Quality versus price competition across countries and industries
Preliminary version

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Abstract

Recent models of international trade with heterogeneous firms suggest a precise sorting of exporters into foreign markets. Only the bests can manage to export to difficult markets. As shown by Baldwin and Harrigan, *AJE* 2011, this prediction can serve to discriminate between price and quality competition. However, the few attempts to provide a systematic classification between these two determinants of firms' relative export performances have failed to find a clear pattern across countries and industries. Our paper sketches a theoretical framework predicting that price competition should prevail in countries specialized in high quality goods. Inversely, quality competition should be more important when the specialization is on low quality goods. Using a worldwide bilateral trade database, we propose a classification of export flows according to the nature of competition and find empirical support to our theoretical predictions.

Keywords: Competitiveness, heterogeneous firms trade theory, quality, product differentiation.

JEL Classification: F12, F14.

1 Introduction

Improving firms' export performances and coping with foreign competition is a serious concern for most policy makers and manufacturers. This is especially the case in high income countries, most of them having lost significant market shares in the manufactured goods world market during the last decade and experienced a rapid deindustrialization process. In this context, economists and public agencies are mobilized to provide policy recommendations aiming to improve competitiveness. In a way, this is a simple task because there is not oodles of determinants of competitiveness. If a firm (or an industry in a given country) cannot manage to maintain its market share it must be because the variety it proposes on the market is too expensive or its quality is too low. Of course, determining whether quality or price competition is crucial because different diagnosis will involve different policy recommendations.

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Many recent research papers have emphasized the role of vertical differentiation in international trade. Most of them rely on comparisons between export prices for the same products to determine the specialization of countries along quality ladders.[1]

Models of international trade allowing for firm-level heterogeneity provide an accurate framework to study the determinants of relative firms' exports performances. Baldwin and Harrigan (2011) and Baldwin and Ito (2008) propose a simple method to classify the HS categories according to the nature of the competitiveness prevailing in international trade: quality competition versus price competition.[2] The intuition for this test is simple. In an price competition model, such like Melitz (2003), the most performant firms in a country are the ones charging the lowest price. Then, since only the best firms manage to export to a difficult market, the country-level export price should decrease with the distance of the destination country. Inversely, the relationship between export price and distance should be positive if quality competition'prevails. We find little evidence to conclude for price or quality sorting in Baldwin and Ito (2008). More they do not clearly identify why the nature of competition differs from an industry to another and observe that in the huge majority of the industries quality competition prevail in some countries while price competition dominates in other places. Empirical research, based on firm-level data, is more successful in providing evidence supporting the quality sorting hypothesis. Considering French exports of Champagne as a case study, Crozet, Head and Mayer (2009) find that average prices and the average quality of exported wines are higher on more difficult market. Manova and Zhang (2009) also show that Chinese firms that export to more destinations charge higher prices. Comparable evidence emerge from firm-level studies for Mexico (Verhoogen, 2008 and Iacovone and Javorcik 2008), Columbia (Kugler and Verhoogen, 2008 and Hallak and Sivadasan, 2008), India, USA and Chile (Hallak and Sivadasan, 2008). Note that many of these firm-level studies rely on data from developing and emerging countries. This clearly suggest that quality competition does not necessarily go with a specialization in higher quality varieties, but may also prevail in countries mainly specialized in lower quality.

Our paper is based on the theoretical framework developed first by Melitz (2003) and then by Baldwin and Harrigan (2011). One aim of our theoretical model is to reconcile these models that are characterized by inverse predictions: the price-sorting versus the quality-sorting of the firms. We show how intermediate predictions can be obtained with simple hypotheses. We propose an example of modelling which predicts that quality competition should prevail among firms that produce relatively cheap good with low quality varieties. Inversely, price competition should drive the sorting of firms into foreign markets. We test then this conclusion using the bilateral worldwide trade database for the period 1995-2007 and the 50th largest exporting countries. We provide strong evidence supporting our theoretical prediction.

The paper proceeds as follows. Section 2 presents a simple theoretical framework. In section 3, we describe the database and the our empirical methodology. We also verify in this section that our data correctly reproduces the stylized fact emphasized by Schott (2004, 2008) and Fontagne, Gaulier and Zignago (2008) which related positively countries' gdp per capital and the relative price of their exports. Section 4 discusses the empirical results and we conclude

[1] Major contributions in this field include Schott (2004), Hummels and Klenow (2005) and Fontagne, Gaulier and Zignago (2008) who study the determinants of countries' specialization along quality ladders. Hallak (2006) and Choi, Hummels and Xiang (2009) investigate the demand side of the story, stressing the influence of income level and income distribution of the importing countries on import prices.

[2] The framework proposed by Baldwin and Harrigan (2011) is very simple. Sutton (2007), Hallak and Sivadasan (2009), Kugler and Verhoogen (2008) and Johnson (2009) propose more sophisticated models where quality and productivity jointly determine firm-level export performances.

with section 5.

2 Theoretical framework

This section proposes a simple general framework, based on Melitz (2003) and Baldwin and Harrigan (2011). It enlightens how the relationship between country-level average export prices and the accessibility of the destination markets reveals the relative importance of price and quality competition.

2.1 General framework

We consider a single category of good and retain the standard Krugman-Dixit-Stiglitz assumption of monopolistic competition. We suppose that each firm produces a single variety, drawing a firm-specific technology, $\epsilon > 0$ that determines jointly the quality of the variety and the corresponding production cost. We consider that producing higher quality always entails higher costs. We set the "capability" parameter, ϵ, such that it is positively related to both the marginal cost and the quality of the variety. All varieties enter into a CES utility function, U_d, where subutilities are positive functions of the quantity and the quality of a variety.

$$U_d = \left(\int_{i \in \Theta_d} [s_i(\epsilon) q_{id}(\epsilon)]^{\frac{\sigma-1}{\sigma}} \, di \right)^{\frac{\sigma}{\sigma-1}} \qquad \sigma > 1 \tag{1}$$

In this equation, Θ_d is the set of all varieties available for consumers in country d, σ is the elasticity of substitution, $q_{id}(\epsilon)$ is the quantity of variety i consumed and $s_i(\epsilon)$ is its measured quality. Assuming all firms consider the price index in each market fixed, firms adopt a mill-pricing strategy such that fob price is a constant mark-up over the marginal cost. We note c the marginal cost. The quality level and the marginal cost of a variety i are entirely determined by the capability level drawn by the firm, ϵ. We thus drop the subscripts i in the following. The fob price for a given exporter is $p_o(\epsilon) = c(\epsilon)\sigma/(\sigma - 1)$. Because we have considered that higher quality can only be attaint at some cost, we have:

$$\frac{\partial c(\epsilon)}{\partial \epsilon} \geq 0 \Rightarrow \frac{\partial p(\epsilon)}{\partial \epsilon} \geq 0 \text{ and } \frac{\partial s(\epsilon)}{\partial \epsilon} \geq 0$$

Noting τ_{od} the iceberg trade cost between countries o and d, we get from (**??**) and the mark-up equation the usual demand function, in country d, for a given variety produced in o:

$$x_{od}(\epsilon) = [p(\epsilon)/s(\epsilon)]^{1-\sigma} X_d \left(\tau_{od}/P_d\right)^{1-\sigma}. \tag{2}$$

