CHINA'S LOCAL COMPARATIVE ADVANTAGE

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Abstract
China's trade pattern is influenced not just by it's overall comparative advantage in labor intensive goods but also by geography. We show theoretically that since trade costs are proportional to weight rather than value, relative distance affects local comparative advantage as well as the overall volume of trade. The model predicts that China has a comparative advantage in heavy goods in nearby markets, and lighter goods in more distant markets. This theory motivates a simple empirical prediction: within a product, China's export unit values should be increasing in distance. We find some evidence for this effect in our empirical analysis on product-level Chinese exports in 2006, although the effect is small.

1 Introduction

China's trading pattern is often seen as an illustration of the power of the Heckscher-Ohlin approach to explaining world trade: labor abundant China specializes in exporting labor intensive goods. A broader Heckscher-Ohlin worldview is also perfectly consistent with China's role in performing the labor-intensive tasks in complex international supply chains.

In this paper, we draw attention to a different determinant of China's comparative advantage: her geographical location. We present a theoretical model of global bilateral trade that builds on the work of Eaton and Kortum (2002) and Harrigan (2006) which shows how China's location influences her competitiveness in different markets around the globe, that is, China's "local comparative advantage". The model also shows how the rise of China differentially affects the competitiveness of other low-wage economies.

The key prediction of the model is that relative transport costs by product and export destination influence China's export success. In particular, the model predicts that China will tend to export "heavy" goods (those with a high transportation cost as a share of value) to nearby export destinations, and will export "light" goods to more distant markets. Furthermore, heavy goods will be sent by ship, while light goods may be shipped by air. Our empirical analysis, which looks at highly detailed Chinese export data in 2006, confirms this prediction of the model: the weight of China's exports is strongly related to distance.

The gravity equation, a relationship between aggregate trade volumes, country size, and distance, is extremely well established empirically and theoretically. Recent research on the trade-distance nexus has started to move beyond the aggregate gravity model, and looks at disaggregated trade in theory and in the data. Relevant papers include Baldwin and Harrigan (2007), Deardorff (2004), Evans and Harrigan (2005), Harrigan (2006), Harrigan and Venables (2006), Hummels (2001), Hummels and Skiba (2004), and Limão and Venables (2002). This line of research has two related purposes: better understanding the effects of distance and transport costs, and enriching our models of comparative advantage. The current paper shares these purposes, along with the goal of better understanding China's comparative advantage in particular. In this it is, we hope, complementary to the other papers in this volume.

2 Theory

In this section we present a general equilibrium model of bilateral trade in a multilateral world where relative distance is a key determinant of comparative advantage. Before moving to an exposition of the model, we introduce the interaction between specific trade costs and trade flows in partial equilibrium.

2.1 Partial equilibrium

The simplest explanation for a relation between export prices and distance is the so-called "Washington apples" effect, which is the basis of the paper by Hummels and Skiba (2004). The theory starts with the observation that per unit transport costs depend primarily on physical characteristics rather than value; that is, they are specific rather than *ad valorem*.

Focusing on a single exporting country, the relationship between import and export prices is given by

$$p_{ic}^{M} = \left(1 + t_{ic}\right) p_{ic}^{X} \tag{1}$$

where p_{ic}^{M} is the c.i.f. import price of good i shipped to country c, p_{ic}^{X} is the f.o.b. export price, and $t_{ic} \geq 0$ is the cost of transport per dollar of value shipped.[1] The usual "iceberg" assumption is that t_{ic} is a function of distance only. This implies that per-unit transport costs are proportional to value and independent of weight, but Hummels and Skiba (2004, Table 1) show that the opposite assumption is closer to the truth. Thus a more realistic assumption about transport costs per dollar of value shipped is that they are given by

$$t_{ic} = \frac{t\left(w_i, d_c\right)}{p_{ic}^{X}} \tag{2}$$

where w_i is weight per unit, d_c is the distance between the exporter and country c, and the function t is non-decreasing in both arguments. In the remainder of the paper, it is appropriate to interpret w as any physical characteristic of the good (such as volume and perishability, in addition to weight in kilos) that affects shipping costs. The specification in (2) has the key implication that shipping costs as a share of f.o.b. price are smaller for higher priced goods, controlling for weight.

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[1] The constant returns to scale assumption that per-unit transport costs are independent of the number of units shipped is inessential.

Now consider a high-priced good H and a low-priced good L, and let

$\tilde{p} = \dfrac{p_H}{p_L}$ denote the price of H in terms of L. Equations (1) and (2) imply that the relative

import price of the two goods in country c is

$$\tilde{p}_c^M = \tilde{p}^X \frac{(1+t_{Hc})}{(1+t_{Lc})} = \tilde{p}^X \frac{\left(1 + \dfrac{t(w_H, d_c)}{p_H^X}\right)}{\left(1 + \dfrac{t(w_L, d_c)}{p_L^X}\right)} \qquad (3)$$

If the two goods weigh the same then the high priced good has lower transport costs as a

share of f.o.b. price, and the ratio of transport factors in (3) will be less than one, so

$\tilde{p}_c^M < \tilde{p}^X$. The law of demand then implies that relative consumption of H will be higher

in country c than at home. This is precisely the "shipping the good apples out" effect:

good apples and bad apples weigh the same, but it is cheaper as a share of value to ship

out the good apples.[2]

The strength of the Washington Apples effect is increasing in distance.[3] The

intuition is simple: as per-unit transport costs increase with distance, the importance of

any difference in f.o.b. prices shrinks.

A similar comparison can be made by reinterpreting the subscripts in (3). Now let

H and L stand for "heavy" and "light" respectively. Then H will be relatively more

expensive in c than at home $\left(\tilde{p}_c^M > \tilde{p}^X\right)$, with obvious effects on relative consumption.

