Quality Choice: Effects of Trade, Transportation Cost, and Relative Country Size.[1]

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We introduce a generalized iceberg transportation cost, which combines per-unit and ad-valorem components, into a monopolistic competition model of trade with endogenous quality choice. In equilibrium, quality increases in per-unit component of the iceberg and in firm-level export share. We derive an equilibrium where the export share and thus the quality of exports decrease in the exporter country size. Next we show empirically on the sample of US imports that larger countries tend to export lower priced goods especially in those industries where transportation cost has a larger per-unit component. This finding raises a possibility that increasing returns play a larger role in international trade than previously thought. This is because the customary approach that uses value of trade to identify the home market effects might underestimate the effect of country size because price and quantity are effected in opposite directions. This supposition is borne out by the data. Home market effect is present in about a quarter to a third more industries when volume of exports is measured by quantity rather than value.

JEL F1, R1

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I. Introduction

The question of international specialization is central to trade theory. Recently we learned that countries specialize within as well as across industries. Notably, Schott (2004) documents substantial variation in product unit values across exporters to the US and relates it to per capita income of exporters. His results highlight considerable international specialization even within the most narrowly defined product categories. Variation in unit value is not accounted for by traditional model of trade with product differentiation and increasing returns to scale. In those models specialization manifests itself as the home-market effect. Hanson and Xiang (2004) show theoretically and confirm empirically that the strength of the home market effect prominently depends on the ad valorem size of transportation cost. The ad valorem incidence of transportation is however different for goods of different unit values. Hummels and Skiba (2004) show that transportation costs are less than one-to-one proportional to the unit value of shipped goods and therefore lead to changes in relative demands because higher priced goods have lower ad valorem equivalent of transportation costs (the Alchian-Allen effect). As a result countries tend to export higher priced goods to more remote destinations. In this paper we combine insights from the previous literature to investigate whether the nature of the transportation costs affects specialization in the models of trade in differentiated goods produced under increasing returns to scale.

We introduce a generalized iceberg transportation cost into a monopolistic competition model of trade with endogenous quality choice. In doing so, we retain analytical simplicity of the traditional iceberg assumption but allow for both a per-unit and an ad valorem component of transportation costs. The resulting model predicts a systematic negative relation between country size and export prices. In equilibrium, quality increases in per-unit component of the iceberg and in firm's export share. This is because the firms that export more of their output face a stronger incentive to upgrade quality as larger share of their output incurs transportation cost. In the corner equilibrium with one-way trade in the differentiated sector, both the export share and quality decrease in the exporter country size. Intuitively, country size matters relatively less when transportation costs are lower. So, if higher priced goods face lower ad valorem transportation cost, the location of the higher transportation cost industry is more sensitive to the transportation cost. Our theory can be anecdotally intuited by notorious examples of small countries specializing in high quality goods such as Swiss watches, Belgian chocolate, or Japanese photo lenses.

In the empirical exercise we first estimate industry level transportation cost functions to determine the degree to which transportation costs co-vary with the product unit value. Next using a sample of US imports we show empirically that larger countries tend to export lower priced goods. The negative effect of market size on the price of exports is stronger in those industries where transportation costs have a larger per-unit component. This finding raises a possibility that increasing returns play a larger role in explaining international trade than previously thought. This is because the customary approach that uses value of trade to identify the home market effects might underestimate the effect of country size on exports because price and quantity are effected in opposite directions. This supposition is borne out by the data. According to our estimates home market effect is present in about a quarter to a third more industries when volume of exports is measured by quantity rather than value.

II. Theoretical Framework

1. Model

We want to explore how the relative country-exporter size and the nature of transportation cost affect the quality choice of exporters. For this purpose, we extend the standard model of trade under monopolistic competition (Helpman and Krugman, 1985) to the case of multiple differentiated-product industries with endogenous quality choice and augmented transportation cost. The major novelty is a generalized iceberg transportation cost which includes both ad-valorem and per-unit components.

1.1. Preferences

The world consists of 2 countries, Home and Foreign, indexed by *h* and *f*, with population L_h and L_f, respectively. The preferences are symmetric in Home and Foreign. For brevity, we will set up the model only from Home's perspective. Preferences of Home's representative consumer are defined over a numeraire good q_0 and *S* differentiated sectors indexed by *s*:

$$(1) \qquad U_h = q_{h0}^{\mu_0} \prod_{s=1}^{S} C_{hs}^{\mu_s} \qquad\qquad \sum_{s=0}^{S} \mu_s = 1,$$

where C_{hs} is a composite of differentiated varieties in sector *s*:

$$(2) \qquad C_{hs} = \left(\sum_k \left(\lambda_{hsk} q_{hsk} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \qquad\qquad \sigma > 1,$$

where q_{hsk} -- is Home's individual consumption of variety *k* in sector *s*;

λ_{hsk} -- is a quality multiplier of variety *k* in sector *s*;

1.2. Production

Labor is the only factor of production and is supplied inelastically. Each consumer is endowed with one unit of labor. The numeraire sector is characterized by perfect competition and constant returns to scale. One unit of labor can produce 1/*w* units of the numeraire in Home and 1 unit in Foreign. The numeraire is traded at zero cost. We assume that the numeraire sector is large enough for both countries to have strictly positive output of the numeraire. The introduction of the numeraire in the model simplifies the balance of trade calculation and ties the wage to productivity in the numeraire sector.

Differentiated varieties are produced by monopolistically competitive firms, with country *i*-sector *s* specific technologies. The production requires a fixed number of workers α_{is}, and marginal labor requirement c_{is}, which is a function of chosen quality:

(3) $$c_{isk} = \frac{1}{A_{is}} \exp\left(\frac{\lambda_{isk}}{Z_{is}}\right) \qquad A_{is}, Z_{is} > 0,$$

where A_{is} and Z_{is} are productivity parameters.[2]

1.3. Augmented functional form of the transportation cost

It is difficult to find a realistic functional form of the transportation cost. If we focus on the vessel mode of transportation, international shipping is a sophisticated technology which includes both fixed and variable cost components. The fixed cost component is a function of port infrastructure, where the variable cost depends on distance, volume of trade, and good-specific characteristics (Hummels, Lugovskyy and Skiba; 2008).