Where P_d is the price index in the destination market d which captures the toughness of competition; as P_d decreases, competition is tougher in country d and it is harder for a typical exporter to sell large quantities on this market. X_d is the total expenditure in country d and τ_{od} is the bilateral "iceberg" trade cost. With mill-pricing, export revenues have to be larger than σ times the fixed cost of exporting in order to ensure positive profits. Noting F_d this fixed cost, the positive export profit condition takes the form:

$$\pi_{od}(\epsilon) \geq 0 \Rightarrow [p(\epsilon)/s(\epsilon)] \leq A_{od}, \tag{3}$$

Where $A_{od} = \left[\left(X_d/P_d^{1-\sigma}\right) / \left(\sigma F_d \tau_{od}^{\sigma-1}\right)\right]^{1/(\sigma-1)}$. The inequality (**??**) shows the selection process of firms across export markets. The A_d term on the right-hand side represents the degree of accessability of the destination market as perceived by potential exporters in country o, while the left-hand side is the (fob) quality-adjusted price of a variety with capabilities ϵ. On a given market, firms with a technology which is sufficient to reach an adjusted price lower than A_{od} will manage to export. As the foreign market becomes more difficult, A_{od} decreases and the firms with the highest quality-adjusted price stop exporting. As a consequence, the country-level average quality adjusted price of exports to some destination must be a decreasing function of the accessability of this export market; average export quality adjusted price is lower on difficult market and higher on more accessible ones.

2.2 Inferring the nature of competitiveness from average export prices

We cannot bring this general model to the data because trade data do not provide us with any information on the quality of the exported products. But we do observe average export (fob) prices for each trade relationship. And a simple analysis of the pattern of average export prices across destinations countries may be used to reveal the main determinants of relative firms' performances in a given exporting countries. More precisely we can use this framework to infer whether quality rather than price is the main determinant of competitiveness.

In our general set-up, the relationship between the observable export prices and the accessibility of the destination market is summarized in equation (**??**). The slope of this relationship depends uniquely on the cost-quality relationship. Assuming that higher quality must be associated with more expensive technology, and consequently with higher price, certainly makes sense. But even though, quality upgrading might be profitable or not.

Drawing a technology associated with a higher quality (i.e. a high ϵ) will be a bad news if the marginal cost of production rises more rapidly than the marginal utility of quality or, saying differently (and given our specific modelling choices), if the marginal cost of quality upgrading is decreasing. In such a case, low cost firms are relatively more competitive and firms with the relatively high cost technology cannot export to the least accessible destinations. Because of this sorting effect, the average export price from a given origin country o decreases with the difficulty of the destination market. Formally, price competition determines firms' performances abroad if $\partial\left[p(\epsilon)/s(\epsilon)\right]/\partial\epsilon > 0$. Of course, homogenous quality models of trade, like Melitz (2003), are extreme examples of this case. Here, all firms, whatever their marginal cost, produce the same quality. The quality adjusted price of the variety is just proportional to its nominal price, which is a positive function of ϵ.

Inversely, if the marginal cost of quality upgrading is decreasing, quality rises always more rapidly than the marginal production cost. Then, better quality always worth its cost and the quality sorting drives the selection of firms. This is the case exposed by Baldwin and Harrigan (2011). They assume a cost-quality relationship of the form: $s(\epsilon) = c(\epsilon)^{1+\theta}$, with $\theta > 0$. Then, the quality adjusted price is a fraction $\sigma/(\sigma-1)$ of $c(\epsilon)^{-\theta}$ and decreases with ϵ. Since $\partial\left[p(\epsilon)/s(\epsilon)\right]/\partial\epsilon < 0$, the firms proposing the most expensive varieties have better export performances. The sorting of firms across export destinations is driven by quality competition and the average export price is larger on destinations that are harder to reach for origin-country exporters.

There is no reason however for having a restrictive relationship between the two elements of firms' capabilities (quality and marginal cost), such that the influence of ϵ on quality adjusted price is monotonous. It could be, for instance, that the marginal cost of quality decreases when quality is low but increases for high level of quality. Indeed, when quality is very low, some quality upgrading may be attained at very minor cost, while improving again the quality of a top-level quality variety may require extremely expensive investments.

If the function of ϵ, $[p(\epsilon)/s(\epsilon)]$ is bell-shaped, then two values of ϵ might satisfy the export cutoff condition, $[p(\epsilon)/s(\epsilon)] = A_{od}$. Then, quality sorting drives the selection of firms across destination markets if ϵ (and thus prices) are relatively low. But price sorting dominates for relatively expensive varieties.

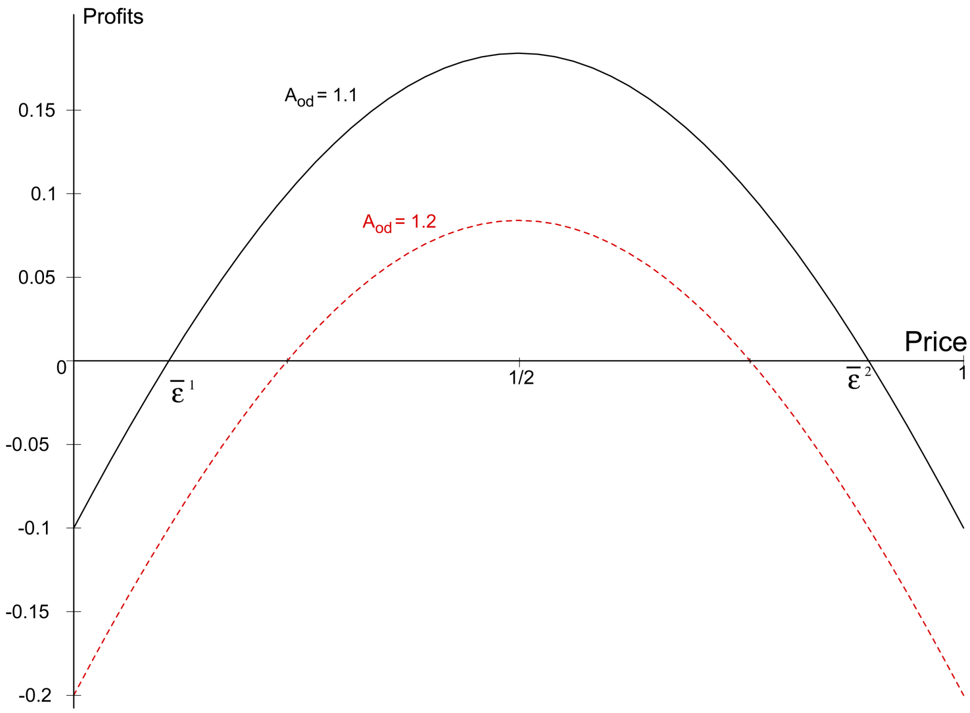
To fix ideas, let us propose an analytical example. Imagine that $c(\epsilon) = \epsilon(\sigma - 1)/\sigma$, and the cost-quality function is:

$$s(\epsilon) = \epsilon e^{\epsilon^{\beta} - \epsilon}, \quad \beta > 1$$

To be more specific, we set $\beta = 2$. This is a very particular specification, but it respects the initial requirements: $\partial c(\epsilon)/\partial \epsilon > 0$ and $\partial s(\epsilon)/\partial \epsilon > 0$. Now, the quality adjusted price is $[p(\epsilon)/s(\epsilon)] = e^{\epsilon - \epsilon^2}$, which is a non-monotonous function of ϵ. The quality adjusted prices rises with ϵ until $\epsilon = 1/2$ and decreases afterwards. In other words, higher quality is associated with higher profits when it is relatively low but not when it is high. In this example, two values of ϵ (and thus prices) ensure zero profits in a given destination market d:

$$\bar{\epsilon_{od}}^1 = [1 + \sqrt{1 - 4\ln(1/A_{od})}]/2, \quad \text{and} \quad , \bar{\epsilon_{od}}^2 = [1 - \sqrt{1 + 4\ln(1/A_{od})}]/2.$$

Figure 1: The price-profit relationship



All firms with a price (and a corresponding quality) between $\bar{\epsilon_{od}}^1$ and $\bar{\epsilon_{od}}^2$ expect positive profits on market d and do export to this country. Firms with a technology $\epsilon < \bar{\epsilon_{od}}^1$ have a too low quality to be profitable. Similarly, those with $\epsilon > \bar{\epsilon_{od}}^1$ are too expensive to be profitable. None of these firms export to country d.