The effect of increasing distance on the strength of this weight effect is in general

ambiguous, and depends on details of the transport cost function $t(w_i, d_c)$[4]. In the case

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[2] The antique textbook by Silberberg (1978, Chapter 11) has a clear discussion of the Washington Apples effect, including some caveats when there are more than two goods.
[3] To see this, note that

$$\frac{\partial \tilde{p}^M}{\partial d_c} = \frac{p_L^X - p_H^X}{\left(p_L^X + t\right)^2} \frac{\partial t}{\partial d_c} \leq 0.$$

In the limit as transport costs go to infinity, f.o.b prices are irrelevant and the c.i.f. relative price is unity.
[4] The relevant cross second derivative is

$$\frac{\partial^2 \tilde{p}^M}{\partial w_H \partial d_c} = \frac{-1}{\left(p_L^X + t(w_L, d_c)\right)^2}\left[\frac{\partial t(w_H, d_c)}{\partial w_H} \frac{\partial t(w_L, d_c)}{\partial d_c}\right] + \frac{1}{p_L^X + t(w_L, d_c)} \frac{\partial^2 t(w_H, d_c)}{\partial w_H \partial d_c}.$$

The first term is negative and the second term is positive, so this derivative can not be signed.

where $t(w_i, d_c)$ has constant elasticities with respect to distance and weight, the effect of greater distance is to amplify the importance of any differences in weight for import prices. Economic intuition suggests that this will be the normal case, unless $t(w_i, d_c)$ increases more rapidly with distance when evaluated at w_L than when evaluated at w_H in some relevant range.

These results about the effect of transport costs on import prices can be restated in terms that will be relevant to our empirical analysis, where we look at variation in export prices from China to different destinations. In our analysis, we will consider narrowly defined product categories that nonetheless may comprise many different goods with differing unit values and different weights per unit.

First, the Washington Apples effect implies a composition effect: since high-quality goods will be relatively less expensive at greater distances, we should expect higher average unit values across countries as a function of distance.

Second, goods with the same value per unit that differ in weight are subject to the weight-composition effect: distance raises the relative price of heavy goods, which will cause the value-weight ratio to be increasing in distance. Clearly the Washington Apples effect and the weight-composition effect are closely related. Indeed, if goods within a category differ only in their value and not their weight, then unit values are proportional to the value-weight ratio, and the two effects are identical.

A final composition effect comes from differences in demand across importers. If higher income countries demand proportionately more higher quality goods, and/or if Chinese exporters price discriminate against high-income importers, then we would also expect a positive association between importer per-capita income and average export unit values from China. See Hallak (2006) for evidence on the relation between income per capita and the demand for quality, and Feenstra and Hanson (2004) for some evidence on price discrimination in Chinese exports.

2.2 General equilibrium

The Washington apples effect offers a useful starting point for thinking about the effect of specific trade costs on trade patterns, but since it takes f.o.b. prices as given it can not be considered a model of trade. Here we embed the partial equilibrium mechanism in a

general equilibrium model to address the question: how does China's position on the globe influence its trade pattern?

Our model has N countries, one factor of production (labor), and a continuum of final goods produced under conditions of perfect competition. Goods are symmetric in demand and in expected production cost. Physical geography is unrestricted, and summarized by the matrix of bilateral distances with typical element d_{cb} denoting the distance between countries b and c. As in Eaton and Kortum (2002), firms located in each country compete head-to-head in every market in the world, with the low-cost supplier winning the entire market. A firm's cost in a particular market depends on its' f.o.b. price and on transport costs between the firm's home and the market (this cost is normalized to zero if the market in question is the home market). By perfect competition, f.o.b. price equals the wage divided by unit labor productivity, which is stochastic. Firms located in c have productivity distributed according to the Fréchet distribution with parameters $T_c > 0$ and $\theta > 1$. With this distribution, the log of productivity has mean $\dfrac{\gamma + \log T_c}{\theta}$ and standard deviation $\dfrac{\pi}{\theta\sqrt{6}}$, so that smaller values of θ imply greater dispersion in productivity[5].

As in Harrigan (2006), consumers value goods which are delivered by air more than goods delivered by ship. Some of the reasons for such a preference are analyzed by Evans and Harrigan (2005) and Harrigan and Venables (2006), but for the purposes of this model we will simply suppose that utility is higher for goods that arrive by air. Let the set of goods shipped by air be A, with measure also given by A. Utility is

$$U(x(z)) = \int_{z \in A} a \ln x(z)dz + \int_{z \notin A} \ln x(z)dz \qquad (4)$$

where $a > 1$ is the air-freight preference, x is consumption, and $z \in [0,1]$ indexes goods. An implication of (4) is that for a given good, the relative marginal utility if it arrives by air versus ship is a.

We now consider the problem of an exporter in c choosing the optimal shipping mode for selling in b. Let $\tau_{cb}^{A}\left(w(z), d_{cb}\right) \geq 1$ be the iceberg shipping cost for air shipment

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[5] The constants are $\gamma = 0.577...$ and $\pi = 3.14159....$ See Eaton and Kortum (2002) for more on the Fréchet distribution and its interpretation.

of good z from c to b, with $\tau_{cb}^{S}\left(w(z),d_{cb}\right)$ defined similarly for surface shipment. Given the premium a that consumers are willing to pay for air shipment, the optimal shipping mode is

$$\tau_{cb}\left(z,d_{cb}\right)=\tau_{cb}^{A}\left(w(z),d_{cb}\right) \quad \text{if} \quad \frac{\tau_{cb}^{A}\left(w(z),d_{cb}\right)}{a}\leq\tau_{cb}^{S}\left(w(z),d_{cb}\right)$$

$$\tau_{cb}\left(z,d_{cb}\right)=\tau_{cb}^{S}\left(w(z),d_{cb}\right) \quad \text{otherwise.} \tag{5}$$