Our goal is to suggest a functional form which would capture both ad-valorem and per-unit components of transportation cost, and, at the same time, would preserve the analytical

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[2] This type of unit labor function was first introduced by Flamm and Helpman (1987). A similar function in conjunction with CES preferences is used by Hummels and Klenow (2005).

simplicity of the iceberg. For this purpose, we allow a part of transportation cost to be incurred in units of labor. In particular, we assume that to transport one unit of the final good (z,λ) it takes $[\varphi(z)-1]$ units of the final good (z,λ) and $f(z)$ units of labor. Shipping industry is characterized by perfect competition, zero profits, and pricing its services at marginal cost of shipping. The shippers are paid by producers with the final good at the market price. The labor used in shipping industry is rewarded at the market wage, since labor is perfectly mobile across all sectors. Under the above assumptions, the generalized iceberg cost function of delivering good *k* produced by Home's industry *s* to Foreign is:

(4) $$\tau_{fhsk} = \varphi_{fh} + \frac{f_{fh}}{c_{hsk}} \frac{\sigma - 1}{\sigma}.$$

Note, that the magnitude of iceberg is now a function of the marginal cost of production. Consequently it is good *k* - industry *s* specific, and given the functional form of marginal cost (3) is endogenous on the quality choice of the producer of good *k*.

1.4 Quality in Autarky Equilibrium

In autarky, the profit-maximizing quality level is equal to the corresponding productivity parameter *Z*:

(5) $$\lambda_{is}{*} = Z_{is}.$$ [3]

1.5. Quality in Trade Equilibrium

Consider the profit function of a firm producing variety *k* in Home's sector *s*:

[3] This a partial case of equilibrium with trade in which the export share is equal to zero. The corresponding derivations are given in the next subsection.

(6) $$\pi_{hsk} = p_{hhsk} Q_{hsk} \left(1 - ES_{hsk}\right) + p_{fhsk} \frac{Q_{hsk} ES_{hsk}}{\tau_{fhsk}} - \alpha_{hs} - c_{hsk} w_h Q_{hsk},$$

where p_{hhsk} and p_{fhsk} are the price charged in Home and in Foreign, respectively;

Q_{hsk} is the firm's total output;

ES_{hsk} is the share of exported quantity in the firm's output;

τ_{fhsk} is the generalized iceberg transportation cost defined by (4);

α_{hs} and c_{hsk} are the fixed and marginal unit labor requirements, respectively;

w_h is the wage in Home.

By solving the profit maximizing problem we can find the optimal quality level:

(7) $$\lambda_{hsk} = Z_{hs} \left(1 - ES_{fhsk} \frac{f_{fh}/c_{hsk}}{\tau_{fhsk}}\right)^{-1},$$

where $\frac{f_{fh}/c_{hsk}}{\tau_{fhsk}}$ is the share of the per-unit component in the total iceberg cost . Note that if the share of exports is equal to zero, as in autarky, the result will coincide with (5). The next two observations are expressed as lemmas.

Lemma 1: *If and only if transportation contains a per unit part, exporters produce higher quality goods than non-exporters.*[4]

Proof: Follows directly from (7).■

Intuitively, as firms begin targeting export markets, they pay attention to the magnitude of trade cost. Endogenous trade cost generates an extra incentive to invest in higher quality: in addition to a higher demand, higher quality now also decreases the iceberg transportation cost. As a result producers choose higher quality compared to autarky level.

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[4] Note that this prediction coincides with Baldwin and Harrigan (2008) prediction.

Lemma 2: *If and only if transportation contains a per unit part, the quality of exported goods is increasing in per unit part of transportation cost and in the share of exports.*

Proof: Follows directly from (7).■

From (7), the magnitude of the (negative) effect of quality on the total iceberg is increasing in the share of the per-unit component in the total transportation cost. Consequently, higher share of per-unit transportation cost increases the incentive to invest in higher quality. Also, from (6), export share increases the weight of transportation cost in overall profit calculation. Accordingly the more the producers are involved in exporting, the more they are motivated to invest in higher quality.

1.6. Firm-Level Export Share

We have established that the export share matters for quality choice. The export share itself, though, is not an exogenous variable, and our next step is to identify its determinants. To start with, we have to distinguish between two scenarios possible for a given sector s: i) interior equilibrium characterized by two-way trade; ii) corner equilibrium in which only one country produces and exports differentiated varieties in sector s. As it will be seen later, this distinction is crucial for determining the firm-level export share both in terms of quantitative and, what is more important, in terms of qualitative results. In particular, the relative size of the economy has no impact on the export share in interior equilibrium, but is the major determinant of export share in the case of corner equilibrium.