The effect of A_{od} on the zero-profit cut-off prices is ambiguous in this case: $p(\bar{\epsilon_{od}}^1)$ is an increasing function of the attractiveness of the destination market (A_d), while $p(\bar{\epsilon_{od}}^2)$ is a decreasing function. Figure **??** plots the profits against the price of the variety, for different values of A_{od}. As the market becomes more difficult to reach, $\bar{\epsilon_{od}}^1$ increases and $\bar{\epsilon_{od}}^2$ decreases and less firms export. The firms with the lowest price, as the ones with the highest one leave the export market.

In this framework, firms' selection operates simultaneously at the two tails of the distribution of firms' capabilities. Both quality and price competition participate to firms' selection, and the relationship between the accessibility of destination markets and the average export prices is fairly unpredictable.

This relationship might be informative however if we consider that firms in a given country do not draw their capabilities (i.e. the parameters ϵ) on the full distribution, but only on a subset. We can consider for instance a two regions world, with region S characterized by the fact that firms draw low-range ϵ, i.e. $\in [0, 1/2]$. In the other region, N, firms have access to a better technology, higher quality and more expensive inputs. They draw their ϵ in the range $\in [1/2, 1]$. Varieties produced in region S are characterized by a smaller price and a lower quality than those produced in region N. But they have not necessarily a lower quality adjusted price and are not less profitable. Then, region S, we do observe the Baldwin and Harrigan (2011) prediction: Average export prices per destination increase as the destination country becomes less accessible. Inversely, the Melitz (2003) prediction is verified for region N: Average export prices are negatively related to destination countries' accessibility.

Note that we can present this finding differently: quality competition is a major determinant of firm-level export performances in countries specialized in low quality varieties, while Price competition dominates in countries specialized in high quality productions. The remaining part of the paper will provide empirical evidence supporting these predictions.

3 Database and empirical method

3.1 The data

Our main datasource is BACI, the international trade database at the product-level, developed by Gaulier and Zignago (2010) .[3] We focus on the period 1994-2007.[4] BACI draws on the UN COMTRADE database and provides consistent information on bilateral trade. It takes into account both declarations of the exporter and the importer to compute a single observation for each bilateral trade flow. For each product, classified by the 6-digit Harmonized System (HS6), and each country pair, BACI provides data on free-on-board traded values and quantities. This reconciliation is first based on the treatment of CIF reported values by importers to enable comparisons with FOB values of exporters and, second, on the estimated reliability of each reporting country. It covers trade for more than 200 countries and 5,000 products.

Because our empirical analysis require a sufficient number of observations per trading country and product, we eliminate from the original data the smallest exporters. We restrict the sample to the 50 largest exporting countries in BACI for the period: the main OECD members and 27 emerging countries. All together, these countries account for 90% of the total trade reported in BACI and 80% of the total number of observations. The importers are all the

[3] `http://www.cepii.fr/anglaisgraph/bdd/baci.htm`.

[4] The original data covers the period 1994-2007, but the data for some countries are missing in 1994.

destination countries in BACI, except Hong-Kong and Singapore because these two countries reexport a quite large part of their imports.

A prerequisite for the empirical analysis is to restrict the database to the industries whose characteristics fit to the main theoretical assumptions. We use three procedures to drop the sectors we are not interested in. First, we eliminate non-manufacturing industries. We use the Lall (2000) classification to identify manufacturing HS-categories. Second, we focus on industries producing differentiated goods. The conservative Rauch (1999) classification of products is used to drop the homogeneous HS-categories.[5] This classification categorizes the products depending on whether they are exchanged on a organized market or not. We retain the latter group, which includes the goods that are usually branded (and thus considered as "differentiated") and the ones that are not traded on organized exchanges, but for which one can find a 'reference price' regularly quoted. Lastly, we go further than Rauch's classification in identifying differentiated goods. Indeed, Rauch categorizes the products according to ex ante characteristics. But a product might be branded and/or reference priced, while the firms in the corresponding industry may produce quite similar varieties with very comparable price. Then, we drop from our sample the HS-categories for which we do observe a significant degree of product differentiation. We drop the HS-categories whose variance of unit values across country pairs belongs to the first decile in our sample.

In addition, we must be sure that we have sufficient observations, and that they are consistent enough to run regressions by exporting country and HS-categories. For each exporting country we restrict the sample to the HS6 where we observe exports to more than 10 destinations. We also exclude the trade flows showing extreme unit values, in order to limit the consequence of measurement errors in trade values or quantities that generate inconsistent proxies for trade prices. To do so, we compute the difference between the unit value of each trade flow and the weighted average unit value of the corresponding HS-category, and keep the observations between the tenth and the ninetieth percentiles of the distribution of this variable.

The following table shows the impact of each step on the total number of observations and HS-categories in the sample.

Table 1: The procedures of data selection

Procedures	Nb. of obs.	Nb. of HS6
Only the 50 largest exporters	62,540,523	4,187
Manufacturing HS6 (Lall (2000))	42,788,931	2,841
Non-Homogeneous HS6 (Rauch (1999))	42,535,823	2,788
Differentiated HS6 (large variance)	39,169,262	2,513
Number of partners > 10	38,996,401	2,511
Non-extreme values	31,197,120	2,475

Our empirical methodology also requires data on bilateral distances and country size. Distances are provided by the Mayer and Zignago (2011).[6] The GDP and GDP per capita of each importing country are collected in the Penn World Tables.

[5] updated data are available on Jon Haveman's web page: http://www.macalester.edu/research/economics/page/haveman/trade.resources/tradedata.html.

