in a cross-section of export markets. I therefore check that the submodularity condition also holds in the open economy setting. Assuming iceberg transport costs τ^{lh} for exporting from l to h, we can derive new expressions for firm-level export revenues, where export sales r_X^{lh} in market h with market size L^h are now given by:

$$r_X^{lh}(c_D, c) = \frac{(\varepsilon_\lambda^h)^2 L^h}{4b(1-e)}\left(c_D^h - \tau^{lh}c\right)^2 + \frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\left(c_D^h - \tau^{lh}c\right)\tau^{lh}c \tag{10}$$

where $\varepsilon_\lambda^h = 1 + B^h\lambda^h = 1 + B^h\frac{\beta^h L^h}{2-(\beta^h)^2 b(1-e)L^h}$. Checking then for submodularity of export revenues by destination market, we have:

$$\frac{\partial (r_X^{lh})^2}{\partial c \partial L^h} = -\frac{(\varepsilon_\lambda^h)^2}{2b(1-e)}\left[\frac{\lambda^h B^h}{L^h}\left(\frac{n+1}{n+2}c_D^h - \tau^{lh}c\right) + \lambda^h B^h(c_D^h - \tau^{lh}c) + \tau^{lh}c\right] \tag{11}$$

where a sufficient condition for submodularity is $\frac{n+1}{n+2}c_D^h > \tau^{lh}c$. Since $c_D^h > \tau^{lh}c$, the overall expression is unambiguously negative as n gets large. Combining this with the fact that $\frac{\partial z_X^{lh}}{\partial c} < 0$, we obtain the prediction that

$$\frac{\partial^2 (r_X^{lh})}{\partial L^h \partial Z} > 0.$$

The hypothesis is thus that export revenues of a firm are increasing in the size of the destination market, and the more so, the higher the level of product quality produced by the firm.

Quality Preference A further dimension of destination country heterogeneity in the model is the strength of consumers' quality preference, β^h. It seems intuitive that high quality firms should be doing relatively better than their lower quality competitors in markets where consumers value quality more. I thus check for submodularity of export revenues also with respect to β^h. We have:

$$\frac{\partial (r_X^{lh})^2}{\partial c \partial \beta^h} = -\frac{L^h}{2b(1-e)} \left\{ \lambda^h B^h (c_D^h - \tau^{lh} c) + c_D^h + \frac{\left[(n+2)L^h - 1\right]}{(n+2)\, L^h} \lambda^h B^h c_D^h - \lambda^h B^h \tau^{lh} c \right\} \frac{\partial \left(\lambda^h B^h\right)}{\partial \beta^h}$$

As market size L and/or the Pareto parameter n get large, the third term in the curly brackets tends to $\lambda^h B^h c_D^h$ and the expression can be written as:

$$\begin{aligned} \frac{\partial (r_X^{lh})^2}{\partial c \partial \beta^h} &= -\frac{L^h}{2b(1-e)} \left\{ 2\lambda^h B^h (c_D^h - \tau^{lh} c) + c_D^h \right\} \frac{\partial \left(\lambda^h B^h\right)}{\partial \beta^h} \\ &< 0. \end{aligned}$$

Again, keeping in mind that the high productivity firms are also the ones who produce the highest quality, I test the hypothesis that $\frac{\partial^2 (r_X^{lh})}{\partial \beta^h \partial Z} > 0$.

Note that this cannot be tested directly, since quality preference *per se* is not easily observable. Hallak (2006), however, shows that there exists a positive relationship between per capita income and aggregate demand for quality in the data. In the empirical analysis below, I therefore think of income per capita as a proxy for quality preference.

2.3. Baseline

I use the following baseline specification which regresses firm-destination export revenue for the Champagne industry on an interaction of firm quality with market size and controls in order to test the prediction that $\frac{\partial^2 (r_X^{lh})}{\partial L^h \partial Z} > 0$. I also test $\frac{\partial^2 (r_X^{lh})}{\partial \beta^h \partial Z} > 0$. The export value relationship for firm f exporting to destination d is:

$$\ln r_{fd}^{FOB} = \beta_1 Z_f * \ln L_d + \gamma_1 Z_f * \ln I_d + `_{\mathrm{d}} + `_{\mathrm{f}} + ''_{fd}, \qquad (12)$$

Here, $\ln r_{fd}^{FOB}$ are the free-on-board[14] export revenues of firm f in destination d, and β_1 is the main coefficient of interest on the market size-quality interaction, where Z_f is an indicator for producer quality and $\ln L_d$ denotes the log of market size. I_d is per capita GDP and θ_d are destinaton level fixed effects. θ_f are firm fixed effects, which are needed to capture the within-firm variation in export revenues as market size increases. The key prediction is thus that $\beta_1 > 0$.[15] I also test the hypothesis that $\gamma_1 > 0$.

The relationship has the basic features of a gravity equation; however, since France is always the exporter, all bilateral characteristics of the trading relationship effectively become destination specific. We can thus account not only for destination market size but also for trade barriers/enhancers using destination fixed effects.

[14] I.e. prices do not include transport costs and insurance.

[15] If fixed quality costs are important, the effect is amplified by additional market-size-induced quality upgrading by the best firms. If quality incurs only variable cost, the estimate of the effect (i.e. the size of the coefficient) can be seen as a lower bound. The prediction that $\beta > 0$ is the same in both cases.

Importantly, the fact that France is always the exporter makes it possible to distinguish between demand and supply side driven market size effects. Since there is no variation in production structure in the data, estimations will identify demand side driven market size effects only without the risk of being confounded by agglomeration effects.

If there are no zeroes in the trade matrix, equation (12) can be estimated using OLS. A particular advantage of OLS is that it is very well suited for estimations involving fixed effects. However, if firms do not export to all markets, OLS estimation no longer yields the maximum likelihood estimator for equation (12). This is relevant for the estimations carried out in this paper, as zeroes are a frequent occurrence in the firm-destination champagne export matrix. From a theoretical point of view, the recent trade literature has argued that these zeroes arise due to selection of firms into export markets. If this is indeed the correct model, a zero would thus be observed if a firm is not good enough to export to a particular market. OLS estimators will be biased in this case. More specifically, since the data are left-censored, we expect a downward bias in the OLS estimators.

Head and Mayer (2014) review the performance of a series of estimators in their recent Handbook chapter on gravity estimation for the case with many structural zeroes. Their Monte Carlo simulations suggest that Eaton and Kortum's (2001) Tobit estimator (the EK Tobit hereafter) performs best by a wide margin when it comes to handling zeroes. The EK Tobit is thus the preferred specification in this paper. Eaton and Kortum (2001) suggest a censoring point for their Tobit estimator in line with the recent trade theory: they show that the value of minimum destination exports is a maximum likelihood estimator of the censoring point as implied by models with fixed export costs; exports are only observed once a firm has high enough sales to cover the fixed costs of entry to a market.[16]

3. Data

I use a dataset constructed by Crozet, Head and Mayer (2012), which matches confidential French firm-product-destination level data of champagne exports with producer quality ratings. I consider a cross-section for the year 2005.