1.6.1. Firm Level Export Share in the Two-Way Trade Equilibrium

As in Helpman and Krugman (1985) model, under two-way trade equilibrium, the export share of individual firm is determined by the technologies available to each country, and the magnitude of the trade costs, and is independent of the country sizes.[5]

1.6.2. Firm Level Export Share in the One-Way Trade Equilibrium

Assume that the parameters of the model are such that Home is the sole producer and exporter of differentiated varieties in sector *s*. Given the Cobb-Douglas upper case utility function and the fact that income spent on the differentiated varieties in sector *s* is equal to the value of these varieties at market prices, we start with the following equalities:

$$\mu_s L_F = N_{hs} \frac{Q_{hs} SE_{hs}}{\tau_{hfs}} p_{hfs} \qquad \mu_s L_h w_h = N_{hfs} Q_{hs} \left(1 - SE_{hs}\right) p_{hhs},$$

which can be transformed into the following expressions after plugging the equilibrium values of price and quantity:

$$\mu L_F = N s_F \alpha \sigma w \qquad \mu L_H = N\left(1 - s_F\right) \alpha \sigma,$$

from which we derive the equilibrium value of export share:

$$\text{(8)} \qquad SE_{hs} = 1 - \frac{wL_h}{wL_h + L_f} = 1 - \frac{Y_h}{Y_h + Y_f}.$$

Thus in the corner equilibrium, the export share is decreasing in the relative size of the exporter. By plugging this result into (7) we get

$$\text{(9)} \qquad 1 - \frac{Y_h}{Y_h + Y_f} = \left(1 + \frac{\varphi_{fhs} A_{hs} \exp\left(\lambda_{hs} / Z_{hs}\right)}{f_{fhs}}\right)\left(1 - \frac{Z_{hs}}{\lambda_{hs}}\right),$$

which allows us to formulate and prove Lemma 3.

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[5] See equation 10.18 on page 207 for a corresponding formula.

Lemma 3: *In the corner on-way trade equilibrium, the quality level is decreasing in the GDP of the exporter. This effect is increasing in the per-unit share of the transportation cost.*

Proof: Follows directly from (9).■

1.7. Home Market Effect Revisited

Starting with Krugman (1980) and Helpman and Krugman (1985) the literature on Home Market effect focuses on the case of interior equilibrium in which, ceteris paribus, larger country exports more varieties than smaller country. We consider a different angle of this issue. Let us combine all differentiated sectors in one industry and assume a perfectly asymmetric distribution of productivities between Home and Foreign. (as, e.g., in Fisher, Dornbush, and Samuelson 1977). The conditions defining the industries in which industries we should observe corner equilibrium are similar to the conditions derived by Helpmand and Krugman (1985).

It is possible to show that a larger country will have more sectors in which it is a sole exporter than a smaller country. Thus, at industry level, the home market effect can stem not only form the fact that larger country produces more varieties in sectors with interior equilibrium, but also from the fact that larger country is a sole exporter in more sectors than a small country is.[6]

If the Home Market Effect stems even partially form the second channel, the magnitude of the Home Market Effect should be greater when we compare the quantities exported than when we compare the values exported, since smaller country will produce higher quality goods and charge higher prices for its exports.

[6] The proof of this statement is available upon request form the authors.

III. Empirics

1. Data

Our data cover the US imports from all exporters worldwide, measured at 10 digit level of the Harmonized Classification System (16800+ categories) in 2004.[7] Denote a 10-digit commodity category by *k*. For commodity *k* imported form country *i* the data include the f.o.b. value, V_{ik}, quantity, Q_{ik}, and shipping charge, S_{ik}. We compute the unit value of commodity *k* from country *i* as $p_{ik} = V_{ik} / Q_{ik}$, and the corresponding freight rate as $f_{ik} = S_{ik} / Q_{ik}$. We refer to HS 10 category as "product", or "good". For GDP and GDP per capita data we used the World Development Indicators data.[8]

2. Estimating industry transportation cost functions

Theory indicates that relative delivered price and hence the quality of exports crucially depend on the specific part of transportation cost. In order to test whether transportation cost is iceberg and to determine the degree to which transportation cost deviates from iceberg, we estimate a transportation cost function that allows for flexible relation between price and transportation cost. For every industry K the following transportation cost function is estimated using a subsample of US imports in from 2002 to 2004 restricted to single shipments.

$$\ln f_{is} = \alpha_{0K} + \alpha_{1K} \ln p_{is} + \alpha_{2K} \ln D_i + \varepsilon_{is} \tag{10}$$

where f_{is} – per unit freight charge to deliver a unit of shipment s from country i

p_{is} – unit value of good in shipment s imported from country i

K – HS 2 digit industry

[7] For trade data, we used the US Census Imports of Merchandise.
[8] Data source: World Bank.

D_i – distance to i

This form of transportation cost function is commonly used in trade literature, see for example Hummels (1999), Hummels, Skiba (2004). Our primary interest lies in the price elasticity of transportation cost, α_{1K}. If $\alpha_{1K} = 0$ transportation cost does not depend on price. This is the case of per unit transportation cost. On the other extreme, if $\alpha_{1K} = 1$ transportation cost is proportional to the value of the shipped good. Summary of the estimation results can be seen in Figure 1. Traditional iceberg transportation cost is rejected for all 97 HS 2-digit industries by a one-sided t-test of the hypothesis that $\hat{\alpha}_{1K} = 0$. There is also a substantial degree of variation across industries in the degree of deviation from the standard iceberg.

Intermodal substitution is potentially an important issue in the estimation of industry transportation cost functions. Every 2-digit industry contains goods imported by air and by vessels. If we combine all shipments into one pooled regression our price elasticity will be affected by the intermodal substitution. The goods that are shipped by air tend to be of higher unit values. This is potentially an issue if quality does not affect the mode of transportation. In order to partially correct for this possibility we also estimate equation (10) separately for air and vessel shipments and take a simple average of the two. The estimated elasticities are summarized in Figure 2. The effect on price on transportation is generally smaller when intermodal substitution is excluded.