What are the properties of the transport cost functions? First, order goods by weight, with $z=0$ being the lightest and $z=1$ the heaviest. We will make three assumptions about the transport cost functions $\forall b,c, \quad z\in[0,1]$:

a. *Air shipping is expensive*

$$\tau_{cb}^{S}\left(w(z),d_{cb}\right)\leq\tau_{cb}^{A}\left(w(z),d_{cb}\right) \tag{6a}$$

b. *Air shipping is proportionately more expensive for heavier goods*

$$\frac{\partial\ln\tau_{cb}^{S}}{\partial\ln z}\leq\frac{\partial\ln\tau_{cb}^{A}}{\partial\ln z} \tag{6b}$$

c. *The cost disadvantage of air shipment declines with distance*

$$\frac{\partial\ln\tau_{cb}^{S}}{\partial\ln d_{cd}}\geq\frac{\partial\ln\tau_{cb}^{A}}{\partial\ln d_{cd}} \tag{6c}$$

The truth of the first assumption, that air shipment is always more expensive than surface shipment, is obvious to anyone who has ever traveled or shipped a package. The second assumption, that surface shipping costs increase more slowly with weight than air costs, is also reasonable, and is consistent with light goods being much more likely to be shipped by air (see Harrigan (2006),Table 10, for statistical confirmation of this commonplace observation). The final assumption is consistent with the fact that air shipment is almost never used on short distances. Assumption (6c) is also consistent with a model of a demand for timely delivery: for short distances, timely delivery can be assured by (cheap) surface shipment, while for longer distances only (costly) air shipment can ensure timeliness.

For any pair of countries, the optimal shipping mode will be a function of weight. It is possible that even the lightest goods will be shipped by surface, and it is also possible that even the heaviest goods will be shipped by air. But the normal case in world

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trade is that some goods are shipped by each mode (for example, for US trade in 2005, every exporter except Sudan sent some goods by air and some by surface). Let $\overline{z}_{cb}$ denote the dividing line between air shipped goods $\left(z \le \overline{z}_{cb} \right)$ and goods shipped by surface $\left(\overline{z}_{cb} < z \right)$ in trade between c and b. By assumption (6c), the cutoff will be lower for nearby countries than for faraway countries. These relationships are illustrated in Figure 1 for exports from China to two countries, one near and one far. In the figure, we illustrate assumption (6b) by having surface transport costs unrelated to weight while air transport costs are increasing in weight.

As noted in the previous section, the iceberg assumption is not realistic and rules out the important Washington Apples effect on relative c.i.f. prices. It was also noted that the Washington Apples effect and the weight-composition effect are very closely related. In the specification used in the current section, a Washington Apples-like effect appears through the influence of weight on transport costs. Because of symmetry in supply and demand, expected f.o.b. prices from a given exporter are the same for all goods, but c.i.f. prices differ due to differences in weight.

We now turn to a discussion of the trade equilibrium. As discussed in Harrigan (2006), wages in each country c are endogenous, and will be determined by the aggregate productivities T_c, labor supplies, and bilateral distances. In this paper we analyze a single country's exports across its trading partners, and thus can treat wages as fixed.

In keeping with the focus of the paper, we will consider China's probability of successfully competing in different markets and in different goods. In the Eaton-Kortum model, the probability that China will supply a given market b is the same for all goods (their equation (8)). In the current model, the probability varies, and will depend on $\tau_{cb}\left(z, d_{cb} \right)$ for all countries c. With this modification the Eaton-Kortum logic goes through otherwise unchanged, so the probability that China will supply good z to country b is

$$\pi_{Cb}\left(z \right) = \frac{T_C \left[w_C \tau_{Cb}\left(z, d_{Cb} \right) \right]^{-\theta}}{\displaystyle\sum_{c=1}^{N} T_c \left[w_c \tau_{cb}\left(z, d_{cb} \right) \right]^{-\theta}} = \frac{T_C \left[w_C \tau_{Cb}\left(z, d_{Cb} \right) \right]^{-\theta}}{\Phi_b\left(z \right)} \qquad (7)$$

The summation in the denominator $\Phi_b(z)$ in (7) includes country b, which reflects the fact that good z might be produced domestically rather than imported.[6] The economics of (7) are fairly simple. The probability that China successfully captures the market for good z in country b depends positively on China's absolute advantage T_C and negatively on China's wage and transport cost to b, relative to an average of world technology levels and wages weighted by transport costs to the same market.

2.3 Implications of Chinese growth for China's competitors

A great virtue of the Eaton-Kortum model is that it is a fully competitive general equilibrium model. Alvarez and Lucas (2005) point out that this implies that all the properties that are known about such models in general can be applied to Eaton and Kortum's model. Unfortunately, the Eaton-Kortum model has no general analytical solution for equilibrium wages, which makes comparative static analysis problematic. In this section, we show that despite its' analytical complexity the model can be used to answer some important questions about how the rise of China affects the trade performance of China's competitors.

We begin by assuming costless trade. In this case, Alvarez and Lucas show that equilibrium wages are

$$w_c = \left(\frac{T_c}{L_c}\right)^{1/1+\theta}$$

where L_c is country c's labor force. National income is

$$Y_c = w_c L_c = T_c w_c^{-\theta} = \left(\frac{T_c}{L_c}\right)^{1/1+\theta} L_c = T_c^{1/1+\theta} L_c^{\theta/1+\theta} \tag{8}$$

Thus, national income is a geometric average of a country's technology level and its labor supply. Setting all transport factors $= 1$, substitution of (8) into (7) implies

$$\pi_{Cb}(z) = \frac{Y_C}{\sum_{c=1}^{N} Y_c}$$

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[6] Here and in what follows we let C stand for China, while c is a generic index for any country.

Thus we have that in the frictionless case, the probability that China supplies a given good z to any country is simply China's share in global GDP.