Empirical Measure of Product Quality Despite the proliferation of empirical trade and quality work over the last decade, it has proven a challenge to find a suitable empirical measure of product quality. The vast majority of the literature has employed unit values of exports.[17] Here,

[16] A model where selection happens via a choke price such as Melitz and Ottaviano (2008) implies a censoring point of zero, since the marginal exporter here has a zero mass. However, Head and Mayer (2014) argue that zero censoring is problematic econometrically since sign and significance of estimators in this case becomes sensitive to the units of measurement of the export flows.

[17] This measure has the advantage that it is widely available in trade data sets and allows a consistent comparison of quality effects across industries. However, variation in price may come to a significant extent from variation in

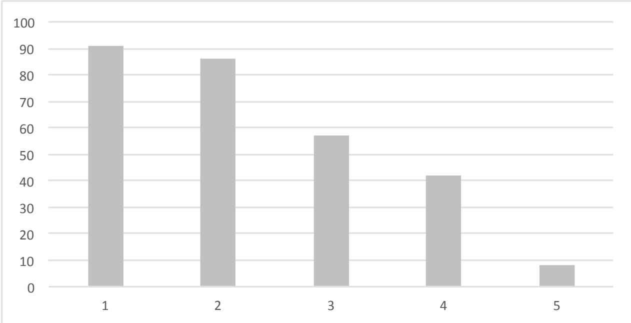

Figure 1 – Number of Exporters by Star Rating

I test the key prediction in the context of the Champagne industry, which allows the use of a very direct empirical measure of product quality: I use a direct quality rating from the world's most comprehensive Champagne guide, the 2008 Juhlin Guide.[18] As explained in Crozet et al (2012), Juhlin (2008) assigns ratings of one to five stars to 487 producers which are based on scores for 6500 individual champagnes. Juhlin gives one star to "producers whose wines have aroused my interest". Five stars are given to the "perfect" Champagne. Juhlin (2008) is a strict grader, with approximately 40% of the included producers receiving a rating of one star such that two stars can be interpreted as average and more stars as above average. The guidebook provides ratings for producers which together cover approximately 90% of all champagne shipments within France and to international destinations. While Champagne producers often produce several varieties and might hence be seen as multiproduct firms, I abstract from this issue and focus on the quality of their overall brand, which corresponds to the level of aggregation of the available quality measure[19]: Juhlin (2008) assigns two ratings at the producer level, one for the latest vintage and one historical rating. I follow Crozet et al (2012) in using the historical rating.

Not all Juhlin rated producers are also exporters. Of the 487 rated producers, 285 export. Figure 1 shows the distribution of stars across exporting firms: approximately one third of exporters are one star firms, just under one third are rated two stars, 20% have three stars, 15% have four stars and just 3% have the top star rating of five.

I use two variants of the quality measure in an interaction with different measures of market size. Product quality is captured by the following indicators: (i) a high quality dummy which takes a value of 1 when Juhlin assigns either two, three, four or five stars and 0 if Juhlin assigns only one star; (ii) a dummy for each quality level from two to five stars, using the one star group as the base category.

cost rather than quality-induced demand effects. Khandelwal (2010) suggests a refinement of this measure based on Sutton's (2012) definition of quality as a demand shifter, which addresses this issue: for a given price, demand should be higher for a higher quality product. In practice, the identification of the alternative empirical quality measure proposed by Khandelwal (2010) therefore relies on information on market shares conditional on price.

[18] Juhlin's ratings correlate highly with other less comprehensive French and international guides.

[19] See Eckel, Iacovone, Javorcik and Neary (2015) for a discussion of brand vs variety quality in the context of multi-product firms.

As Crozet et al (2012) argue, Champagne is a fitting product for this analysis for many reasons[20]: (i) it is one of very few products for which a comprehensive producer quality rating exists. Furthermore, it is common for Champagne producers to blend vintages in order to guarantee a stable quality such that these ratings remain valid over time; (ii) the industry structure closely resembles the monopolistically competitive structure assumed in the model: the Champagne industry consists of many small producers (Herfindahl index of 0.033), who produce differentiated varieties; (iii) 80% of Champagne is exported by firms classified either as grape-growers or wine-makers, and only 13% is exported by wholesalers; (iv) of those direct exports, 94% in 2005 came from firms which can be matched to Juhlin ratings.

A direct quality measure as the one employed here is arguably a better way to test for the intensive margin effect than using productivity estimates. Productivity can only be estimated as a residual and estimation procedures are extremely data intensive (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg, Caves and Frazer, 2006). In addition, Foster, Haltiwanger and Syverson (2008) present evidence which suggests that firm selection is better explained by profitability rather than productivity alone, which is consistent with quality being an important part of the story. More direct evidence of the importance of product quality in explaining variation in the firm size distribution is presented in Hottman, Redding and Weinstein (2014). The authors find that variation in quality and product scope together account for more than 80 percent of variation in firm sales.

Export Data I use confidential French export data which is disaggregated at the firm-product-destination-year level. The data comes from declarations made by French exporters to French Customs. The fact that firms report their exports by destination makes it possible to exploit within-firm variation in export sales and quantities. Information about export flows is collected annually at the 8-digit level according to the EU NC8 nomenclature. Champagne has its own 8-digit product code (22041011) in this nomenclature. Customs record the values of export flows on a free-on-board (fob) basis, i.e. excluding transport costs, insurance etc., as well as export quantities. Figure (2) shows average exports per firm in million euros by star rating. With 30 million euros per year, four star firms export the most on average, followed by five star firms with just under 20 million euros, followed by three, two and one star firms with averages under 5 million.

Table 2 shows summary statistics on the number of export destinations by star rating: the number of destinations is systematically increasing by star rating. The average one star firm exports to five markets, with the best one star firm having a reach of thirty markets. The firm with the largest number of destinations is a four star firm which sells in more than 100 markets; however, on average, five star firms serve the largest number of destination markets with a mean of 46.

[20] See Crozet, Head and Mayer (2012) p. 616-618

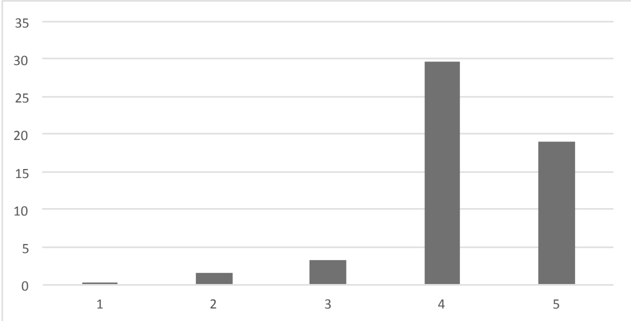

Figure 2 – Average Exports per Firm by Star Rating (in million euros)

Juhlin rating	# observations	mean	median	75% ile	std dev
1 star	91	4.89	3	7	5.11
2 star	86	7.56	6	10	8.03
3 star	57	11.79	10	17	10.71
4 star	42	25.52	13	34	29.58
5 star	8	45.75	48.5	57.5	15.78

Table 2 – Summary Statistics: Export Destinations per Firm

In order to test for the presence of the intensive margin effect, I consider the log of fob firm-destination export values as the dependent variable. Table 3 shows summary statistics for destination export values for each star rating.