3. Effect of size on the price of exports

Next we investigate the relation between exporter's size and the price of exports. Since transportation is not iceberg for all industries, we expect size to lower the price of exports. This correlation alone would be consistent with our theory but might also arise through some other channel. A more persuasive case in favor of our explanation could be made if the negative effect of market size on the price of exports were stronger for industries where transportation cost is less like iceberg. In order to formally test the varying strength of the size-price connection we use the following empirical specification:

$$\ln P_i^K = \beta_0 + \beta_1 \ln Y_i + \left(\beta_2 T_K\right) \ln Y_i + \beta_3 T_K + \beta_4 \ln C_i + \beta_5 D_i + \varepsilon_{iK} \tag{11}$$

where P_i^K – measure of exporter i's price in industry K (average price or Fisher's ideal price index)

Y_i – measure of exporter i's market size (nominal GDP or market potential)

C_i – vector of i specific cost shifters (GDP per capita, human capital, physical capital, labor)

D_i – distance to i

T_K – vector of variables that reflect distortions to relative prices introduced by transportation of goods from industry K

The price of country's exports can be simply measured as a trade weighted average. Such approach would however blend differences in price levels with differences in composition of exports. Therefore, a price index could offer distinct advantages. We modify Hummels and Klenow's (2002) use of Fisher price index to construct a separate index for exporter i in industry K.

$$P_i^K = \left(\frac{\sum_{k \in X_{ijK}} p_{ijk} q_{ijk}}{\sum_{k \in X_{ijK}} p_{Wjk} q_{ijk}} \right)^{1/2} \left(\frac{\sum_{k \in X_{ijK}} p_{ijk} q_{Wjk}}{\sum_{k \in X_{ijK}} p_{Wjk} q_{Wjk}} \right)^{1/2}$$

where j – US

X_{ijK} – set of categories k imported from i to the US

p_{Wjk} – average price of US imports in category k

q_{Wjk} – total quantity of US imports in category k

We use nominal GDP and market potential as two alternative measures of the market size. Market potential augments country's GDP to include distance weighted GDP of its trading partners. Following the Fujita, Krugman, and Venables (1999), and Hanson and Xiang (2004), we calculate the market potential as:

$$MP_i = \sum_{j \neq i} \frac{GDP_j}{D_{ij}^{\phi}} + GDP_i \sqrt{\frac{A_i}{\pi}}$$

where GDP – nominal GDP

D_{ij} – distance from between i and j

A_i – land surface area of country i

We set ϕ equal 0.92 using Hummels's estimate of the distance coefficient in the gravity model.[9]

The results of estimation are presented in tables 1 and 2. Table 1 reports estimated coefficients for pooled regression, and Table 2 reports estimation results for similar specifications with industry fixed effects. Industry fixed effects control for unobservable industry specific characteristics but also remove some of the useful variation in the transportation cost parameters. The effect of size on price is universally negative when statistically significant. The effect of size on the Fisher's ideal price index is consistently weaker than on the average price indicating that the change in composition of exports plays a role in the lowering of the exports

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[9] Setting ϕ equal 0.92 is also consistent with Hanson and Xiang (2004)

price with exporter's size. Not only larger exporters tend to export lower priced products they also tend to export more of the lower priced exports. Consistently with the theoretical predictions industries whose transportation costs are closer to iceberg (farther from 0 and closer to 1) exhibit a weaker negative relation between market size and price of exports. This is evidenced by the positive coefficient on the ($\hat{\alpha}_{1K} \times$ size) interaction term.

4. Distinguishing price from quality

Product quality is not the only reason for variation in prices. We use approach suggested by Hummels and Klenow (2003) to separate effect of market size on exporter's quality. For every HS 2-digit category we estimate the effect of market size on both price and quantity index .

$$\text{(12)} \quad \begin{aligned} \ln P_i^K &= \beta_0^K + \beta_1^K \ln Y_i + \left(\beta_2^K T_K\right) \ln Y_i + \beta_4^K \ln C_i + \beta_5^K D_i + \varepsilon_{iK} \\ \ln Q_i^K &= \gamma_0^K + \gamma_1^K \ln Y_i + \left(\gamma_2^K T_K\right) \ln Y_i + \gamma_4^K \ln C_i + \gamma_5^K D_i + \varepsilon_{iK} \end{aligned}$$

Vector of cost controls C_i includes GDP per capita, human capital, physical capital, and labor

Quantity is measured as the quantity index in a similar fashion to the Fisher ideal price index according to the following formula

$$Q_i^K = \left(\frac{\sum_{k \in X_{ijK}} p_{ijk} q_{ijk}}{\sum_{k \in X_{ijK}} p_{ijk} q_{Wjk}} \right)^{1/2} \left(\frac{\sum_{k \in X_{ijK}} p_{Wjk} q_{ijk}}{\sum_{k \in X_{ijK}} p_{Wjk} q_{Wjk}} \right)^{1/2}$$

If variation in quantity was solely due to variation in prices the effect of size on price and quantity would differ by a factor equal to the elasticity of substitution. The effect of market size quality therefore can be calculated as the price adjustment necessary for a change in price to generate corresponding change in quantity given elasticity of substitution. The effect of size on quality can be calculated as

$$\frac{\partial \ln \lambda_i^K}{\partial \ln Y_i} = \frac{-\hat{\sigma}_K \left(\hat{\beta}_1^K + \left(\hat{\beta}_2^K T_K\right)\right) + \left(\hat{\gamma}_1^K + \left(\hat{\gamma}_2^K T_K\right)\right)}{\hat{\sigma}_K}$$

We borrow estimates of elasticities $\hat{\sigma}_K$ from Broda and Weinstein (200X) by calculating median of HS? elasticities for every HS2 category. The results are shown in

Figure 3. Only quality of Machinery and Transportation seems to strongly increase with market size. Effect of size on quality in Agriculture and in Wood and Paper is close to zero. In general 62 out of 97 2-digit HS industries exhibit negative effect of market size on quality. This effect is stronger for industries and sectors where transportation cost is closer to the traditional iceberg.