Now re-introduce transport costs. For small transport costs this won't affect national income much, so we can replace $T_c w_c^{-\theta}$ by Y_c in (7). This gives the following approximation to (7),

$$\pi_{Cb}(z) \simeq \frac{Y_C \tau_{Cb}^{-\theta}}{\sum_{c=1}^{N} Y_c \tau_{cb}^{-\theta}} \simeq \frac{Y_C \tau_{Cb}^{-\theta}}{\Phi_b} \tag{9}$$

Since equation (9) is independent of z, we can integrate over z and reinterpret (9) as giving China's market share in country b. This result is useful because it links China's market share to observables. Because a change of subscripts makes (9) applicable to every country's sales in every other country, it also allows us to analyze how international competition is affected by Chinese growth.

By the same reasoning used to derive (9), we have the approximation

$$\Phi_b \simeq \sum_{c=1}^{N} Y_c \tau_{cb}^{-\theta}$$

This term is very similar to the country price indexes derived by Anderson and van Wincoop (2003). It is also close to what Harrigan (2003) defines as a country's "centrality" index, which is a GDP-weighted average of a country's inverse bilateral trade costs. It is larger the closer b is to big countries: Belgium will have a large value of Φ_b, while New Zealand will have a small value.

A natural way to consider the impact of China's growth on its neighbors in this model is to ask how an improvement in China's technical capability T_C affects China's export market share. By (8) and (9) we have

$$T_C \frac{\partial \pi_{Cb}}{\partial T_C} \simeq \pi_{Cb}(1 - \pi_{Cb}) \tag{10}$$

This expression says that a one percent improvement in T_C raises China's market share in all markets, but the largest gain comes where China's share is already large.[7] The effect on some other country k's market share in b when China grows is given by

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[7] To see this, note that $\pi_{Cb}(1 - \pi_{Cb})$ is increasing in π_{Cb} for $\pi_{Cb} < 0.5$, a condition that holds in the data $\forall b$.

$$T_C \frac{\partial \pi_{kb}}{\partial T_C} \simeq -\pi_{Cb}\pi_{kb} \tag{11}$$

Equation (11) states that the biggest market share losses are felt by countries that have large market share where China also has large market share.

Equations (10) and (11) show the impact effect of an increase in T_C before equilibrium adjustments in world wages and trade flows. As noted above, analytical solutions for these general equilibrium effects are not available, but we can conjecture some effects. Since the impact effect of Chinese growth is largest in markets where China already has a substantial presence, the increased competition from China will be felt most keenly in precisely these markets. By (7), these locations will be markets that are close to China and far from the rest of the world, such as East and Southeast Asia. With China's market share rising in these markets, other countries that sell there will suffer loss of market share given by (11), with consequent reductions in factor demand. These negative factor demand effects in export markets are of course balanced by the consumption gains from cheap Chinese imports at home, with the net effect on real income uncertain. This is an application of an old but sometimes neglected point from trade theory: in a multi-country trade model, technological progress in one country may lower real income in some other countries even as it raises global real income.

2.4 Testable predictions for Chinese export data

We can use (7) to generate testable predictions about China's export unit values. For a given good z, increases in distance reduce the probability of export success. This is simply the usual gravity effect operating through the extensive margin.

Now consider some set of goods $Z \subseteq [0,1]$. For every good $z \in Z$, the extensive margin effect of distance is operative. However, given our characterization of trade costs in (6), it is clear that the extensive margin effect is stronger for heavier goods. That is, as distance increases, the probability that a heavy good will be successfully exported decreases faster than the same probability for a lightweight good.

Next consider a heavy good and a light good $z^H, z^L \in Z$. If both goods are exported from China to some group of markets, the weight-composition effect discussed in Section 2.1 is operative: the more distant the market from China, the greater the

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relative c.i.f. price of z^H, and thus the greater the share of z^L in local consumption. If goods weigh the same $\forall z \in Z$, the (very similar) Washington Apples logic will apply: high-quality goods will be "light" in the sense of having low shipping costs as a share of f.o.b. value, and thus their relative c.i.f. price will be lower, and consumption higher, in more distant markets. These are intensive margin effects, since they describe how relative consumption of goods actually exported changes with distance.

With an understanding of how the extensive and intensive margins for goods $z \in Z$ operate as a function of distance, we can now answer the following question: how does the average unit value of exports vary with distance? From what we have just elucidated in the previous two paragraphs, the answer is clear, and we highlight it as the key empirical prediction that we will test in the remainder of the paper:

> *Prediction: For a given set of goods, the average unit value of Chinese exports will be non-decreasing in distance, controlling for other determinants of the demand for quality.*

3 Data Analysis

We used highly disaggregated Chinese export data from 2006. Exports are reported by 8-digit Harmonized System (HS) code, importing country, province of origin, type of exporting firm (seven categories that we aggregate as state or collective owned and private), type of trade (18 categories that we aggregate as ordinary, processing, and other), and transport mode (air and sea). Export destinations are classified by the location of the final consumer.

3.1 Specification

As discussed in section 2.4, we are primarily interested in variation in Chinese export unit values across importing countries. The theory is silent about the appropriate degree of aggregation across products, and we would expect the composition effects to work across broad product categories: China should export heavy products to nearby markets and lighter goods to more distant markets. Nonetheless, there are two compelling reasons to analyze the predictions of the model using the most disaggregated data possible. The first reason is simply that different HS8 categories are measured using different units, and it is literally meaningless to compare unit values measured as (for

example) dollars/kilo and dollars/(number of shirts). The second reason is related, which is that there are systematic differences in unit values and per-unit transport costs even among goods measured in common physical units (for example, dollars/(kilos of diamonds) and dollars/(kilo of coal)). Thus, in all specifications we will include product fixed effects that remove product specific means and identify remaining parameters using solely cross-country variation.