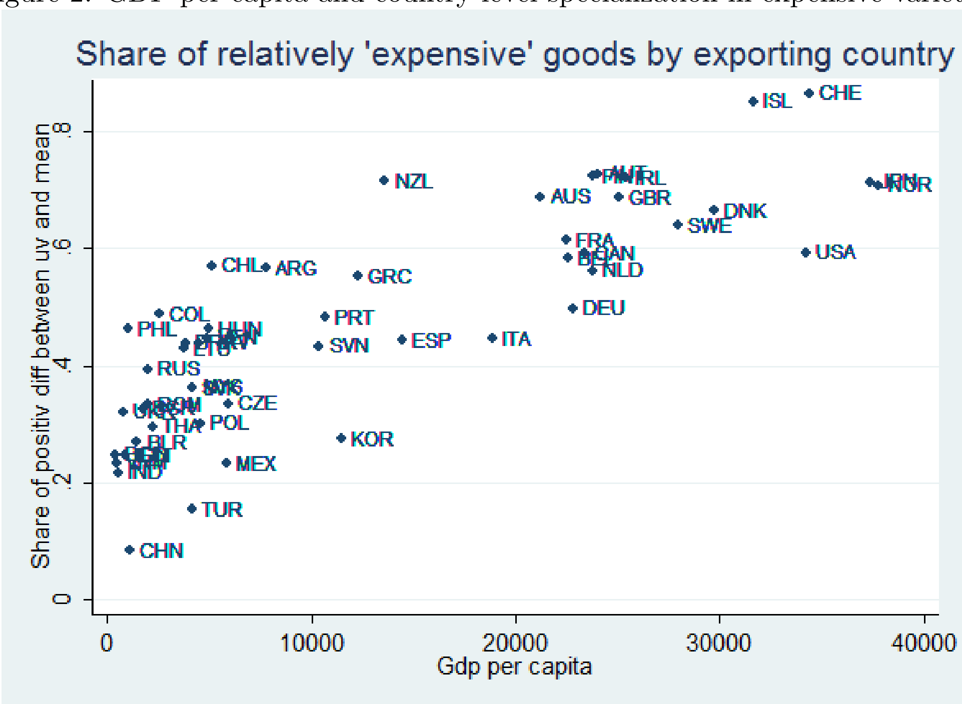
[6] http://www.cepii.fr/francgraph/bdd/distances.htm.

3.2 An overview of vertical specialization

It is well established result that richer countries export, on average, more expensive goods. This result is quite intuitive and empirically confirmed by several studies including Schott (2004), Hummels and Klenow (2005) and Fontagne, Gaulier and Zignago (2008).

In order to check the consistency of our database, we verify it replicates this stylized fact. To do so, we calculate the difference between the unit value of a given export flow of product k to a destination d and the weighted average price of exports of k to country d. Then, we compute the average of these differences for each exporter and each good, weighted by the value of the flow. A positive value denotes that country o exports of good k are more expensive, on average on the world market, than the ones of its competitor, while a negative values means that o exports of k are relatively cheaper. Calculating, for each exporting country, the share of the positive values gives an idea of its vertical specialization on the world market. The Figure (??) plots this share against the GDP per capita of the exporting country. The figure exhibits a quite sharp positive slope between the two variables. This confirm that the regular empirical finding that richer countries specialize in higher quality varieties also prevails with our database. It appears, for instance, that only 10 percent of the products exported by China are more expensive than the average competing export flow, in the markets where China is present. Inversely, almost in 90% of the product it sells abroad, the Swiss manufacturing industry export varieties that are more expensive that the ones of its competitors for the same product on the same market. As discussed in the previous section, this specialization pattern does not necessarily mean that quality competition does not matter for Chinese firms nor that the ability to produce at relatively low prices is not determinant for the export performances of Swiss firms.

Figure 2: GDP per capita and country-level specialization in expensive varieties



3.3 Empirical method

The method in this paper is similar to the empirical work in Baldwin and Harrigan (2011) and Baldwin and Ito (2008). We estimate the influence of market accessibility of destination countries (d) on the average export price for a given exporter (o) and a product category (k). The sign of this relationship should tell us whether price or quality competition explains most relative trade performances of firms in the exporting country.

If quality sorting drives firms' selection, all variables that contribute negatively to the destination market accessibility should have a positive influence on origin country export prices. Inversely, we expect that these variable have a negative influence if price-sorting dominates. Baldwin and Harrigan (2011) show that US export prices across increase with the distance between the USA and the destination country, and decrease with the GDP, the GDP per capita and the remoteness of country d. All these results, obtained on a database pooling together 4,886 HS-10 product categories, confirm the prevalence of quality-sorting. The purpose of our empirical analysis is slightly different however. We aim to estimate a price-accessibility relationship for each exporting country and each product separately, in order to get a categorization of the nature of competition across countries and products, as Baldwin and Ito (2008). Hence, we cannot, has Baldwin and Harrigan (2011), estimate separately the influence of the different components of market accessibility on export prices because it will certainly provide us with too many inconsistent results. Baldwin and Ito (2008) rely only on the sign of the estimated coefficient of distance on export prices to discriminate between quality and price competition.[7] We consider a more comprehensive proxy of the inverse of destination country accessibility: the ratio of the distance over the GDP of the importer, $ln(Dist_{od}/GDP_{dt})$. This ratio is lower for closer and bigger countries that are easier to reach. We estimate the following price equation, separately for each exporter o and HS-category k:

$$ln(p_{okdt}) = \beta_0+\beta_1 ln\left[\frac{Dist_{od}}{GDP_{dt}}\right]+\beta_2 ln(GDP_{dt}/Pop_{dt})+\beta_4 ln(MeanPrice_{kdt})+\beta_5 YFE+\epsilon_{d,t}, \quad (4)$$

where p_{okdt} is the unit value of the trade flow between countries o and d, for the HS-category k at year t. $Dist_{od}/GDP_{dt}$ is our proxy for the difficulty to access a market; the ratio of the distance between o and d over the GDP of d at time t. GDP_{dt}/Pop_{dt} is the GDP per capita of the importer at year t, $MeanPrice_{d,t}$ is the weighted mean price of imports of the product k in the destination market at time t (the weight is the value of the import flow) and YFE is a vector of year fixed-effect. In this equation, the GDP per capita is a demand-related control aiming to capture the relative consumers' preference for high quality varieties in richer countries, documented by Hallak (2006) and Choi et al. (2009). The average price of imports on each market captures the competition pressure on this market, which appears in the model with the CES theoretical price index, P_d. Baldwin and Harrigan (2010) also rely on a proxy to control for the price index. They use the standard remoteness index, which is, for each destination, the distance weighted sum of GDPs of all surrounding countries. We decided to proxy the price index with the average price of imports for two reasons. Fist, the computation of this variable is straightforward and does not require any arbitrary assumption on the trade cost function or the measurement of intra-national distances. Second, it is a comprehensive measure that encompasses the consequences of the sorting of firms across destination, and their pricing and

[7] Of course, their estimates control for the importing country GDP and GDP per capita.

quality differentiation strategies. On the other hand, our proxy misses an important part of competition pressure because it does not include the prices of the local firms on their domestic market. Our variable of interest is $ln(Dist_{od}/GDP_{dt})$. If the coefficient β_1 is negative, we can conclude that price-competition determines the export performances of exporters of good k in country o. A positive sign for

β_1 will denote a that quality-competition dominates.

4 Empirical results

We perform $95,670$ estimates of (**??**) and obtain a coefficient of interest, $\hat{\beta_{1,ok}}$, for each exporter and HS-category. Some of these estimated coefficients have an unexpectedly large value. We retain for further analysis the coefficients $\hat{\beta_{1,ok}}$ whose student statistic lies in reasonable range. We restrict the sample to the exporter-product pairs for which $t(\hat{\beta_{1,ok}}) \in [-25; 25]$. This procedure excludes 30 outliers and leave us with 95,640 estimated $\hat{\beta_{1,ok}}$. Recall that positive coefficients denote that quality competitions drives the sorting of firms, negative coefficients are associated with price-sorting and non-significant coefficients should correspond to "unclassifiable" HS-categories.

We first provide examine distributions of these estimates across products and countries in order to see whether some product or country-level characteristics influence the nature of competition. In a second subsection we explicitly test our theoretical prediction.