Of the Juhlin-rated firms, in 2005, 284 can be matched with exporting firms which export to 157 countries, yielding a sample of 44,586 observations once two price outliers are removed.[21] 3205 of these observations correspond to positive export flows. A full dataset with all relevant gravity controls is available for 38,574 observations of which 2882 are non-zero export flows.[22]

[21] The champagne exporters which were not rated by Juhlin, are currently not included in the sample. They account for approximately 6% of exports.

[22] GDP data is not available for the following 19 countries to which France exports Champagne: Aruba, Anguilla, Andorra, Netherlands Antilles, Bahamas, Bermuda, Cuba, Cayman Islands, Cyprus, Gibraltar, Iraq, New Caledonia, Oman, French Polynesia, San Marino, Saint Pierre and Miquelon, Turks and Caicos Islands, British Virgin Islands, Wallis and Futuna. I thus exclude these countries from all specifications.

Juhlin rating	# observations	mean	median	75% ile	std dev
1 star	91	2,601	542	3,537	4,512
2 star	86	9,878	1,139	4,080	31,226
3 star	57	21,064	2,346	10,679	56,921
4 star	42	188,861	5,164	49,978	535,889
5 star	8	121,161	103,186	189,987	106,344

Table 3 – Summary Statistics: Firm Destination Export Value (in euro)

Market Size In establishing the intensive margin mechanism, I employ different measures of market size. I firstly use log GDP, which yields the pure market size effect in the Krugman (1979) sense when also controlling for GDP per capita. As a measure of market size, GDP has the advantage of being completely exogenous to the value and volume of Champagne exports.[23]

A second measure which I employ to capture market size is the log of absorption based on Eaton, Kortum and Kramarz (2004). Eaton et al (2004) define absorption as gross production + imports - exports, which I implement at the product level. This measure captures the true level of consumption. In their discussion of structural gravity estimation, Head and Mayer (2014) argue that strictly, absorption should be used to capture import market size, and not GDP. Since champagne is produced only in France, champagne absorption in a destination market consists only of France's total exports to that destination. Note that this definition of market size implies that champagne is not substitutable with other alcoholic beverages.

As a measure of market size, GDP and champagne absorption lie at opposite extremes of the spectrum. Ideally, one would want to use destination-specific total alcoholic beverage absorption; however, this data is not readily available for the 138 countries in the dataset.

Quality Preference In addition, I test the hypothesis that high quality firms do relatively better in countries where consumers have a stronger preference for quality. Following Hallak's (2006) empirical findings, I proxy quality preference by GDP per capita.

Controls In the baseline, I control for destination and firm-specific characteristics using destination and firm fixed effects. The specification then identifies only the coefficient on the interaction between destination market size and firm-level quality as well as the coefficient on the quality-income interaction.

In order to gain an understanding of the absolute size of the market size effect for both high and low quality firms, I also estimate a specification without destination fixed effects such that the coefficient on market size for the low quality firms can be identified. It is then necessary to control for destination geography and bilateral trade barriers/enhancers as in a standard gravity setup. The geography variable is needed to control for the level of competition in the destination market arising from proximity to third countries. Importantly, predictions for the impact of market size on firm-level sales are for a given level of income. I therefore also control for income effects, using the log of GDP per capita when destination fixed effects are not included.

For the specifications which control explicitly for geography and bilateral factors, I adopt the strategy in Mayer et al (2014). As a control for geography, the authors suggest a variation on

[23] See appendix table 10 for source.

Redding and Venables' (2004) measure of supply potential which, unlike Redding and Venables' (2004) measure, is independent of country-level information on the destination country. The measure is defined as "the aggregate predicted exports to a destination based on a bilateral trade gravity equation (in logs) with both exporter and importer fixed effects and the standard bilateral measures of trade barriers/enhancers" (Mayer et al, 2014, p.25). Following Head and Mayer (2014), they thus construct log *foreign* supply potential which drops importer fixed effects. This is the measure which I also employ here. I control for characteristics of the bilateral relationship using the standard gravity variables provided by the CEPII: distance, contiguity, colonial links, common-language, RTA membership, GATT/WTO membership, and membership of a common currency area.[24]

In the specifications with destination fixed effects I cluster standard errors at the destination country level. This addresses correlations in the error term which would otherwise lead to standard errors being biased downward.

4. Estimations

As the preferred specification, I estimate the baseline relationship given in equation (12). Where I control for destination characteristics and trade barriers/enhancers explicitly in order to estimate the absolute market size effect, the regression equation is the following:

$$\ln r_{fd}^{FOB} = \beta_2 Z_f * \ln L_d + \delta_2 \ln L_d + \gamma_2 Z_f * \ln I_d + \delta \mathbf{X}_d + `_{\mathrm{f}} + ''_{fd}, \tag{13}$$

where $\mathbf{X}_d$ is the vector of destination-level controls. Here, β_2 and δ_2 are the main coefficients of interest. I then estimate the relationship using individual star dummies as quality indicators rather than a high/low dummy:

$$\ln r_{fd}^{FOB} = \sum_{s=2}^{5} \beta_3^s Z_f^s * \ln L_d + \sum_{s=2}^{5} \gamma_3^s Z_f^s * \ln I_d + `_{\mathrm{d}} + `_{\mathrm{f}} + ''_{fd}. \tag{14}$$

where Z^s are dummies for $s =$two, three, four and five star firms. I discuss results for the OLS and EK Tobit estimations in turn.

4.1. Results

Market size effects are present and highly significant in all specifications. I also find strong differential effects of per capita income on producers of different quality levels, whereby the effect is close to monotonically increasing with the quality rating of the firm.

[24] See appendix table 10 for detailed descriptions and source.

OLS In a first step, I estimate my model using OLS. Table 4 shows results. All variables are in logs such that coefficients can be interpreted as elasticities.

The key coefficient on all market size interactions is significant and of the expected sign: a larger market allows high quality firms to pull away from their low quality competition. Whether GDP or champagne absorption is used as a measure of market size only affects results marginally. The OLS estimates suggest for every 1% increase in market size, high quality producers see their sales rise approximately by an additional 0.25% compared to low quality producers. These estimates are robust to controlling for destination characteristics either by using fixed effects or explicitly by using gravity variables. Columns (2), (3) and (5) employ foreign supply potential/gravity controls and therefore allow for an identification of the effect of market size on the low quality base group.[25] They suggest that the effect is positive also for the baseline group at around 0.25% (GDP) or 0.44% (champagne absorption) for every 1% increase in market size.

All specifications control for per capita income and its interactions with quality. Results are in line with the prediction that a high quality firm should benefit disproportionately from selling in a richer market via the quality preference mechanism discussed above. Indeed, for every 1% increase in destination country income, high quality firms see their sales increase by between 0.32% and 0.39% more than low quality producers, depending on controls and market size proxies used. At this stage it is, however, not yet clear whether this increase is coming from higher prices (as firms exploit higher willingness to pay in richer countries) or larger quantities sold, or both. I explore this in more detail below.