Province of origin, transport mode, firm type and trade type as are characteristics of exports that are quite likely to be jointly determined with unit value, and so can not be considered exogenous to an equation that explains unit values. Feenstra and Spencer (2005) provide a model and analysis of Chinese export data that support this supposition , although they focus on geographical variation within China rather than across China's export markets. These concerns motivate the following specification, where we pool across all characteristics of exports except product and destination

$$v_{ic} = \alpha_i + \beta_d d_c + \beta_y y_c + error \qquad (12)$$

where

v_{ic} = log unit value of exports of product i from China to country c

α_i = fixed effect for 8-digit HS code i

d_c = distance of c from Beijing.

y_c = log real GDP per capita of c in 2004.

The fixed effect α_i will remove any average differences in unit values across products, so that the estimated distance elasticity is meaningful. Note that export values are measured f.o.b, so they do not include transport charges. The model predicts $\beta_d > 0$: across importers within an 8-digit commodity category, China will sell higher unit value goods to more distant importers.

Notwithstanding the comments above about the endogeneity of customs regimes and firm types, preliminary data mining reveals large differences in unit values associated with these categories. This suggests that pooling across all such categories as done in (12) may cause aggregation bias. To address this issue, we estimate a model which has separate intercepts and slopes for different customs regimes and firm types. Letting these categories be indexed by j, this model is

$$v_{ijc} = \alpha_i + \alpha_j + \sum_j \left(\beta_{jd} d_c \right) + \beta_y y_c + error \tag{13}$$

We do not specify interactions on the GDP per capita variable because this effect is not our primary focus. Because of the endogeneity of the firm and trade type classifications, interpretation of the β_{jd}'s in (13) will be more reduced form than the interpretation of β_d's in (12).

We measure distance in two ways. The first is simply log kilometers from Beijing to the capital of the importing country, using "great circle" distance. The second breaks distance down into two categories:

1-2500km	Korea, Taiwan, Hong Kong, Japan
2500+ km	Rest of world

The motivation for this split can be seen in Chart 1, which compactly illustrates a number of patterns in China's exports. Because of the Pacific Ocean, there is a natural break in distance at 2500 kilometers, with four large trading partners (Korea, Taiwan, Japan, and Hong Kong) being less than this distance from Beijing and most other important trading partners, in particular the US and Western Europe, being at least 5000km away. Note that the limitations of our great circle distance data makes Western Europe seem much closer than it would be for an ocean going freighter. This caveat is not relevant in regressions where we use the binary distance indicator.

As noted above, interpretability of regression coefficients is problematic in (12) and (13) as we are pooling across such disparate goods. To address this, we split the sample in a number of ways:

1. All observations
2. Observations where unit is a count, and where the count is at least 2.
3. Observations where unit is kilos.
4. All of the above cuts restricted to manufactured goods.

In addition, for each regression we drop trade flows below \$10,000, to dampen the measurement error that always plagues unit values.

Before turning to the results, we need to take a detour to discuss the appropriate computation of the covariance matrix for estimates of (12) and (13). We report two sets of standard errors: ones that do and do not "cluster by country". As shown by Moulton

(1990), in a panel where the same value of the explanatory variable is repeated across multiple micro units, not correcting for such repetition may drastically overstate the significance of the repeated variables on the micro units. In our context, the concern is that unmeasured country characteristics may account for the sample correlations between unit values and our observed country characteristics (distance and income per capita), leading to inaccurate inference about the effect of country characteristics on unit values. There are two approaches to correcting for the problem identified by Moulton. The first (proposed by Moulton) is to compute a random effects estimator, with the random effect assumed orthogonal to the observed variables. In our context, this would mean assuming random country effects. In the appendix to Harrigan (2006), it is shown in a similar dataset that computing the random effects estimator has no effects on inference, so we do not pursue this approach here.

The second approach to dealing with Moulton's problem is to compute a non-parametric "clustered" estimator of the covariance matrix. The asymptotic theory behind clustered covariance estimation assumes "many small clusters"; formally, that the number of observations per cluster is fixed while the number of clusters goes to infinity (see Wooldridge (2002), pg 228ff for an exposition). This is exactly the opposite of the characteristics of our sample, where we have a few countries each of which has very many products exported to it, that is, we have "few large clusters". Thus in our view the asymptotic theory of clustered standard errors (which is implemented in the *Stata* `cluster` option) is inappropriate to our application. Nonetheless, in the interests of full disclosure we report clustered standard errors along with the typical robust standard errors.

3.1 Results

Table 1 reports China's top twenty export destinations in 2006. While only 16 percent of Chinese exports are sent by air, there is wide variation across markets. The largest share of exports by air, 35 percent, goes to Malaysia and Singapore, a result that is suggestive of China's role in time-sensitive international production networks. A surprisingly (and suspiciously) high share of exports also goes to Hong Kong by air. See Feenstra *et al* (1999) for a discussion of the difficulties of separating Chinese exports to

Hong Kong and exports through Hong Kong. As always with aggregate international trade data, the importance of gravity (distance and country size) is clearly visible in Table 1.

Table 2 reports results of estimating various versions of equation (12). Focusing first on the full sample, the distance elasticity is 0.022, which is economically significant given the large variation in distance. But this effect is fragile across specifications ranging from -0.016 to 3.9. The indicator variable for distance greater than 2500 km is more consistent: in the full sample the effect is to raise export unit values by 8.4%, and the effect ranges between 2.6% and 9.9% depending on the sample. While not trivial, this effect is much smaller than the distance effect on U.S. import unit values found by Harrigan (2006) and on U.S. export unit values by Baldwin and Harrigan (2007).

While it is not our main focus here, the small size and fragility of the effect of importer GDP per capita on unit values is striking, although consistent with the results of Baldwin and Harrigan (2007) on U.S. data.