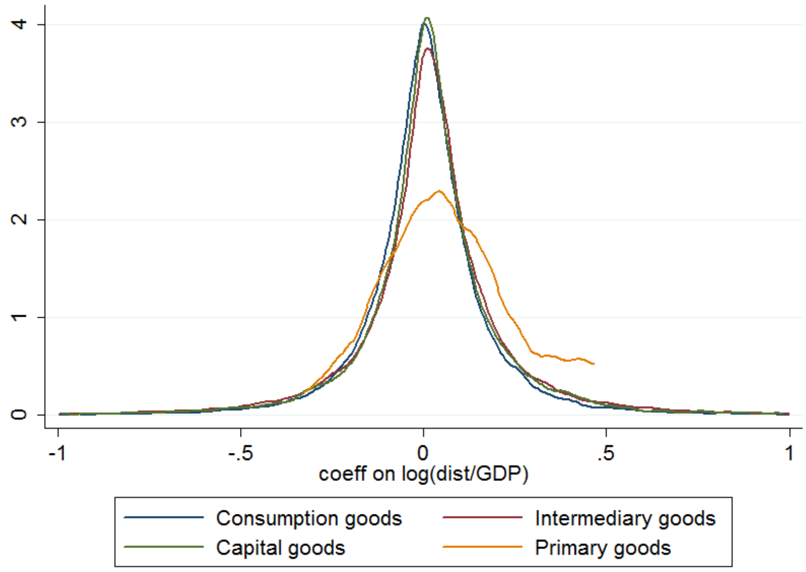
4.1 Looking for product and country-specific determinants of the nature of competition

As for Baldwin and Ito (2008) a simple inspection of the $\hat{\beta_{1,ok}}$ fails to reveal a simple and systematic pattern governing the distribution of these estimates. Basic intuition might suggest that quality competition should dominates in industries producing more sophisticated goods and/or in richer countries, specialized in higher quality productions. Our theoretical analysis, however, suggests that there is no reason to observe such correlations. This is confirmed by the variance decomposition analysis shown in Table (**??**). This table reports the share of variance (R^2) of the estimates $\hat{\beta_{1,ok}}$ that is explained respectively by country and product fixed effects. The R^2 reported in this table are extremely small, which suggests that country and industry characteristics do not determine whether quality or price competition prevail. The following results confirm this finding.

Table 2: Variance decomposition of estimates $\hat{\beta_{1,ok}}$: Explanatory power (R^2) of different set of fixed effects

	Country fixed effects	HS-category fixed effects
All $\hat{\beta_{1,ok}}$	0.0001	0.0003
Significant $\hat{\beta_{1,ok}}$	0.0002	0.0005

Figure 3: Distributions of $\hat{\beta_{1,ok}}$ by product categories



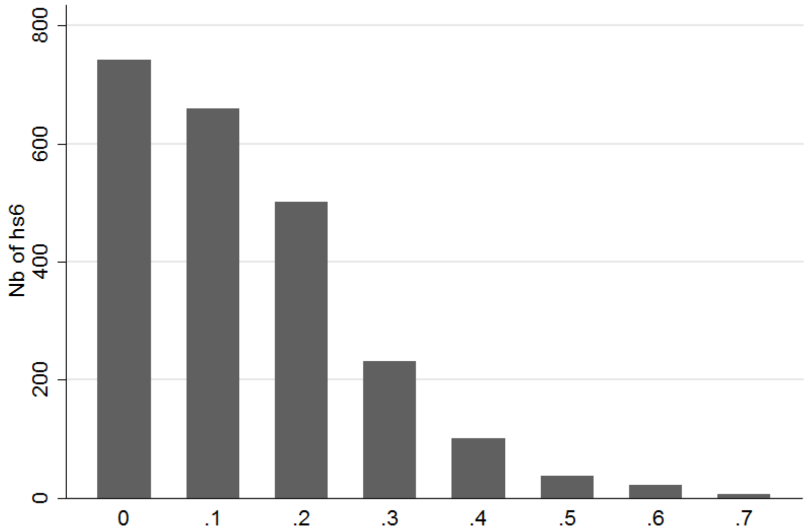
4.1.1 Results by product categories

Figure (**??**) plots de distribution of the 95,640 estimates $\hat{\beta_{1,ok}}$, by class of products. Using the classification by Broad Economic Categories (BEC) proposed by the UN statistics division, we distinguish between consumption, capital, intermediary and primary goods. All the distributions, but the one for primary goods for which we do not have many observations, have a quite big kurtosis and are roughly centered around zero: in many cases, the type of competition cannot be clearly identified and the are "unclassifiable". These distributions are not exactly the same however. The Kolmogorov Smirnov tests for each pair of BEC categories reject the hypothesis that the coefficients $\hat{\beta_{1,ok}}$ for consumption, intermediary and capital product categories have the same distribution (the test cannot reject at the 1% level of confidence, the equality of the distributions for intermediary and primary goods and for capital and primary goods). More importantly, quality competition seems to be more frequent for intermediary goods and, in a less remarkable proportion, for capital goods than for consumption goods.

Of course, it is hard to say which of these product categories is the most sophisticated and for which of them the final demand is the most sensitive to differences in quality. Somehow, the fact that quality sorting is slightly more prevalent for capital and intermediary goods than for consumption goods might make sense. The statistical difference between the three distributions seems to be too weak however to constitute a sound evidence that the type of competition is mainly determined by the characteristics of the products. Another evidence suggesting that product characteristics have not a great influence on whether price or quality competition prevails is the very weak coincidence between the estimates $\hat{\beta_{1,ok}}$ for the same product across countries. To examine whether a given product might be classified has a quality or price-competition good, we compute the following index of coincidence:

$$C_k = 2\left[\left(\frac{\text{\# majority signs for } k}{\text{\# estimated coefficients for} k}\right) - 1/2\right].$$

Figure 4: Distributions of the coincidence index (all $\hat{\beta_{1,ok}}$)



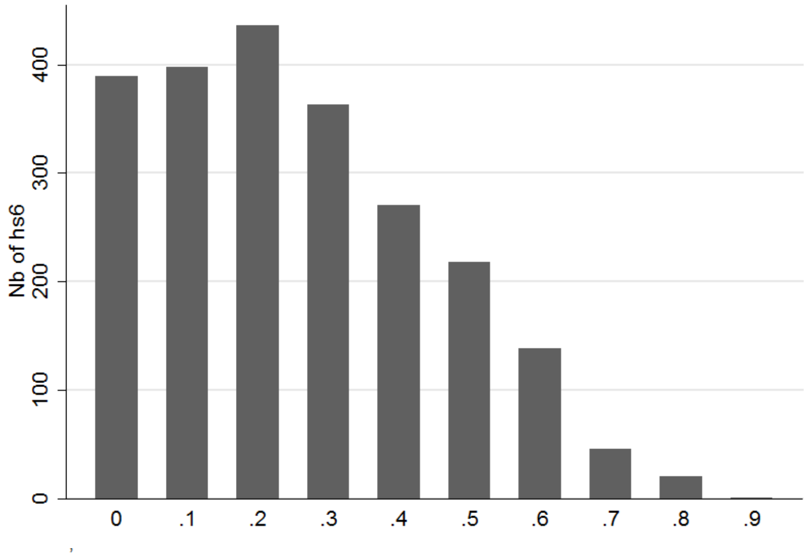
In words, the index C_k represents the greatest proportion of matching signs of $\hat{\beta_{1,ok}}$, for a given k across countries o. The index is normalized in order to range between 0 and 1. It will be equal to 1 if all coefficients $\hat{\beta_{1,ok}}$, estimated for the good k have the same sign, and zero if exactly 50% of the coefficients are positive and 50% are negative. These index are very low. The average value across the 2242 HS-categories in our database is only 0.16. The average weighted by the number of countries exporting the HS-category is 0.18 and the average weighted by the world export value is 0.22. More details are given in Figure (**??**) which shows the distribution of this index. More than 700 HS-goods have a coincidence index lower than 0.1 and the products for which the percentage of majority signs exceeds 75% of the total number of estimates (i.e. with a coincidence index above 0.5) is only 2.52% of our sample. The distribution of the coincidence index computed with significant $\hat{\beta_{1,ok}}$ only is shown in Figure (**??**). Dropping non-significant $\hat{\beta_{1,ok}}$ improve distinctly the index, but it still have a very small number of HS-categories where the nature of competition is consistent across a large number of countries. The average index weighted by the total volume of trade is 0.28 and the share of HS-category with a coincidence index above 0.5 raises only to 13.78%.