An advantage of OLS estimation is that the inclusion of fixed effects does not pose any estimation issues. There is, however, a source of bias which OLS cannot address: empirical estimations of models involving quality selection are subject to a specific type of bias as shown by Crozet et al (2012). Within the framework of their model, a low quality firm will only be observed to be exporting to a tough market if it has experienced a positive demand shock. There is hence a negative correlation between quality conditional on exporting and unobservable demand shocks which leads to OLS estimators being biased downward. Indeed, in terms of total size, coefficients on log GDP in Table 4 are smaller than what is predicted by the theory (Anderson, 1979) and what is generally found in the gravity literature (Head and Mayer, 2014). Crozet et al (2012) conduct Monte Carlo simulations to show that an EK Tobit estimator can correct for this bias. I next discuss results for the EK Tobit specification.

EK Tobit Table 5 shows results for the Tobit estimations with Eaton-Kortum censoring at the minimum export value. Columns (1) and (4) control for destination characteristics using fixed

[25] Note that defining market size narrowly as "champagne" absorption implies that champagne is not substitutable with other sparkling wines or alcoholic beverages. There is thus no "absorption" specification which controls explictly for foreign supply potential, which by the foregoing argument is zero.

Table 4 – Export Values (OLS)

	(1) ln export	(2) ln export	(3) ln export	(4) ln export	(5) ln export
ln GDP*quality	0.271***	0.258***	0.249***		
	(0.0359)	(0.0597)	(0.0576)		
ln ch-absorption*quality				0.246***	0.218***
				(0.0458)	(0.0500)
ln GDP dest		0.234***	0.264***		
		(0.0567)	(0.0558)		
ln ch-absorption					0.439***
					(0.0474)
ln GDP pc*quality	0.388***	0.386***	0.374***	0.331***	0.317***
	(0.0811)	(0.111)	(0.107)	(0.0870)	(0.101)
ln GDP pc dest		-0.0867	0.0915		-0.307***
		(0.108)	(0.106)		(0.0994)
ln fsp		0.195***	-0.204***		
		(0.0260)	(0.0489)		
ln distance			-0.674***		-0.192***
			(0.0779)		(0.0597)
firm fe	yes	yes	yes	yes	yes
destination fe	yes	no	no	yes	no
gravity vars	no	no	yes	no	yes
Observations	3003	2881	2881	3003	3003
Adjusted R^2	0.558	0.292	0.349	0.556	0.424

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

effects, while columns (2), (3) and (5) use explicit gravity controls.[26]

Results are fully in line with the key prediction on the market size effect also once we control for the fact that high quality firms are more likely to be present in larger and thus tougher markets. Within-firm export revenues are increasing in market size for all firms, and they increase more than proportionately for the high quality firms. Using GDP as a measure for market size, the coefficient of interest is highly significant and positive. High quality producers are estimated to have 0.21%-0.29% additional increase in sales over low quality firms for every 1% increase in market size. The size of the "high quality premium" is similar to the one estimated by OLS. For the champagne absorption proxy for market size, the size of the effect varies more widely across specifications with different sets of control variables. It is positive at just under 0.19% and significant for the most conservative specification which controls for destination characteristics using destination fixed effects. As columns (2), (3) and (5) show, the effect of market size on the baseline low quality group is much larger once selection is taken into account. In fact, for the GDP specifications, log GDP is close to unit elasticity which is in line with a key prediction from the classic gravity theory. For high quality firms, it is just above unit elasticity in column (2).

Income effects are positive and significant whereby the jump in revenues for high quality firms is higher in the Tobit estimation than for OLS: for every 1% increase in destination income, high quality firms increase their sales by around 0.5% more than low quality firms. Again, this is fully in line with the quality preference prediction.

Disaggregated Star Ratings I next disaggregate the high quality dummy into the individual ratings for the 2-5 star firms and check for market size and income effects by star rating. Results are shown in table 6. I use an OLS estimator in columns (1) and (2) and the EK Tobit in columns (3) and (4). For all four specifications I take the most conservative approach and include both firm and destination fixed effects. Estimations thus only identify coefficients on the interaction terms. Standard errors are always clustered at the destination level.

Point estimates of the market size interactions in the OLS specifications are monotonically increasing in the star ratings for both market size proxies. T-tests reveal that most coefficients are significantly different from each other. Specifications in columns (3) and (4) address selection bias. Point estimates of the effects are still close to monotonic, with only the five star firms

[26] Greene (2002) shows that fixed effects estimators in Tobit models are not affected by incidental parameter problems (unlike Probit and Logit). Slope estimators are thus unbiased and consistent. Ancillary parameter problems can arise with the estimated disturbance variance, with standard errors biased towards zero. However, Greene (2002) also shows that the bias in the variance estimator is falling very quickly in "T" (here, the number of destinations, which is large). In addition, in the present case, the number of fixed effects is small compared to the number of observations, which reduces the issue further. Crozet, Head and Mayer (2012) run Monte Carlo simulations on the EK Tobit estimator with the same order of magnitude of fixed effects and show that the EK Tobit indeed performs very well.

Table 5 – Export Values (EK Tobit)

	(1)	(2)	(3)	(4)	(5)
	ln export	ln export	ln export	ln export	ln export
ln GDP*quality	0.286***	0.207***	0.233***		
	(0.0591)	(0.0651)	(0.0610)		
ln ch-absorption*quality				0.186**	0.130**
				(0.0842)	(0.0584)
ln GDP dest		0.833***	0.753***		
		(0.0589)	(0.0568)		
ln ch-absorption					1.085***
					(0.0546)
ln GDP pc*quality	0.494***	0.492***	0.510***	0.514***	0.517***
	(0.103)	(0.101)	(0.0937)	(0.137)	(0.0988)
ln GDP pc dest		0.545***	0.644***		-0.324***
		(0.0938)	(0.0899)		(0.0948)
ln fsp		0.682***	-0.200***		
		(0.0393)	(0.0635)		
ln distance			-1.075***		-0.550***
			(0.103)		(0.0792)
firm fe	yes	yes	yes	yes	yes
destination fe	yes	no	no	yes	no
gravity vars	no	no	yes	no	yes
Observations	38906	38338	38338	38906	38906
Pseudo R^2	0.424	0.346	0.374	0.424	0.401

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

dropping off.[27] This could be due to capacity constraints of five star firms, of which there are only eight in total.

Further, coefficients on the income interactions are monotonic in the EK Tobit specifications. This is consistent with the prediction that consumers consume more high quality varieties as their income increases.

Overall, the results confirm that the market size mechanism which skews sales towards the higher quality firms exists independently of the income channel.

4.2. Quantity Effects

I next decompose the market size effect on firm revenues into its quantity and price components. I estimate quantity effects using the EK Tobit model. I include destination fixed effects and estimate coefficients for both quality indicators; the baseline specification is:

$$\ln q_{fd} = \beta_4 Z_f * \ln L_d + \gamma_4 Z_f * \ln I_d + \theta_d + \theta_f + {}''_{fd}, \quad (15)$$

where q_{fd} is the volume of champagne exported by firm f to destination d. Analogously to the revenue estimations, I also estimate the specifications which control for gravity variables explicitly. Results are shown in table 7. While coefficients differ slightly in magnitude compared to the estimations which have export revenues as their dependent variable, results are perfectly in line with the revenue estimations - i.e. these results suggest that revenue effects are to a large extent driven by quantity adjustments.