Table 3 reports results of estimating various versions of equation (13). The coefficients in the Table are somewhat hard to interpret, so we turn immediately to Table 4, which reports the linear combinations of interest from Table 3. The excluded trade regime category is "other", which accounts for just 4% of total exports. The first two rows report the effect of distance relative to this excluded category, and the estimated effects are much larger and more stable than seen in Table 2. For Ordinary trade, the effect of distance is to raise export unit values by 14% in the full sample, and by 12% for manufactured goods, an effect which is quite precisely estimated. For Processing trade, the effect is 14% in the full sample, an effect which jumps around a bit depending on the sub sample but which is always positive and (for manufactured goods) statistically significant and economically important.

The final row of Table 4 shows that, relative to goods from state and collectively owned enterprises, the effect of distance on unit values is negative for private and foreign firms. This is a puzzling result about which we have little more to say.

4 Conclusion

There is little doubt that China has an overall comparative advantage in labor intensive goods. In this paper, we have argued that understanding Chinese trade also requires accounting for *local* comparative advantage: products where China has a competitive advantage in some locations but not others.

In our formulation of Deardorff's (2004) concept of local comparative advantage, we focus on cost differences due to differences in transport costs and the transport-intensity (weight) of goods. In the theory section, we showed that China could be expected to have a comparative advantage in heavy goods in nearby markets, and lighter goods in more distant markets. This theory motivates a simple empirical prediction: within a product, China's export unit values should be increasing in distance. We find strong though not overwhelming evidence for this effect in our empirical analysis. Splitting up China's export markets into two groups, one nearby (Korea, Taiwan, Hong Kong, and Japan) and one more than further away, we find that the average unit value of exports sent beyond the nearby group is about 14% higher[8].

Beyond its relevance to Chinese trade, we believe this paper makes the broader point that economists should strive to escape the powerful field exerted by the gravity model. Understanding the effect of distance on economic activity is an important intellectual and policy issue, and much can be accomplished outside the gravity framework.

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[8] We refer here to the coefficients in the first two rows of the first column of Table 4.

Figure 1 - Optimal transport mode choice for Chinese exporters

$\dfrac{\tau_u^A}{a}$

τ_u^S

$\dfrac{\tau_k^A}{a}$

τ_k^S

$z = 0$ $\overline{z}_k$ $\overline{z}_u$ $z = 1$
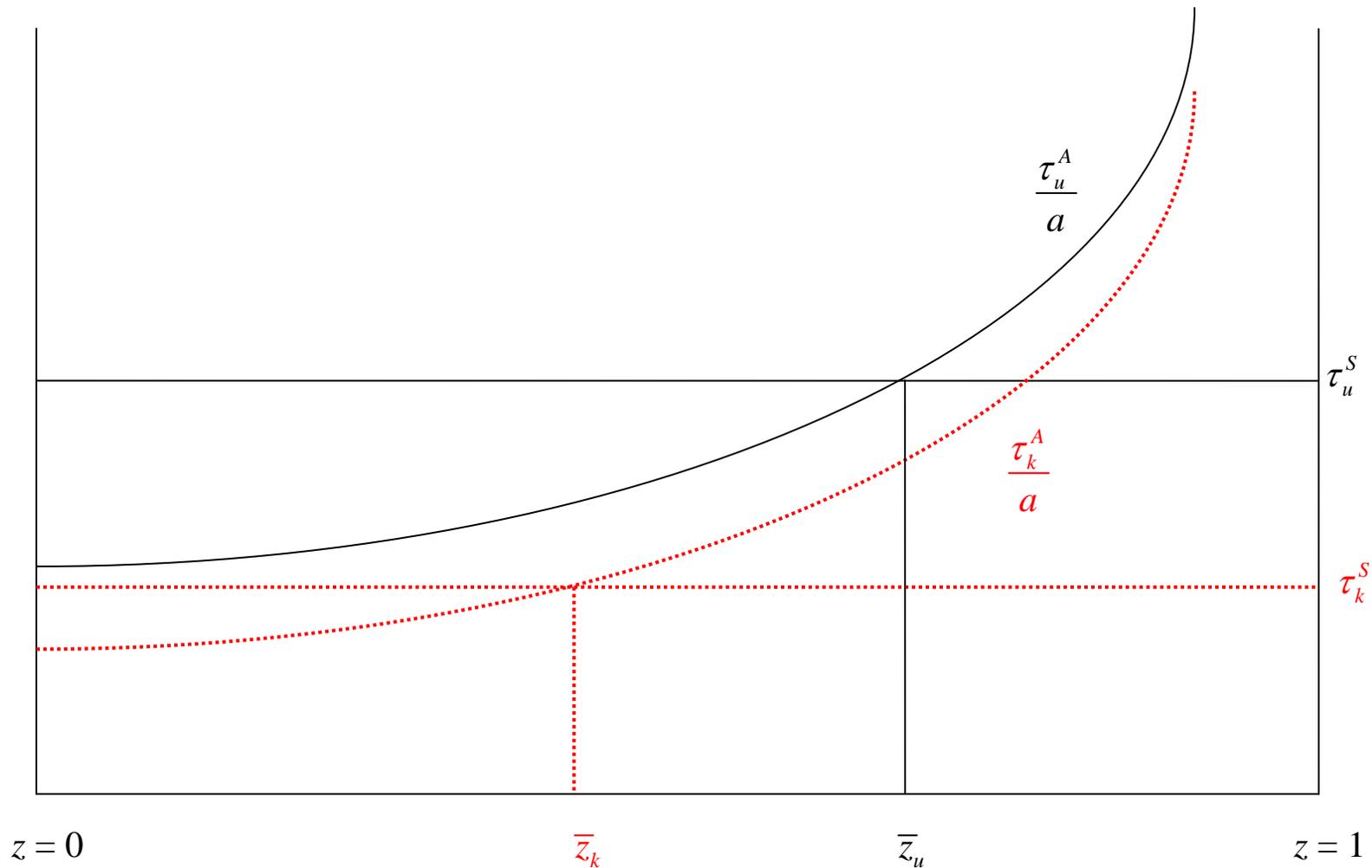
Notes to Figure 1: Vertical axis is iceberg transport cost factor, horizontal axis indexes weight from lightest ($z = 0$) to heaviest ($z = 1$). Country k ("Korea") is relatively close to China, while country u ("United States") is further away. The horizontal lines are surface transport costs, and the upward sloping lines are air transport costs relative to the air preference parameter a. The vertical lines show the division between optimal mode choices for the two destinations. See text for further discussion.