4.1.2 Results by countries

We show in Figure (**??**) the kernel distributions of our $\hat{\beta_{1,ok}}$, for different groups of countries: High income countries, Asiatic emerging countries, Latin American countries and Central European countries. No clear feature emerges from these distributions. All of them are more or less centered around zero. More, it appears that the distributions for $\hat{\beta_{1,ok}}$ is very similar to the one for emerging Asia, but significantly different than the ones obtained with Centra European and Latin American Countries. Though, those countries are much closer to high income countries in many respects than developing Asia.

This is confirmed by the statistics reported in Table **??**. The fist column shows the average value of $\hat{\beta_{1,ok}}$, and the the standard deviation of these estimates is given in column 2. An specific

Figure 5: Distributions of the coincidence index (significant $\hat{\beta_{1,ok}}$)



difficult for averaging these estimates is that some of them might be large in absolute value but not statistically different from zero. More generally, as for a meta-analysis, we must take into account the fact that the coefficients have been estimated on distinct samples of different size, and are more or less significant. We show in the third column of the table, the average $\hat{\beta_{1,ok}}$, weighted by the inverse of the standard error of $\hat{\beta_{1,ok}}$, which gives more importance to more significant estimates. In the last three columns, we show respectively the share of significantly positive coefficients, the share of significantly negative coefficients and the share of coefficients that are not significantly different from zero.

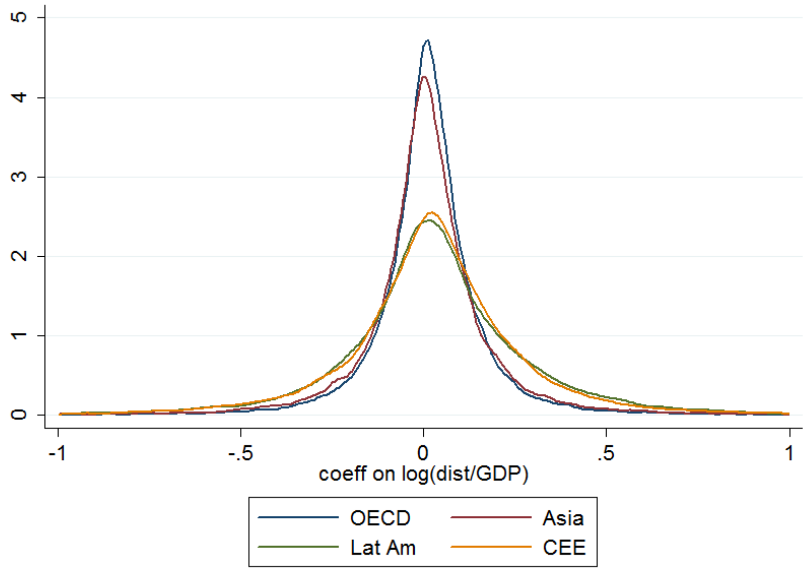
Table 3: Statistics on $\hat{\beta_{1,ok}}$ for the 50th largest exporters in BACI (1995-2007) by exporting zone.

	Mean $\hat{\beta_{1,ok}}$	Std $\hat{\beta_{1,ok}}$	W. Mean $\hat{\beta_{1,ok}}$	$t(\hat{\beta_{1,ok}})$ > 1.96	$t(\hat{\beta_{1,ok}})$ < -1.96	$\lvert t(\hat{\beta_{1,ok}}) \rvert$ < 1.96
All HS-categories						
World	0.02	0.26	0.02	27.76%	18.49%	53.75%
High Income	0.01	0.21	0.02	30.00%	19.21%	50.79%
Asia	0.01	0.22	0.00	25.95%	20.88%	53.17%
Lat. America	0.04	0.33	0.06	27.76%	18.49%	53.75%
C. E. Europe	0.03	0.33	0.03	25.99%	16.54%	57.47%

Authors' calculations based on BACI (CEPII).

In a majority of cases, we cannot discriminate between the two alternative modes of competition. On the whole sample, 53.75% of the estimates are not statistically different from zero. This figure is very close to the one obtained by Baldwin and Ito (2008). Limiting their analysis to 9 exporting countries, they find a share of unclassified cases of 53.2%, with a maximum of

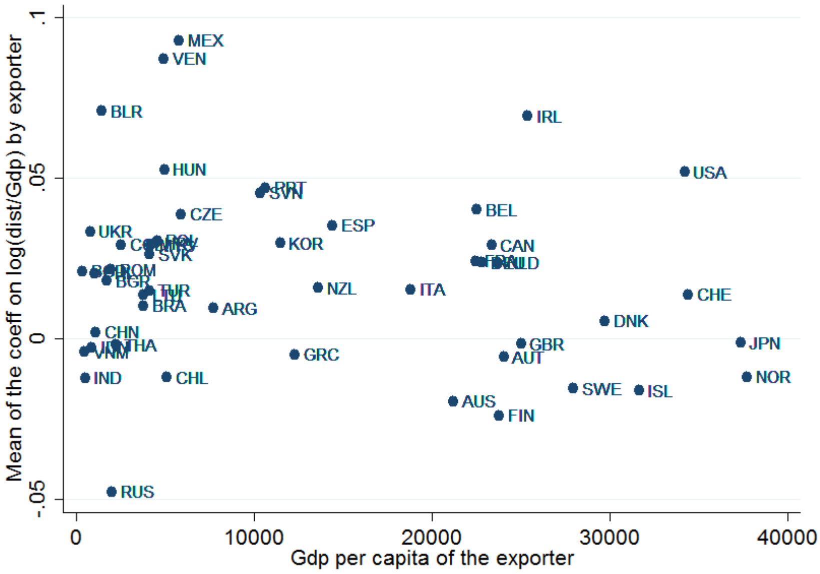
Figure 6: Distributions of $\hat{\beta_{1,ok}}$ by geographical zones



60% for the USA and a minimum of 33% for Italy. Almost 28% of the HS-categories in our sample display a significantly positive coefficient and the corresponding exports as driven by quality competition, and 18.5% that reveal a domination of price competition. This is a quite important difference with Baldwin and Ito (2008) who find a share of price-competition goods of lower than 7%.