5. Implications for identification of the home market effects

It is customary in the literature on the home market effect, for example Feenstra, Markusen, and Rose (1998), Davis and Weinstein (1999), Hanson and Xiang (2004), to rely on value to identify the relation between size of the domestic market and volume of exports. Value of trade is more commonly available and usually more precisely measured than quantity. In addition, standard model of trade in differentiated products based on Krugman's framework do not allow for price variation. So price and quantity can be used interchangeably. However if the price reducing effect described in this paper is sufficiently pervasive, the effect of market size on the value of exports is likely to be smaller than the effect on quantity. Using values of trade could lead to underestimating of the strength and extent of the home market effect. In order to gauge whether the price channel plays an important role we will estimate the effect of home market size separately on price and quantity for all HS 2-digit industries across exporters to the US in 2000.

$$\left(PQ\right)_{iK} = \delta_{0K} + \delta_{1K} Y_i + \delta_{2K} \ln C_i + \delta_{3K} D_i + \delta_{4K} t_{iK} + \varepsilon_{iK}$$
$$Q_{iK} = \gamma_{0K} + \gamma_{1K} Y_i + \gamma_{2K} \ln C_i + \gamma_{3K} D_i + \gamma_{4K} t_{iK} + \varepsilon_{iK}$$

where Y_i – measure of exporter i's market size (nominal GDP or market potential)

C_i – vector of i specific cost shifters

D_i – distance to i

t_{iK} – trade weighted average tariff rate on industry K exports from country i

The home market effect is defined by more than one-to-one relation between exporter's size and volume of exports. For every industry we perform a one sided *t* test of the null hypothesis that the coefficient on size is smaller or equal to unity: $H_0 : \delta_{1K} \leq 1$ and $H_0 : \gamma_{1K} \leq 1$. The results of this exercise are summarized in Table 3. Consistently with previous findings home market effect is more pronounced in specifications that use market potential rather than GDP to measure the size of domestic market. The home market effect is clearly more pronounced when quantity rather than price is used to measure the volume of trade.

6. On the issue of generated regressors

Statistical significance of transportation cost function parameters in estimating equation (11) is central for our conclusions about the effect of size on export's quality. Simple t-statistics could be misleading because the parameters of the cost function are generated regressors estimated from specification in equation (10). Unfortunately, there is no straightforward adjustment for the generated nature of the parameters of the cost function. For example we cannot construct the variance-covariance matrix of the estimated coefficients similarly to two stage least squares estimator because our generated regressor is constructed from two estimates obtained from two subsets of a dataset that is different from the dataset used in the second stage regression.

Since the exact adjustment is not known we design a two stage bootstrap procedure to estimate standard errors of the estimated coefficients. The bootstrap procedure performs 100 draws with replacement each time estimating equation (11) by HS 2-digit sampling strata. Every time a sample is drawn we re-estimate transportation cost function (10) for air and vessel imports on a randomly drawn sample of single shipments using HS 2-digit as sampling strata. The results of the estimation are presented in Table 4.

We believe that the problem of generated regressors is not as severe in our application as in others. First, all transportation cost function coefficients are estimated very precisely with small standard errors. The value of the smallest t-statistics exceeds 2.3 for both air and vessel transportation cost functions. The median of the t-statistics for both modes exceeds 21. Second, there is significantly more variation in the estimated elasticities than in the sample variation of the estimated elasticities is about an order of magnitude larger than the average

IV. Conclusions and Discussion

We find that when a good is exported by many countries the average price of exports is lower for larger countries, although not universally. We show how this link between the size and average price can arise from the interaction between the Alchian-Allen effect and the home market effect. The effect of size on price is stronger when transportation cost co-varies less with the unit value of the shipped good.

The empirical results are consistent with our theoretical predictions. Not only larger countries tend to ship lower priced goods but also this negative relation is stronger when transportation cost is less ad valorem. There can be potentially other reasons of why large countries have lower export prices. In particular, large countries might choose a “high fixed cost - low variable cost” technology due to larger size of the domestic market. Alternatively, importers might consider a country of origin as additional factor of differentiation which might force producers form large countries to charge lower export markups due to higher competition with similar varieties. Unfortunately with the data in hands, we are not able to test what is exactly the mechanism which lowers the export prices for large countries. In terms of theoretical contribution, our message is that even if we assume endogenous technological choice and differences in markups, larger countries have incentives to specialize in lower quality.

In this paper we do not model a relation between elasticity of substitution and quality. The elasticities of substitution for high and low qualities are identical. This assumption of convenience is not always innocuous because it is the interaction between the iceberg transportation cost and elasticity that determine existence and relative strength of the home market effect for high and low quality varieties.

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Table 1. Effect of market size on export price, pooled specifications.