Chart 1 - China's export markets, 2006
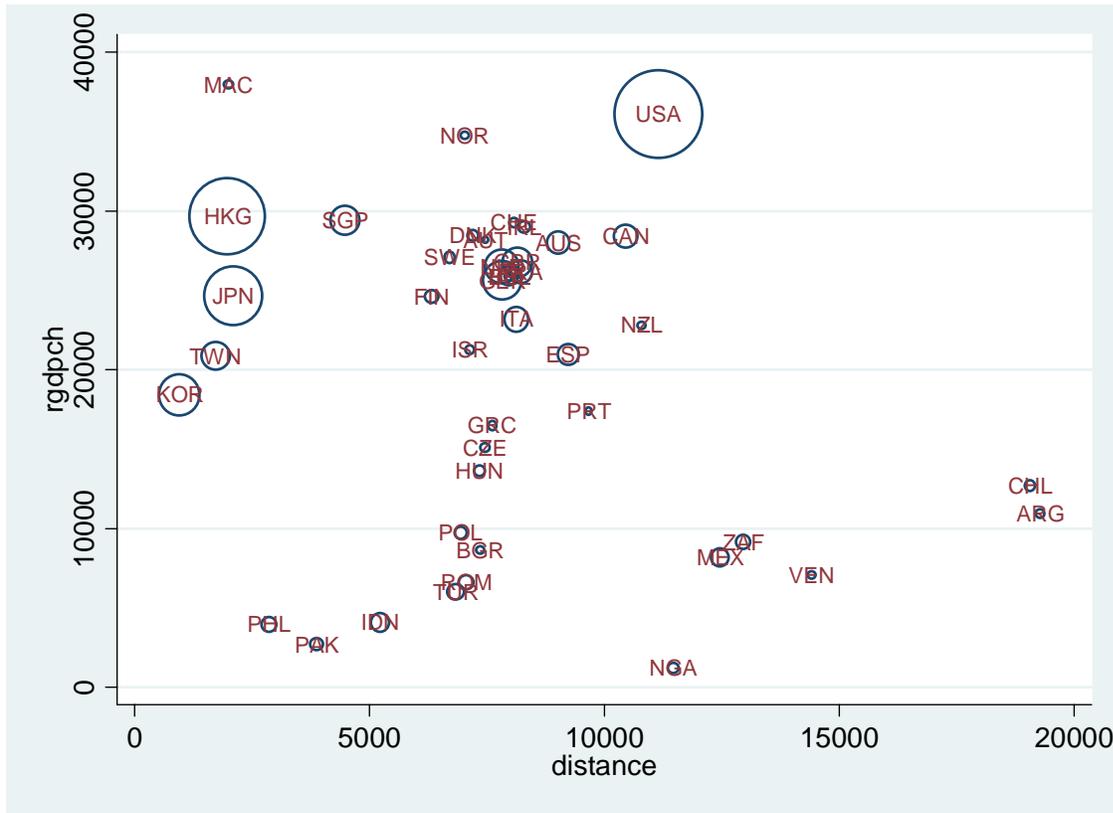
Notes to Chart 1: Vertical axis is real GDP per capita, horizontal axis is distance in kilometers from Beijing. Size of circles is proportional to China's exports to indicated country. All markets where China sold at least $1 billion in 2006 are depicted.

Table 1 - China's top 20 export markets, 2006

	distance from Beijing	Exports ($ billions)	% exports sent by air
United States	11,154	203	19
Hong Kong	1,979	155	12
Japan	2,102	92	15
Korea	956	45	14
Germany	7,829	40	33
Netherlands	7,827	31	22
United Kingdom	8,146	24	15
Singapore	4,485	23	35
Taiwan	1,723	21	26
Italy	8,132	16	9
Russia	5,799	16	7
Canada	10,458	16	12
India	3,781	15	17
France	8,222	14	26
Australia	9,025	14	14
Malaysia	4,351	14	35
Spain	9,229	12	9
United Arab Em.	5,967	11	7
Belgium	7,969	10	14
Thailand	3,301	10	16

Table 2 - China Export Unit Value Regressions, 2006

	All products					
	all units		unit = count, >1		unit = kilos	
log importer GDP/capita	0.065 *22.62* [*4.74*]	0.070 *24.00* [*5.16*]	-0.016 *-2.50* [*-0.71*]	-0.010 *-1.62* [-0.48]	0.117 *42.65* [*9.34*]	0.121 *43.89* [*9.52*]
log distance	0.022 *6.76* [*0.84*]		-0.016 *-2.20* [*-0.44*]		0.039 *11.10* [*1.60*]	
distance > 2500km		0.084 *12.29* [*1.21*]		0.048 *3.11* [*0.56*]		0.099 *13.43* [*1.45*]
R^2 within	0.0047	0.0055	0.0002	0.0004	0.0220	0.0231
HS 8 fixed effects	6,820		1,951		4,334	
N	155,419		55,280		87,868	

	manufacturing products only					
	all units		unit = count, >1		unit = kilos	
log importer GDP/capita	0.047 *12.05* [*3.07*]	0.050 *12.87* [*3.41*]	-0.030 *-4.18* [*-1.28*]	-0.024 *-3.40* [-1.08]	0.116 *30.24* [*9.10*]	0.118 *30.44* [*9.37*]
log distance	.0008 *0.18* [*0.03*]		-0.013 *-1.51* [*-0.36*]		0.004 *0.86* [*0.17*]	
2500+ km		0.045 *4.81* [*0.65*]		0.052 *3.02* [*0.67*]		0.026 *2.36* [*0.37*]
R^2 within	0.0023	0.0026	0.0006	0.0008	0.0245	0.0246
HS 8 fixed effects	3,608		1,538		1,644	
N	95,534		43,477		41,497	