4.3. Price Effects

This section examines the relationship between prices and destination market size. Customs record the values of export flows (on an FOB basis) as well as export quantities. From this information, it is possible to calculate firm-destination-product prices (unit values) as $ln\, p_{fd}^{FOB} = ln(\frac{x_{fd}^{FOB}}{q_{fd}})$, where f indexes firms and d indexes export destinations. I clean these unit values of outliers following the method employed in Crozet et al (2012). Subsequently, I first decompose the champagne prices into within- and across-firm variation over destination markets. I then check whether this variation can be explained by market size.

Price Decomposition The price decomposition follows Harrigan, Ma and Shlychkov (2012) and shows for champagne that within-firm variation is a relatively larger source of price variation across markets than industry composition effects. The deviation of destination average price, $\bar{p}_d$, from the average world price, $\bar{p}$, can be decomposed as follows:

[27] Wooldridge (2002) shows that t-tests can be used on Tobit interaction coefficients (cf chapter 16 Wooldridge (2002) and Ai and Norton (2003) on Tobit with interaction terms).

Table 6 – Export Values (OLS and EK Tobit)

	(1)	(2)	(3)	(4)
	ln export	ln export	ln export	ln export
ln GDP*2star	0.106**		0.228***	
	(0.0472)		(0.0511)	
ln GDP*3star	0.249***		0.317***	
	(0.0431)		(0.0651)	
ln GDP*4star	0.344***		0.326***	
	(0.0519)		(0.0838)	
ln GDP*5star	0.347***		0.218**	
	(0.0509)		(0.103)	
ln GDP pc*2star	0.271***	0.297***	0.398***	0.380***
	(0.0874)	(0.0953)	(0.0966)	(0.109)
ln GDP pc*3star	0.173	0.125	0.384***	0.437***
	(0.105)	(0.107)	(0.0971)	(0.137)
ln GDP pc*4star	0.434***	0.318***	0.506***	0.529***
	(0.0944)	(0.118)	(0.141)	(0.186)
ln GDP pc*5star	0.477***	0.408***	0.757***	0.782***
	(0.0989)	(0.122)	(0.173)	(0.211)
ln ch-abs*2star		0.0886*		0.181***
		(0.0512)		(0.0659)
ln ch-abs*3star		0.230***		0.179**
		(0.0452)		(0.0878)
ln ch-abs*4star		0.358***		0.212*
		(0.0823)		(0.126)
ln ch-abs*5star		0.316***		0.139
		(0.0794)		(0.138)
firm fe	yes	yes	yes	yes
destination fe	yes	yes	yes	yes
Observations	3003	3003	38906	38906
Adjusted R^2	0.568	0.567		
Pseudo R^2			0.425	0.424

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Table 7 – Export Quantities (EK Tobit)

	(1) log qty	(2) log qty	(3) log qty	(4) log qty	(5) log qty
ln GDP*quality	0.281***	0.212***	0.240***		
	(0.0598)	(0.0676)	(0.0639)		
ln ch-absorption*quality				0.173**	0.123**
				(0.0873)	(0.0611)
ln GDP dest		0.907***	0.816***		
		(0.0612)	(0.0594)		
ln ch-absorption					1.174***
					(0.0570)
ln GDP pc*quality	0.490***	0.481***	0.497***	0.523***	0.515***
	(0.106)	(0.106)	(0.0995)	(0.139)	(0.104)
ln GDP pc dest		0.514***	0.630***		-0.388***
		(0.0985)	(0.0958)		(0.0995)
ln fsp		0.785***	-0.105		
		(0.0416)	(0.0661)		
ln distance			-1.057***		-0.617***
			(0.110)		(0.0845)
firm fe	yes	yes	yes	yes	yes
destination fe	yes	no	no	yes	no
gravity vars	no	no	yes	no	yes
Observations	38906	38338	38338	38906	38906
Pseudo R^2	0.418	0.340	0.367	0.417	0.395

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

%ile	price disc	mkt share	interaction
5	-12.93024	-1.908474	-14.90586
10	-7.38087	-.7414563	-9.619112
25	-1.364731	-.0645392	-2.223278
50	1.651816	.1916454	-.7016925
75	3.131027	.5206336	2.165871
90	10.06632	1.353846	7.67339
95	15.3994	3.647792	12.44544

Table 8 – Price Decomposition

$$\bar{p}_d - \bar{p} = \underbrace{\sum_{f=1}^{N}(p_{fd} - \bar{p}_f)\bar{w}_f}_{price\,discrimination} + \underbrace{\sum_{f=1}^{N}(w_{fd} - \bar{w}_f)\bar{p}_f}_{industry\,composition} + \underbrace{\sum_{f=1}^{N}(p_{fd} - \bar{p}_f)(w_{fd} - \bar{w}_f)}_{interaction\,term}.$$

where p_{fd} is the price charged by firm f in destination d; w_{fd} is firm $f's$ quantity market share in destination d : $w_{fd} = \frac{q_{fd}}{\sum_{f=1}^{N} q_{fd}}$; and $\bar{w}_f$ is "firm f's average quantity market share in the world market": $\bar{w}_f = \frac{\sum_{d=1}^{D} q_{fd}}{\sum_{d=1}^{D}\sum_{f=1}^{N} q_{fd}}$ (Harrigan et al, 2012, p.4). Table 8 summarizes the components at various percentiles of the distribution. These patterns are consistent with other studies which present evidence of substantial within-firm price variation across export destinations, including Harrigan, Ma and Shlychkov (2012) (Fontagné et al, 2009; Görg et al, 2010; di Comite, Thisse and Vandenbussche, 2011; Manova and Zhang, 2012; Martin, 2012). This is unsurprising in light of the fact that markets are still highly fragmented by fixed and variable trade costs.

Prices and Market Size I subsequently estimate the differential impact of market size on price (fob unit values), controlling for destination characteristics. A linear projection of fob log champagne export prices of a variety produced by firm f exported to destination market d can be written as:

$$\ln p_{fd}^{FOB} = \beta_5 Z_f * \ln L_d + \gamma_5 Z_f * \ln I_d + \theta_d + \theta_f + {''}_{fd}$$

Parameters and variables are defined as in the export value equations.

Table 9 shows results for the OLS estimations. Columns (1) and (2) control for destination characteristics using gravity variables, while columns (3) and (4) use destination fixed effects. The first two columns suggest that market size reduces prices overall, while five star firms compete even harder in larger markets, reducing prices by more than their lower quality competitors. This is in line with toughening competition putting pressure on firms' mark-ups. In addition, in my model mark-ups are increasing in quality/productivity giving high quality firms the opportunity to compete harder by lowering mark-ups relatively more than the other firms.

GDP per capita has a positive impact on prices for all firms in columns (1) and (2), with five star firms charging an additional premium in a richer market. This is consistent with consumers' willingness to pay increasing in income.

While the income effect favouring five star firms disappears in the fixed effects estimations in columns (3) and (4), the market size effect for these firms remains highly significant.

5. Conclusion

This paper has presented the most direct test to date of the key welfare mechanism put forward by Melitz and Ottaviano (2008): the best firms benefit disproportionately from an increase in market size. I have tested for this mechanism using product quality as a proxy for productivity showing that high quality firms increase their sales relatively more as market size increases. The analysis was guided by a quality-augmentation of Melitz and Ottaviano (2008). Product quality was captured empirically using a unique dataset containing firm-level quality ratings. The results are in line with the key predictions of the model. I have established that the market size effect is driven by quantity adjustments rather than prices. In the aggregate, this implies a positive contribution to overall welfare. I have also found a strong positive relationship between a proxy for consumer quality preference and demand for quality which is consistent with the theory.