Dep. variable	Average price			Fisher's ideal price index			Average price			Fisher's ideal price index		
Measure of size	GDP			GDP			Market potential			Market potential		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Size	-0.17	-0.301	-0.498	-0.117	-0.407	-0.512	-0.085	-0.168	0.028	-0.044	-0.248	-0.093
	[13.98]**	[4.74]**	[3.01]**	[11.76]**	[7.57]**	[3.69]**	[8.47]**	[2.91]**	[0.38]	[5.38]**	[5.15]**	[1.50]
Transportation cost parameters												
$\hat{\alpha}_{0K} \times$ size		0.084	0.051		0.026	0.016		0.045	0.036		0.019	0.012
		[6.85]**	[3.47]**		[2.46]*	[1.27]		[4.32]**	[3.28]**		[2.21]*	[1.33]
$\hat{\alpha}_{1K} \times$ size		0.302	0.122		0.555	0.326		0.181	-0.007		0.382	0.233
		[2.69]**	[0.82]		[5.84]**	[2.62]**		[1.79]	[0.06]		[4.52]**	[2.37]*
$\hat{\alpha}_{0K}$		-2.275	-1.393		-0.84	-0.569		-1.511	-1.202		-0.789	-0.55
		[7.26]**	[3.62]**		[3.16]**	[1.77]		[4.59]**	[3.45]**		[2.86]**	[1.88]
$\hat{\alpha}_{1K}$		-14.509	-9.954		-17.05	-11.433		-12.663	-6.732		-15.033	-10.38
		[5.28]**	[2.66]**		[7.33]**	[3.64]**		[4.12]**	[1.86]		[5.85]**	[3.42]**
Distance	0.225	0.211	0.225	0.126	0.117	0.101	0.157	0.155	0.263	0.065	0.065	0.128
	[5.58]**	[5.53]**	[5.10]**	[3.79]**	[3.64]**	[2.72]**	[3.75]**	[3.91]**	[5.80]**	[1.91]	[1.97]*	[3.37]**
Cost controls												
GDP p.c.	0.145	0.144	0.757	0.109	0.107	0.567	0.072	0.09	0.408	0.058	0.068	0.274
	[8.48]**	[8.87]**	[6.01]**	[7.74]**	[7.80]**	[5.37]**	[4.40]**	[5.80]**	[6.80]**	[4.32]**	[5.19]**	[5.44]**
Human cap.			-0.186			-0.205			-0.203			-0.223
			[3.30]**			[4.33]**			[3.41]**			[4.46]**
Capital			-0.246			-0.109			-0.326			-0.157
			[3.31]**			[1.74]			[4.45]**			[2.55]*
Labor			0.592			0.415			0.222			0.09
			[4.22]**			[3.53]**			[2.49]*			[1.20]
N obs.	8487	8487	5633	8487	8487	5633	6805	6805	5407	6805	6805	5407
R sq	0.02	0.13	0.13	0.02	0.07	0.07	0.01	0.12	0.13	0.01	0.06	0.07

Notes: 1) Absolute value of t statistics in brackets. 2) * significant at 5%; ** significant at 1%. 3) All variables except $\hat{\alpha}_{0K}$ and $\hat{\alpha}_{1K}$ are in logarithms. 4) $\hat{\alpha}_{0K}$ and $\hat{\alpha}_{1K}$ are obtain by estimating transportation cost function $\ln f_{ik} = \alpha_{0K} + \alpha_{1K} \ln p_{ijk} + \alpha_{2K} \ln D_i + \varepsilon_{ijk}$ for every HS 2 digit category.

Table 2. Effect of market size on export price, specifications with industry dummies.

Dep. variable	Average price			Fisher's ideal price index			Average price			Fisher's ideal price index		
Measure of size	GDP			GDP			Market potential			Market potential		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Size	-0.104	-0.237	-0.373	0.011	-0.21	-0.363	-0.053	-0.124	0.016	0.026	-0.127	-0.105
	[12.85]**	[5.19]**	[3.43]**	[1.41]	[4.87]**	[3.63]**	[8.23]**	[3.13]**	[0.33]	[4.27]**	[3.38]**	[2.34]*
Transportation cost parameters:												
$\hat{\alpha}_{0K} \times$ size		0.019	0.02		-0.015	-0.011		0.014	0.019		-0.003	-0.003
		[2.11]*	[1.96]*		[1.73]	[1.16]		[1.89]	[2.63]**		[0.44]	[0.47]
$\hat{\alpha}_{1K} \times$ size		0.24	0.124		0.397	0.317		0.128	-0.017		0.272	0.22
		[2.96]**	[1.25]		[5.20]**	[3.47]**		[1.83]	[0.22]		[4.13]**	[3.08]**
Distance	0.158	0.181	0.063	0.061	0.075	0.115	0.116	0.202	0.043	0.043	0.079	0.158
	[6.05]**	[6.30]**	[2.55]*	[2.46]*	[2.82]**	[4.33]**	[4.35]**	[6.82]**	[1.72]	[1.73]	[2.92]**	[6.05]**
Cost controls:												
GDP p.c.	0.144	0.143	0.621	0.1	0.099	0.455	0.103	0.103	0.378	0.107	0.108	0.276
	[12.84]**	[12.81]**	[7.55]**	[9.52]**	[9.44]**	[6.00]**	[9.76]**	[9.81]**	[9.63]**	[10.84]**	[10.92]**	[7.64]**
Human cap.			-0.139			-0.151			-0.135			-0.154
			[3.78]**			[4.45]**			[3.47]**			[4.30]**
Capital			-0.232			-0.058			-0.288			-0.07
			[4.76]**			[1.29]			[6.02]**			[1.58]
Labor			0.466			0.293			0.22			0.096
			[5.10]**			[3.48]**			[3.78]**			[1.78]
N obs.	8487	8487	5633	8487	8487	5633	6805	6805	5407	6805	6805	5407
R sq	0.59	0.59	0.64	0.46	0.46	0.53	0.61	0.61	0.64	0.47	0.47	0.53

Notes: 1) Absolute value of t statistics in brackets. 2) * significant at 5%; ** significant at 1%. 3) All specifications include HS 2 digit industry dummies. 4) All variables except $\hat{\alpha}_{0K}$ and $\hat{\alpha}_{1K}$ are in logarithms. 5) $\hat{\alpha}_{0K}$ and $\hat{\alpha}_{1K}$ are obtain by estimating transportation cost function $\ln f_{ik} = \alpha_{0K} + \alpha_{1K} \ln p_{ijk} + \alpha_{2K} \ln D_i + \varepsilon_{ijk}$ for every HS 2 digit category.

Table 3. Number of HS 2-digit industries exhibiting the home market effect.