<u>Notes to Table 2</u>: Independent variable is log Chinese bilateral export unit value by HS8 and importer. Robust *t*-statistics are in *italics*, *t*-statistics clustered by country are in [*italics*]. Observations with export value less than $10,000 excluded from sample.

Table 3 - China Export Unit Value Regressions, 2006
with trade type and firm type controls

	all observations			manufacturing only		
	all units	unit = count, >1	unit = kilos	all units	unit = count, >1	unit = kilos
log importer GDP/capita	0.058	-0.013	0.108	0.041	-0.021	0.102
	24. 04	*-2.71*	*46.46*	*12.89*	*-3.76*	*30.41*
	[*4.43*]	[*-0.52*]	[*10.14*]	[*2.82*]	[*-0.79*]	[*9.07*]
Far = 2500+ km	-0.191	-0.177	-0.206	-0.180	-0.099	-0.270
	-11.35	*-5.91*	*-10.22*	*-8.40*	*-3.04*	*-9.20*
	[*-1.81*]	[*-1.46*]	[*-2.21*]	[*-1.55*]	[*-0.92*]	[*-2.24*]
Far × Ordinary trade	0.330	0.303	0.353	0.299	0.218	0.387
	18.83	*9.34*	*17.07*	*13.29*	*6.16*	*12.82*
	[*5.19*]	[*4.83*]	[*6.15*]	[*4.12*]	[*3.93*]	[*4.38*]
Far × Processing trade	0.331	0.436	0.238	0.358	0.349	0.366
	17.24	*12.56*	*10.46*	*14.51*	*9.16*	*11.00*
	[*5.67*]	[*4.99*]	[*5.55*]	[*4.94*]	[*4.18*]	[*4.27*]
Far × Private and Foreign	-0.088	-0.133	-0.061	-0.114	-0.117	-0.120
	-9.13	*-6.51*	*-5.83*	*-8.80*	*-5.10*	*-7.48*
	[*-2.81*]	[*-2.76*]	[*-2.28*]	[*-3.40*]	[*-2.38*]	[*-4.00*]
Private and Foreign Firms	0.136	0.180	0.127	0.152	0.132	0.209
	15.13	*9.26*	*13.01*	*12.41*	*6.04*	*13.87*
	[*5.25*]	[*4.15*]	[*5.87*]	[*5.35*]	[*2.95*]	[*9.02*]
Ordinary trade	-0.616	-0.554	-0.661	-0.617	-0.451	-0.796
	-38.28	*-18.28*	*-34.87*	*-29.79*	*-13.70*	*-28.48*
	[*-12.74*]	[*-13.12*]	[*-14.03*]	[*-10.45*]	[*-16.11*]	[*-9.98*]
Processing trade	-0.459	-0.477	-0.456	-0.479	-0.408	-0.574
	- 26.25	*-14.77*	*-22.27*	*-21.24*	*-11.56*	*-19.00*
	[*-9.10*]	[*-6.30*]	[*-11.51*]	[*-7.45*]	[*-5.78*]	[*-6.93*]
R^2 within	0.0208	0.0128	0.0411	0.0214	0.0091	0.0643
HS 8 fixed effects	6816	1944	4331	3575	1508	1642
N	334,858	130,524	179,457	210,195	101,015	87,960

Notes to Table 3: Independent variable is log Chinese bilateral export unit value by HS8, importer, type of firm (state-collective and private-foreign), and customs regime (ordinary, processing, and other). Robust *t*-statistics are in *italics*, *t*-statistics clustered by importer are in [*italics*]. Observations with export value less than $10,000 are excluded from sample. Excluded dummy variables are "0-2500 km", "other" customs regime, and "state-owned and collective" firm type. Therefore, the coefficients on far in regressions above are the effects of distance on unit values of "other" customs regimes and state firms.

Table 4 – Effect of distance on export unit values,
by customs regime and firm type, 2006

	all observations			manufacturing only		
	all units	unit = count, >1	unit = kilos	all units	unit = count, >1	unit = kilos
Far + (Far × Ordinary Trade)	0.139 *17.7* [*2.04*]	0.126 *7.13* [*1.38*]	0.147 *17.2* [*2.12*]	0.119 *11.2* [*1.94*]	0.119 *6.00* [*1.58*]	0.117 *9.18* [*1.83*]
Far + (Far × Processing Trade)	0.140 *12.2* [*1.39*]	0.259 *11.7* [*2.34*]	0.032 *2.45* [*0.332*]	0.178 *11.8* [*1.88*]	0.250 *9.94* [*2.24*]	0.096 *5.01* [*1.17*]
Far + (Far × Private and Foreign)	-0.279 *15.8* [*2.89*]	-0.310 *9.607* [*2.93*]	-0.267 *12.723* [*3.00*]	-0.294 *12.941* [*2.56*]	-0.217 *6.142* [*2.06*]	-0.389 *12.672* [*3.00*]

Notes to Table 4: This table reports the sum of the coefficients of various linear combinations (left column) for each regression reported in Table 3. The square roots of chi-square statistics of the null that the sum of coefficients is zero are shown in *italics* for non-clustered standard errors and in [*italics*] for clustered standard errors.

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