If one were to translate results from the cross-section to a time-series perspective, the data suggest a disproportionate boost to competitiveness in the face of progressing globalization from being a high quality producer. The existence of the market size effect in the data supports the assumption of variable elasticity of demand over CES preferences. This is an important finding given existing insights regarding the sensitivity of welfare results to the exact properties of preference structures.

Table 9 – FOB Export Prices (OLS)

	(1)	(2)	(3)	(4)
	ln price	ln price	ln price	ln price
ln GDP dest	0.00454			
	(0.00938)			
ln GDP*2star	0.00506		0.00201	
	(0.00843)		(0.00706)	
ln GDP*3star	0.00156		0.000577	
	(0.0111)		(0.00923)	
ln GDP*4star	-0.00438		-0.00440	
	(0.00950)		(0.00855)	
ln GDP*5star	-0.0371**		-0.0363***	
	(0.0148)		(0.0133)	
ln GDP pc dest	0.0260*	0.0538***		
	(0.0145)	(0.0150)		
ln GDP pc*2star	-0.0137	-0.0176	-0.0213	-0.0276
	(0.0187)	(0.0196)	(0.0189)	(0.0189)
ln GDP pc*3star	-0.0169	-0.0196	-0.0265	-0.0280
	(0.0226)	(0.0222)	(0.0207)	(0.0210)
ln GDP pc*4star	-0.000885	-0.00999	-0.0229	-0.0248
	(0.0146)	(0.0171)	(0.0157)	(0.0186)
ln GDP pc*5star	0.0539*	0.0696**	0.0170	0.0212
	(0.0278)	(0.0332)	(0.0247)	(0.0295)
ln ch-absorption		-0.0139**		
		(0.00642)		
ln ch-abs*2star		0.00379		0.00429
		(0.00837)		(0.00892)
ln ch-abs*3star		0.00107		-0.000710
		(0.00915)		(0.00990)
ln ch-abs*4star		0.000288		-0.00310
		(0.00972)		(0.0110)
ln ch-abs*5star		-0.0424***		-0.0289*
		(0.0160)		(0.0147)
firm fe	yes	yes	yes	yes
destination fe	no	no	yes	yes
Observations	2881	2881	3003	3003
Adjusted R^2	0.019	0.028	0.121	0.118

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

References

Ackerberg, Daniel, Kevin Caves and Garth Frazer (2006), "Structural identification of production functions," MPRA Paper 38349, University Library of Munich, Germany.

Ai, Chunrong and Edward C. Norton (2003) "Interaction terms in logit and probit models," Economics Letters, Elsevier, vol. 80(1), 123-129, July.

Anderson, James (1979), "A Theoretical Foundation for the Gravity Equation", American Economic Review, 1979, vol. 69, issue 1, pages 106-116

Antoniades, Alexis (2015), "Heterogeneous Firms, Quality and Trade", Journal of International Economics, Volume 95, Issue 2, 263-273

Baldwin, Richard and James Harrigan (2011), "Zeroes, Quality and Space: Trade Theory and Trade Evidence", American Economic Journal: Microeconomics, 3(2): 60–88

Baller, Silja (2012), "Does Product Quality Matter for Gains from Trade?", CESifo Conference Paper, CESifo Munich

Baller, Silja (2013), "Product Quality, Market Size and Welfare: Theory and Evidence from French Exporters", Job Market Paper, Department of Economics, University of Oxford

Baller, Silja (2014), "Essays on Product Quality, International Trade and Welfare", DPhil Thesis, University of Oxford

Bastos, P. and J. Silva (2010). "The quality of a firm's exports: Where you export to matters", Journal of International Economics 82(2), 99 — 111.

Behrens, Kristian, Gilles Duranton and Frédéric Robert-Nicoud (2014), "Productive Cities: Sorting, Selection, and Agglomeration", Journal of Political Economy, vol. 122(3), pages 507-553

Bellone, Flora, Patrick Musso, Lionel Nesta, Frédéric Warzynski (2014), "International Trade and Firm-Level Mark-Ups when Quality Matters", Journal of Economic Geography, p.1-25

Besedes, Tibor and Thomas J.Prusa (2011), "The role of extensive and intensive margins and export growth", Journal of Development Economics, Volume 96, Issue 2, November 2011, Pages 371-379

Campbell, Jeffrey R. and Hugo Hopenhayn (2005), "Market Size Matters," Journal of Industrial Economics, vol. 53(1), 1-25

Chen, Natalie and Luciana Juvenal (2013), "Quality, Trade, and Exchange Rate Pass-Through", CEPR Discussion Paper 9744

Combes, Pierre-Philippe, Gilles Duranton, Laurent Gobillon, Diego Puga, Sébastien Roux (2012), "The Productivity Advantages of Large Cities: Distinguishing Agglomeration from Selection", Econometrica, Vol 80, issue 6, p.2543-2594

Crozet, Matthieu, Keith Head and Thierry Mayer (2009), "Quality-Sorting and Trade: Firm-level Evidence for French Wine", CEPR Discussion Paper, No.7295

Crozet, Matthieu, Keith Head and Thierry Mayer (2012), "Quality-Sorting and Trade: Firm-level Evidence for French Wine", Review of Economic Studies 79(2), 609-644

di Comite, Francesco, Jacques-Francois Thisse and Hylke Vandenbussche (2011), "Vertizontal Differentiation in Monopolistic Competition", IRES Discussion Paper 2011-46, Université Catholique du Louvain

Dixit, Avinash and Joseph Stiglitz (1977), "Monopolistic Competition and Optimum Product Diversity", American Economic Review, 67(3), 297-308

Eaton, Jonathan and Samuel Kortum (2001), "Trade in Capital Goods", European Economic Review, 45, 1195–1235.

Eaton, Jonathan, Samuel Kortum and Francis Kramarz (2004), "Dissecting Trade: Firms, Industries and Export Destinations", American Economic Review, Vol. 94(2), pp. 150-154

Eckel, Carsten and J.Peter Neary (2010), "Multi-Product Firms and Flexible Manufacturing in the Global Economy", Review of Economic Studies (2010) 77, 188–217

Eckel, Carsten, Leonardo Iacovone, Beata S.Javorcik and J.Peter Neary (2015), "Multi-Product Firms at Home and Away: Cost- vs Quality-based Competence", Journal of International Economics, p.216-232

Fajgelbaum, Pablo, Gene M. Grossman, Elhanan Helpman (2011), "Income Distribution, Product Quality, and International Trade", Journal of Political Economy, Vol. 119, No. 4, pp. 721-765

Fieler, Ana Cecilia (2011), "Nonhomotheticity and Bilateral Trade: Evidence and a Quantitative Explanation", Econometrica, Vol.79, No.4, 1069-1101

Fontagné, Lionel, Thierry Mayer and Gianmarco Ottaviano (2009), "Of markets, products and prices: The effects of the Euro on European Firms", Bruegel Blueprint 8

Foster, L., J. Haltiwanger, and Chad Syverson (2008): "Reallocation, firm turnover, and efficiency: Selection on productivity or profitability?" American Economic Review, 98, 394– 425.