Measure of market size	Market potential			GDP		
Dependent variable	Value	Quantity	Δ%	Value	Quantity	Δ%
Significance level:						
0.1	26	33	27	6	9	50
0.2	36	46	28	15	15	0
0.3	43	51	19	18	22	22
0.4	51	60	18	21	26	24
0.5	59	65	10	27	35	30

Notes: 1) there are 97 HS 2-digit industries. 2) Significance level refers to the p-value of the one sided *t* test of null that the coefficient on exporter's size is less or equal to unity in the following two equations :

$$(PQ)_{iK} = \delta_{0K} + \delta_{1K} Y_i + \delta_{2K} \ln C_i + \delta_{3K} D_i + \delta_{4K} t_{iK} + \varepsilon_{iK}$$

$$Q_{iK} = \gamma_{0K} + \gamma_{1K} Y_i + \gamma_{2K} \ln C_i + \gamma_{3K} D_i + \gamma_{4K} t_{iK} + \varepsilon_{iK}$$

Table 4. Effect of market size with two stage bootstrap correction for generated regressors

Industry fdummies	No			No			Yes			Yes		
Measure of size	GDP			Market potential			GDP			Market potential		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Size	-0.117	-0.367	-0.435	-0.044	-0.235	0.02	0.011	-0.111	-0.301	0.026	-0.02	-0.064
	[12.58]**	[3.46]**	[2.65]**	[5.85]**	[3.17]**	[0.27]	[1.37]	[1.78]	[2.98]**	[4.34]**	[0.37]	[1.21]
Transportation cost parameters												
$\hat{\alpha}_{0K} \times$ size		0.06	0.053		0.047	0.008		-0.025	-0.039		-0.028	-0.017
		[1.38]	[1.19]		[1.43]	[0.28]		[0.90]	[1.29]		[0.96]	[0.69]
$\hat{\alpha}_{1K} \times$ size		0.634	0.31		0.487	0.054		0.147	0.104		0.007	0.099
		[2.59]**	[1.36]		[2.87]**	[0.35]		[1.02]	[0.77]		[0.06]	[0.95]
Distance	0.126	0.11	0.102	0.065	0.062	0.124	0.063	0.062	0.075	0.043	0.043	0.079
	[4.04]**	[3.02]**	[2.77]**	[1.83]	[1.83]	[3.09]**	[2.41]*	[2.48]*	[2.68]**	[1.94]	[1.82]	[2.68]**
Cost controls												
GDP p.c.	0.109	0.107	0.58	0.058	0.062	0.274	0.1	0.1	0.456	0.107	0.108	0.277
	[7.97]**	[6.90]**	[4.88]**	[4.38]**	[4.67]**	[4.78]**	[8.83]**	[9.06]**	[5.72]**	[10.23]**	[9.26]**	[6.62]**
Human cap.			-0.208			-0.222			-0.151			-0.153
			[4.58]**			[4.42]**			[4.11]**			[4.02]**
Capital			-0.116			-0.162			-0.057			-0.071
			[1.61]			[2.30]*			[1.11]			[1.30]
Labor			0.431			0.094			0.293			0.097
			[3.18]**			[1.16]			[3.31]**			[1.68]
N obs.	8487	8487	5633	8487	8487	5633	6805	6805	5407	6805	6805	5407
R sq	0.02	0.13	0.13	0.02	0.07	0.07	0.01	0.12	0.13	0.01	0.06	0.07

Notes: 1) The dependent variable in all specifications is the Fisher's ideal price index.

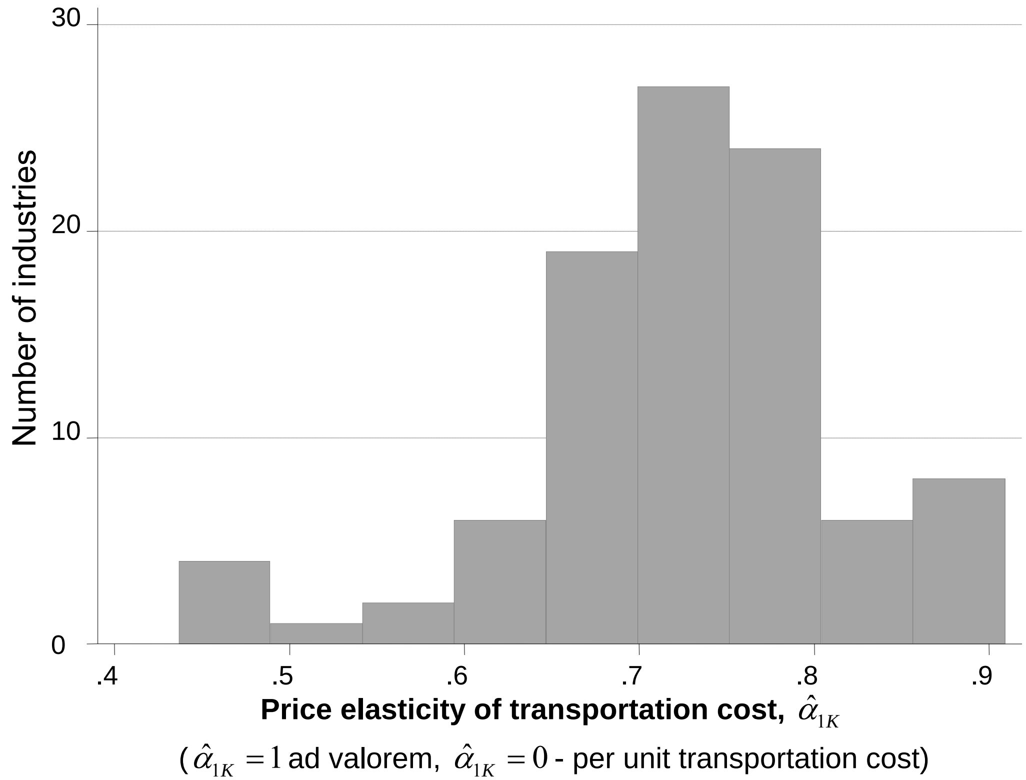

Figure 1. Distribution of industries by the price elasticity of transportation cost