We see that the weighted mean of $\hat{\beta_{1,ok}}$ slightly differs between export zones. Asia faces the lowest weighted mean (0.00) and the highest share of price-competition goods. As suggested by figure (**??**), the weighted mean for high income countries is not the highest (0.02), and their share of price-competition goods, reported in the fourth column of Table **??**, is not the lowest. This share is 19.21% which is almost one percentage point less than the corresponding figure for the world average. But high income countries also exhibit the highest rate of significantly positive coefficients. While less than 28% of the coefficients denote a domination of quality competition on the world sample, this proportion is 30% for high income countries. This mixed evidence is interesting. As confirmed by Figure (**??**), richers countries are specialized is high quality goods, but it seems from Table **??** that such a specialization does not systematically involves that the firms producing the most expensive goods in these countries have better export performances. The same kind of conclusion prevails for Latin American exporters. While the varieties they export are, on average, less expensive than the ones from high income countries, they have the highest weighted mean of $\hat{\beta_{1,ok}}$ (0.06) and a lower share of price competition exported goods. Figures (**??**) and (**??**) confirm this finding. They relate respectively the average and the weighted average of $\hat{\beta_{1,ok}}$ by exporting country against the gdp per capita of the exporter. The absence of significant relationship in this graphs contrasts with the strong correlation between gdp per capita and countries' specialization in relatively high quality goods. Definitively, we find no evidence that quality competition more prevalent when the specialization is on higher quality varieties.

Figure 7: GDP per capita and country-average $\hat{\beta_{1,ok}}$



4.2 Quality competition for low price goods?

The statistical evidences shown in previous section fail to reveal a simple and systematic pattern helping to understand why quality competition dominates in some countries while price competition is more important in others. It is clear, as shown in our theoretical analysis, that being specialized in high quality varieties does not mean that firms' export performances are mainly driven by their capacity to produce higher quality. Firm-level differences in prices also play an important role, even in the richest countries.

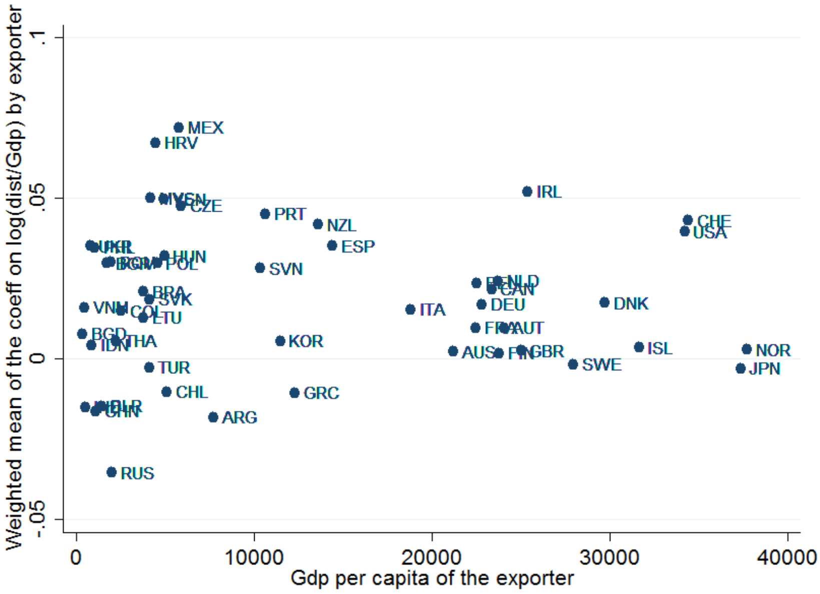
This section tests explicitly our theoretical prediction: quality competition is more likely to prevail between firms that export low price goods, while price competition should be more influential in countries specialized in relatively expensive varieties.

To do so, we relate, for each exporting country o and each good k, the coefficient $\hat{\beta_{1,ok}}$ estimated in the fist step, to a measure of the average price of the varieties of good k exported by o relative to the world average. This relative price is, explicitly, the ratio between the unit value of the flow of good k from country o and the average unit values of exports for this HS-category, weighted by the value of the export flow. Our simple model suggests a negative relationship between $\hat{\beta_{1,ok}}$ and the relative price variable.

According to Figure **??**, which plots the country-level weighted averages of these two variables, our data seems to support our prediction. Countries whose exports are relatively expensive have also a substantially higher proportion of quality-competition exported goods (i.e. a larger share of positive $\hat{\beta_{1,ok}}$). This is confirmed by the econometric analysis.

A first set of results are shown in Table (**??**). Here, the dependant variable is the coefficient $\hat{\beta_{1,ok}}$). All columns report within-product estimates. Our test is actually a two step procedure where the dependant variable in the second step is an estimated coefficient, and we must take into account the variance of this estimator. Following Saxonhouse (1976), all our regressions are weighted by the inverse of the standard error of $\hat{\beta_{1,ok}}$. This gives more importance to more

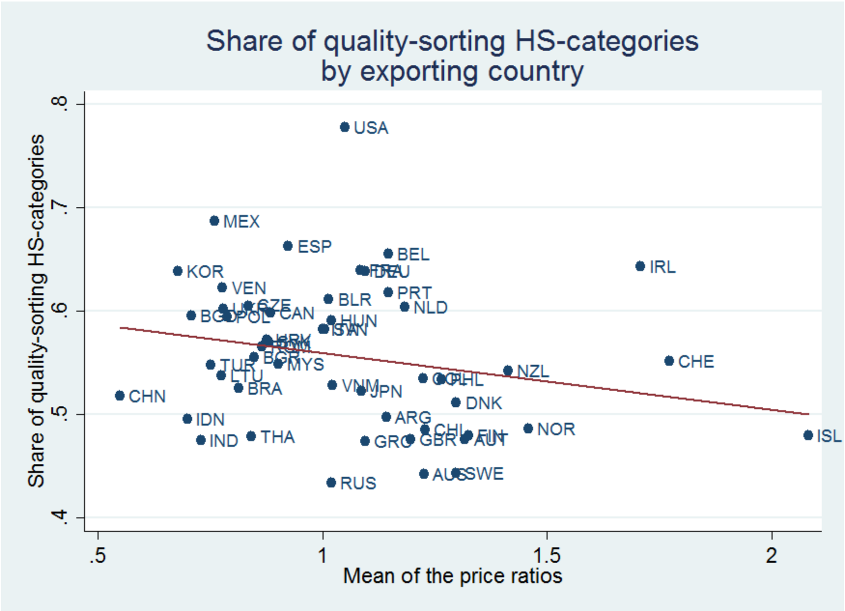
Figure 8: GDP per capita and weighted country-average $\widehat{\beta}_{1,ok}$



significant estimates. Table (**??**) in appendix shows the estimates we obtain with a different weight: the number of observations in the fist step. The results are very close to the ones presented in Table (**??**). Column (1) confirm our intuition. The coefficient on the relative price variable is significantly negative which means that the highest the relative price of a variety shipped by a country, the lowest is the importance of quality competition. We obtain a similar result in column (3), where we replace the relative price variable by a dummy which takes the value of 1 when the price ratio is greater than 1 and 0 otherwise. We obtain a coefficient of -0.016 on this dummy. This is not only negative as expected and statistically significant, but also quite large in magnitude. Indeed, the absolute value of this coefficient and $\widehat{\beta}_{1,ok}$ are of the same order of magnitude (the average value of $\widehat{\beta}_{1,ok}$, reported in table **??** is 0.02). Considering the estimated value of the intercept reported in column (3), the average coefficient $\widehat{\beta}_{1,ok}$ is 0.022 for export flows that have a price lower than the world average, but only 0.006 (i.e. 0.022-0.016) for flows with a price above the world average. Note that this change is meaningful. Since 0.006 is lower than the mean standard error of the coefficients $\widehat{\beta}_{1,ok}$, the average $\widehat{\beta}_{1,ok}$ looses its significance when one considers relatively expensive export flows only. In column (2) we introduce the square of the price ratio variable. The small but significant coefficient associated to this term shows that our relationship is non-linearity. Quality competition gives ground to price competition when relative export prices rise, but this tendency progressively slows down as relative export prices become very large. In the two last columns we restrict the sample to relatively cheap varieties (i.e when the price ratio is lower than 1), in column (4) and relatively expensive ones , in column (5). Our prediction holds in both cases on the whole distribution of the relative price, even if the effect is lower for "expensive" goods.