Görg, H., L. Halpern, and B. Murakozy (2010). "Why Do within Firm-Product Export Prices Differ Across Markets?", CEPR Working Paper 7708

Greene, William (2002), "The Bias of the Fixed Effects Estimator in Non-Linear Models", NYU mimeo

Hallak, Juan Carlos (2006), "Product Quality and the Direction of Trade", Journal of International Economics 68, 238-265

Harrigan, James, Xiangjun Ma, Victor Shlychkov (2012), "Export Prices of US firms", mimeo

Head, Keith and Thierry Mayer (2014), “Gravity Equations: Workhorse, Toolkit and Cookbook”, paper to appear in the Handbook of International Economics Vol. 4, eds. Gopinath, Helpman, and Rogoff, Elsevier

Helpman, Elhanan, Marc Melitz and Yona Rubinstein (2008), “Estimating Trade Flows: Trading Partners and Trading Volumes”, The Quarterly Journal of Economics, vol. 123(2), 441-487

Colin Hottman, Stephen Redding and David Weinstein (2014), “What is 'Firm Heterogeneity' in Trade Models? The Role of Quality, Scope, Mark-Ups and Cost”, NBER Working Paper 20436

Iacovone, Leonardo and Beata S. Javorcik (2010), “Multi-product Exporters: Product Churning, Uncertainty and Export Discoveries”, Economic Journal, 120 (May), 481-499

Iacovone, Leonardo and Beata S. Javorcik (2012), “Getting Ready: Preparation for Exporting”, CEPR Discussion Paper No. 8926

Iacovone, Leonardo, Ferdinand Rauch and L. Alan Winters (2013), “Trade as an Engine of Creative Destruction: Mexican Experience with Chinese Competition”, Journal of International Economics, vol. 89(2), 379-392

Juhlin, Richard (2008), Champagne Guide (Richard Juhlin Publishing AB)

Kee, H. L. and Krishna, K. (2008), “Firm-level heterogeneous productivity and demand shocks: Evidence from Bangladesh”, American Economic Review 98: 457–62.

Khandelwal, Amit (2010), “The Long and Short (of) Quality Ladders”, Review of Economic Studies, 77, 1450–1476

Kneller, Richard and Zhihong Yu (2008), “Quality Selection, Chinese Exports and Theories of Heterogeneous Firm Trade”, research paper 2008/44, University of Nottingham

Krugman, Paul (1979), "Increasing Returns, Monopolistic Competition and Trade", Journal of International Economics, November 1979, 9, 469-479

Levinsohn, J. and Petrin, A. (2003) “Estimating Production Functions Using Inputs to Control for Unobservables”, Review of Economic Studies, 317-342

Manova, Kalina and Zhiwei Zhang (2012), "Export Prices Across Firms and Destinations", The Quarterly Journal of Economics, Volume 127 (1), 379-436

Martin, Julien (2012), “Markups, Quality and Transport Costs”, European Economic Review, 56(4), 777-791

Mayer, Thierry, Marc Melitz and Gianmarco Ottaviano (2014), "Market Size, Competition, and the Product Mix of Exporters", American Economic Review 104(2)

Melitz, Marc J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", Econometrica, Vol.71(6), 1695-1725

Melitz, Marc and Gianmarco Ottaviano (2008), "Market Size, Trade and Productivity", Review of Economic Studies 75, 295-316

Merton, Robert K. (1968), “The Matthew Effect in Science”, Science 159 (3810), 56–63.

Milgrom, P., J. Roberts (1990), “The Economics of Modern Manufacturing: Technology, Strategy, and Organization”, American Economic Review 80(3), 511–528.

Mrázová, Monika and J.Peter Neary (2011), "Selection Effects with Heterogeneous Firms", University of Oxford, Discussion Paper Series No.588

Mrázová, Monika and J.Peter Neary (2013), “Not so Demanding: Preference Structure, Firm Behaviour and Welfare”, University of Oxford, Department of Economics Discussion Paper Series 691

Neary, J. Peter (2010) "Two-And-A-Half-Theories of Trade", The World Economy, Vol.33(1)

Norton, Edward C., Hua Wang and Chunrong Ai (2004) "Computing interaction effects and standard errors in logit and probit models", Stata Journal, StataCorp LP, vol. 4(2), 154-167, June.

Olley, S. and Pakes, A.(1996), “The Dynamics of Productivity in the Telecommunications Equip- ment Industry”, Econometrica 64, 1263-1295

Parenti, Mathieu (2012), “International Trade: David and Goliath”, mimeo

Parenti, Mathieu, Philip Ushchev and Jacques-Francois Thisse (2014), “Toward a Theory of Monopolistic Competition”, CEPR Discussion Paper 10014

Redding, Stephen J. and Anthony J. Venables (2004) “Economic Geography and International Inequality.” Journal of International Economics 62 (1): 53-82.

Schott, Peter K. (2004), "Across-Product vs Within-Product Specialization in International Trade", Quarterly Journal of Economics, Vol.119(2), 647-687

Sutton, John (2012), “Competing in Capabilities”, Clarendon Lectures, Oxford University Press

Syverson, Chad (2004), "Market Structure and Productivity: A Concrete Example", Journal of Political Economy, 112, 1181-1222

Syverson, Chad (2007), “Prices, Spatial Competition, and Heterogeneous Producers: An Empirical Test“, The Journal of Industrial Economics, Vol. LV NO.2, 197-222

Tinbergen, Jan (1962), “An Analysis of World Trade Flows,” in Shaping the World Economy, edited by Jan Tinbergen. New York, NY: Twentieth Century Fund.

Topkis, D.M. (1978), “Minimizing a Supermodular Function on a Lattice”, Operations Research 26, 305–321.

Verhoogen, Eric (2008), “Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector”, Quarterly Journal of Economics, vol. 123, no. 2, 489-530

Wooldridge (2002), "Econometric Analysis of Cross-Section and Panel Data", MIT Press

6. Appendix

6.1. Theory

6.1.1. Submodularity of closed economy revenues wrt cost and market size

$$
\begin{aligned}
r &= \frac{\varepsilon_\lambda^2 L}{4b(1-e)}(c_D - c)^2 + \frac{\varepsilon_\lambda L}{2b(1-e)}(c_D - c)\,c \\
\frac{\partial r}{\partial c} &= -\frac{\varepsilon_\lambda L}{2b(1-e)}\left[B\lambda(c_D - c) + c\right] \\
\frac{\partial r^2}{\partial c \partial L} &= -\frac{\varepsilon_\lambda L}{2b(1-e)}\left[\frac{B\lambda\varepsilon_\lambda}{L}\left(\frac{n+1}{n+2}c_D - c\right)\right] + \left[B\lambda(c_D - c) + c\right]\left[-\frac{\varepsilon_\lambda}{2b(1-e)} - \frac{\varepsilon_\lambda}{2b(1-e)}\frac{\beta BL}{2-\beta BL}\right] \\
&= -\frac{\varepsilon_\lambda}{2b(1-e)}\left[\frac{B\lambda\varepsilon_\lambda}{L}\left(\frac{n+1}{n+2}c_D - c\right) + \left[B\lambda(c_D - c) + c\right](1 + B\lambda)\right] \\
&= -\frac{\varepsilon_\lambda^2}{2b(1-e)}\left[\frac{B\lambda}{L}\left(\frac{n+1}{n+2}c_D - c\right) + B\lambda(c_D - c) + c\right]
\end{aligned}
$$