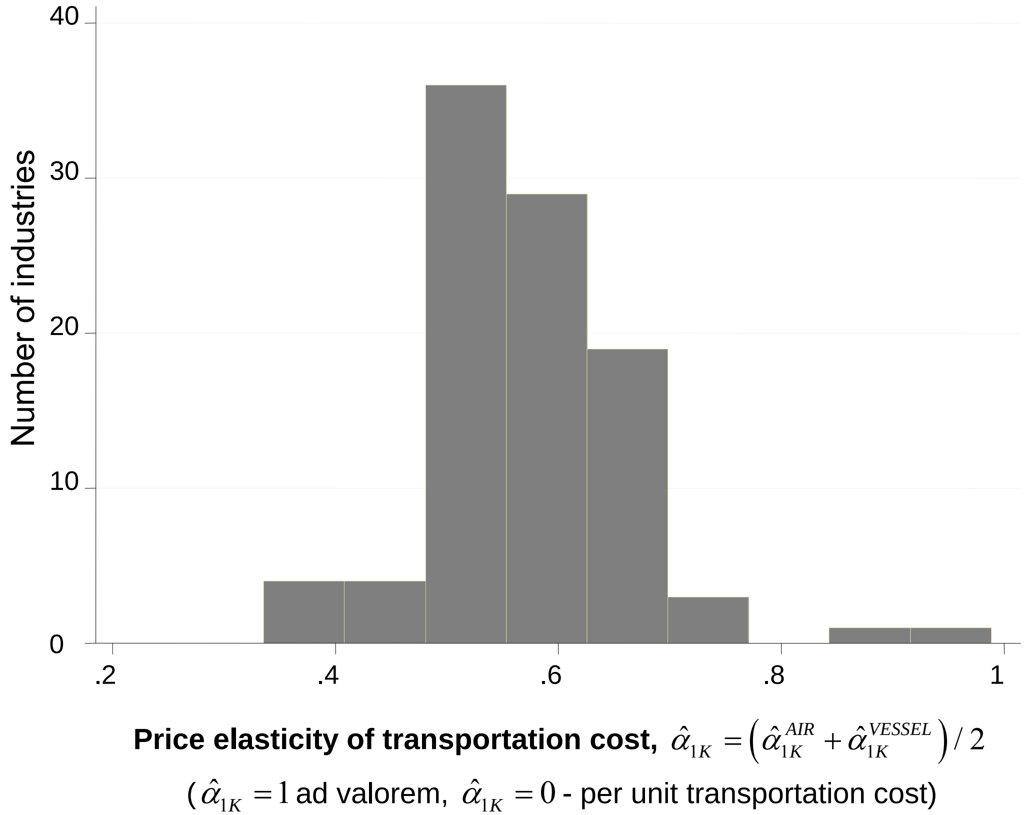

Figure 2. Distribution of industries by the average intermodal price elasticity of transportation cost

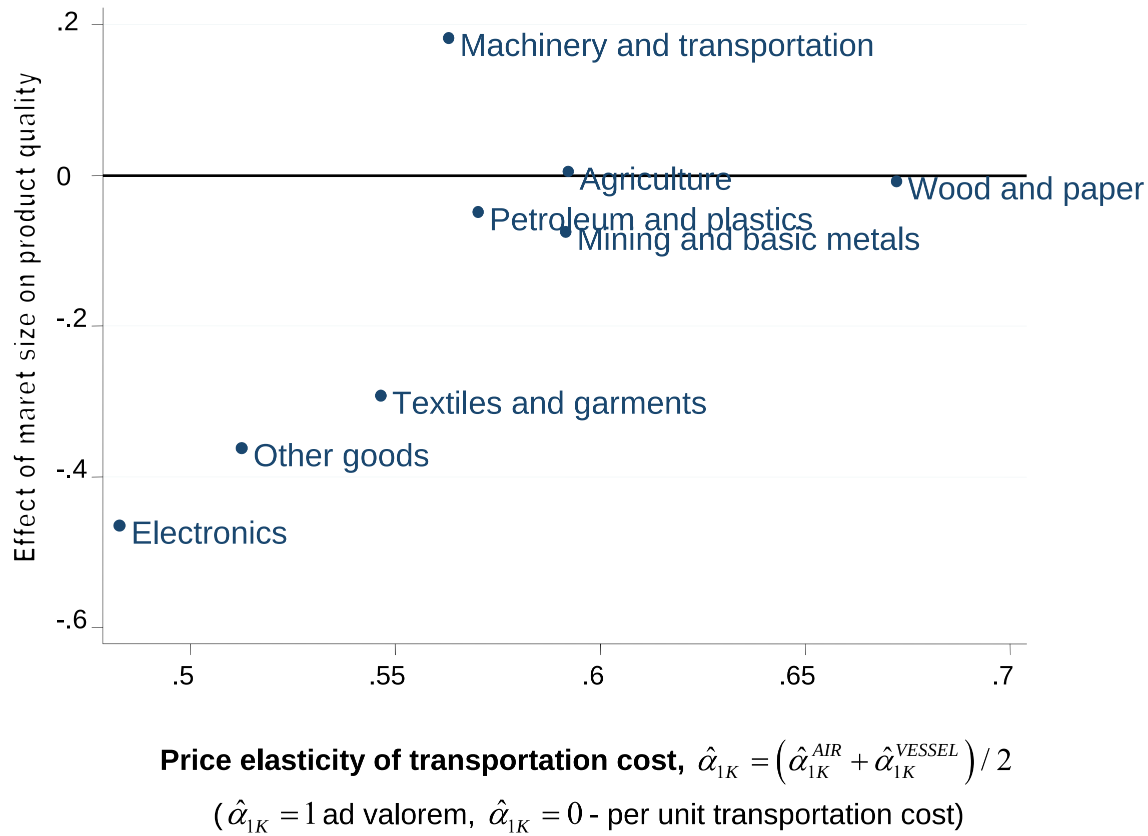

Figure 3. Market Size Effect and Price Elasticity of Transportation Costs.