Table (**??**) considers $\widehat{\beta}_{1,ok}$ as a dependant variable. However, the magnitude of these coefficients is far less informative than their sign. Indeed, $\widehat{\beta}_{1,ok}$ depends on all the parameters of the model. The sign of $\widehat{\beta}_{1,ok}$ tels us whether price or quality competition determines firms' export performances in a country, but the relative magnitude between two positive or two neg-

Figure 9: Country-average export price and country-average $\hat{\beta_{1,ok}}$



ative coefficients is much harder to interpret and does not say much on the determinants of competitiveness. Then, we run probit regression, as a robustness check, using as dependant variable a dummy taking the value 1 for positive values of $(\hat{\beta_1})_{o,k}$ and 0 otherwise. Results are displayed in Table (tabresults2). They are very consistant with the ones shown in Table (tabresults1). Higher price ratio is undoubtedly associated with a higher probability of having a negative $t(\hat{\beta_1})_{o,k}$; once again, price competition tends to predominates in a country when the firms produce relatively expensive varieties for the foreign markets. Table (**??**) proposes the same tests, but dropping all coefficients $(\hat{\beta_1})_{o,k}$ that are non-significantly different from zero. Not surprisingly, this reinforces our conclusions.

5 Conclusion

This paper has explored the nature of the competition between firms in international trade at the country level, and its determinants. We show theoreticaly that the nature of the competitiveness depends on the relative prices of the varieties provided by a given country. These prices are determined by the "capability" of the firm to produce a given level of quality, but also by the technological level of the country. More precisely, our model predicts that countries with a relatively small weighted average FOB prices of exported varieties tend to be in "quality-sorting". In these countries firms that access less attractive markets provide better quality varieties, and then at a higher price. Inversely, in countries where the weighted mean price is larger, firms exporting to distant and/or small markets have to provide cheaper goods. At a sectoral level it leads to the prediction that: in countries providing relatively expensive varieties, the weighted mean price of an origin country is larger the more difficult to access a destination market is. But in countries characterized by relatively cheap varieties (and then low quality varieties), this weighted mean is lower the less attractive a destination market is. These predictions are estimated on the 50th largest exporters in BACI (1995-2007): the results

Table 4: A determinant of quality-competition ($y = \hat{\beta_{1,ok}}$): the relative price

	(1)	(2)	(3)	(4)	(5)
				$UV_{ok}/UV_k < 1$	$UV_{ok}/UV_k > 1$
Priceratio	-0.007[a]	-0.010[a]		-0.017[a]	-0.005[a]
	(0.000)	(0.000)		(0.003)	(0.000)
Sqr(Priceratio)		0.000[a]			
		(0.000)			
Dummy(Priceratio>1)			-0.016[a]		
			(0.001)		
Constant	-0.002[a]	-0.002[a]	0.022[a]	-0.005[a]	0.002[a]
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Observations	95,670	95,670	95,670	50,186	45,484
R^2	0.005	0.006	0.004	0.001	0.004

HS6-within weighted regressions with weight = inverse of the standard error of $\hat{\beta_{1,ok}}$, Priceratio= UV_{ok}/UV_k
Standard errors in parentheses, Significance levels:[c] p<0.1, [b] p<0.05, [a] p<0.01

are coherent with the theoretical predictions.

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Table 5: Determinants of quality competition ($y = 1$ if $t(\hat{\beta_{1,ok}}) > 0$; $y = 0$ if $t(\hat{\beta_{1,ok}}) < 0$)

	(1)	(2)	(3)	(4) $UV_{ok}/UV_k < 1$	(5) $UV_{ok}/UV_k > 1$
Priceratio	-0.043[a]	-0.074[a]		-0.177[a]	-0.023[a]
	(0.002)	(0.003)		(0.026)	(0.002)
Sqr(Priceratio)		0.001[a]			
		(0.000)			
Dummy(Priceratio>1)			-0.205[a]		
			(0.008)		
Constant	0.204[a]	0.241[a]	0.244[a]	0.357[a]	0.087[a]
	(0.006)	(0.006)	(0.006)	(0.018)	(0.008)
Observations	95,640	95,640	95,640	50,166	45,474

Probit Estimation with HS6 random effects, Priceratio= UV_{ok}/UV_k

Standard errors in parentheses, Significance levels:[c] p<0.1, [b] p<0.05, [a] p<0.01

Table 6: Determinants of quality-competition ($y = 1$ if $t(\hat{\beta_{1,ok}}) > 1.96$; $y = 0$ if $t(\hat{\beta_{1,ok}}) < -1.96$)

	(1)	(2)	(3)	(4) $UV_{ok}/UV_k < 1$	(5) $UV_{ok}/UV_k > 1$
Priceratio	-0.098[a]	-0.131[a]		-0.228[a]	-0.058[a]
	(0.004)	(0.005)		(0.040)	(0.005)
Sqr(Priceratio)		0.001[a]			
		(0.000)			
Dummy(Priceratio>1)			-0.322[a]		
			(0.013)		
Constant	0.387[a]	0.424[a]	0.410[a]	0.561[a]	0.208[a]
	(0.010)	(0.010)	(0.010)	(0.028)	(0.014)
Observations	44,233	44,233	44,233	23,429	20,804

Probit Estimation with HS6 random effects, Priceratio= UV_{ok}/UV_k

Standard errors in parentheses, Significance levels:[c] p<0.1, [b] p<0.05, [a] p<0.01

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7 Appendix

Table 7: A determinant of quality-sorting ($y = \hat{\beta}_1$): the relative price

	(1)	(2)	(3)	(4)	(5)
				$UV_{ok}/UV_k < 1$	$UV_{ok}/UV_k > 1$
Priceratio	-0.007[a]	-0.010[a]		-0.016[a]	-0.005[a]
	(0.000)	(0.000)		(0.004)	(0.000)
Sqr(Priceratio)		0.000[a]			
		(0.000)			
Dummy(Priceratio>1)			-0.023[a]		
			(0.001)		
Constant	-0.001[b]	-0.001[b]	0.030[a]	-0.003[a]	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	95,670	95,670	95,670	50,186	45,484
R^2	0.004	0.005	0.004	0.000	0.003

HS6-within Weighted OLS (Weight=number of partners of o by k), Priceratio= UV_{ok}/UV_k

Standard errors in parentheses, Significance levels:[c] p<0.1, [b] p<0.05, [a] p<0.01