6.1.2. Submodularity of open economy revenues wrt cost and market size

Analogous to the closed economy case, we can show:

$$
\begin{aligned}
r_X^{lh} &= \frac{L^h \varepsilon_\lambda^h}{2b\,(1-e)}\left(c_D^h - \tau^{lh}c\right)\left[\frac{\varepsilon_\lambda^h}{2}\left(c_D^h - \tau^{lh}c\right) + \tau^{lh}c\right], \\
\frac{\partial r_X^{lh}}{\partial c} &= -\frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\left[\lambda^h B^h (c_D^h - \tau^{lh}c) + \tau^{lh}c\right]
\end{aligned}
$$

where $c_D^h = \left[\frac{b(1-e)\phi}{(1+\rho)\varepsilon_\lambda^h L^h}\right]$ and $\varepsilon_\lambda^h = 1 + B^h\lambda_X^h = 1 + B^h\frac{\beta^h L^h}{2-\left(\beta^h\right)^2 b(1-e)L^h}$. Then:

$$
\frac{\partial (r_X^{lh})^2}{\partial c \partial L^h} = -\frac{(\varepsilon_\lambda^h)^2}{2b(1-e)}\left[\frac{B^h\lambda_X^h}{L^h}\left(\frac{n+1}{n+2}c_D^h - \tau^{lh}c\right) + B^h\lambda_X^h(c_D^h - \tau^{lh}c) + \tau^{lh}c\right].
$$

A sufficient condition for submodularity,

$$
\frac{\partial (r_X^{lh})^2}{\partial c \partial L^h} < 0,
$$

is $\tau^{lh}c < \frac{n+1}{n+2}c_D^h$.

6.1.3. Submodularity of open economy revenues wrt cost and quality preference

$$\frac{\partial r_X^{lh}}{\partial c} = -\frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right]$$

$$\frac{\partial (r_X^{lh})^2}{\partial c \partial \beta^h} = -\frac{L^h}{2b(1-e)}\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right]\frac{\partial \varepsilon_\lambda^h}{\partial \beta^h} - \frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\frac{\partial\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right]}{\partial \beta^h}$$

$$= -\frac{L^h}{2b(1-e)}\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right]\frac{\partial \varepsilon_\lambda^h}{\partial \beta^h} - \frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\left[\underbrace{\frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h}(c_D^h - \tau^{lh} c)}_{+} + \underbrace{\frac{\partial c_D^h}{\partial \beta^h}\lambda^h B^h}_{-}\right]$$

Differentiating the individual parts of the above expression:

$$\varepsilon_\lambda^h = 1 + B^h \lambda^h = 1 + \beta^h b(1-e)\frac{\beta^h L^h}{2 - (\beta^h)^2 b\,(1-e)\,L^h}$$

$$\frac{\partial \varepsilon_\lambda^h}{\partial \beta^h} = \frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h} = \frac{4b\,(1-e)}{\beta^h L^h}\left(\lambda^h\right)^2 > 0$$

$$c_D^h = \left[\frac{\phi b\,(1-e)}{(1+\lambda^h B^h)\,L^h}\right]^{\frac{1}{n+2}}$$

$$\frac{\partial c_D^h}{\partial \beta^h} = -\frac{c_D^h}{(n+2)\,(1+\lambda^h B^h)\,L^h}\frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h} < 0$$

Substituting back in:

$$\frac{\partial (r_X^{lh})^2}{\partial c \partial \beta^h} = -\frac{L^h}{2b(1-e)}\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right]\frac{\partial \varepsilon_\lambda^h}{\partial \beta^h} - \frac{\varepsilon_\lambda^h L^h}{2b(1-e)}\left[\frac{(n+2)\left(1+\lambda^h B^h\right)L^h (c_D^h - \tau^{lh} c) - \lambda^h B^h c_D^h}{(n+2)\,(1+\lambda^h B^h)\,L}\right]\frac{\partial\left(\lambda^h B\right.}{\partial \beta^h}$$

$$= -\frac{L^h}{2b(1-e)}\left\{\left[\lambda^h B^h (c_D^h - \tau^{lh} c) + \tau^{lh} c\right] + \left[\varepsilon_\lambda^h (c_D^h - \tau^{lh} c) - \frac{\lambda^h B^h}{(n+2)\,L^h} c_D^h\right]\right\}\frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h}$$

$$= -\frac{L^h}{2b(1-e)}\left\{\lambda^h B^h (c_D^h - \tau^{lh} c) + c_D^h + \frac{\left[(n+2)L^h - 1\right]}{(n+2)\,L^h}\lambda^h B^h c_D^h - \lambda^h B^h \tau^{lh} c\right\}\frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h}$$

As L and/or n get large, the third term in the big brackets tends to $\lambda^h B^h c_D^h$ and the expression can be written as:

$$\frac{\partial (r_X^{lh})^2}{\partial c \partial \beta^h} = -\frac{L^h}{2b(1-e)}\left\{2\lambda^h B^h (c_D^h - \tau^{lh} c) + c_D^h\right\}\frac{\partial\left(\lambda^h B^h\right)}{\partial \beta^h}$$

$$< 0.$$

6.2. Definition of Gravity Variables

Source for the Gravity Dataset: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8, see also Head, Mayer and Ries (2010) "The erosion of colonial trade linkages after independence", Journal of International Economics, 81(1):1-14. For description of variables see table 10.

Variable	Description	CEPII Source
GDP	destination GDP in 2005 (nominal)	World Bank World Development Indicators (WDI)
GDP per capita	destination GDP per capita in 2005 (nominal)	World Bank World Development Indicators (WDI)
foreign supply potential	as defined in the main text	n/a, provided by Thierry Mayer
distance	population-weighted great circle distance between large cities of the France and export destination	CEPII distances database http://www.cepii.fr/anglaisgraph/bdd/distances.htm
contiguity	1 if export market shares a border with France	CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/
colonial post-45	1 if there was a colonial link with France post-1945	CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/
common language	1 if official language of export destination is French	CEPII distances database http://www.cepii.fr/anglaisgraph/bdd/distances.htm
GATT/WTO membership	1 if export destination is a member of the WTO	WTO website www.wto.org
RTA membership	1 if export destination has an RTA with France	Table 3 of Baier and Bergstrand (2007) supplemented with the WTO web site (http://www.wto.org/english/tratop_e/ region_e/summary_e.xls) and qualitative information contained in Frankel (1997).
common legal system	1 if export destination shares has the same legal system as France	Andrei Shleifer's website: http://post.economics.harvard.edu/faculty/shleifer/ Data/qgov_web.xls.
common religion	1 if export destination shares a common religion with France	CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/
membership of a common currency area	1 if export destination is a member of the euro	updated and extended version of the list provided by Glick and Rose (2002)

Table 10 – Definition of Gravity Variables from CEPII Gravity Dataset