Factor Endowment Differences, Cost Non-Homotheticity and the Pattern of Home Market Effects Across Countries

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Abstract

This paper develops a factor proportions driven monopolistic competition model of trade with a non-homothetic cost function to examine how home-market effects (HME) vary across countries and industries. I extend the multi-sector framework of Hanson and Xiang (AER 2004) to a two factor case where fixed cost of starting a business is more capital intensive than the marginal cost. Countries with different factor endowments have different extensive and intensive margins of output growth in every sector due to factor price differences. Most importantly, rich and poor countries experience HME in different sectors. For large capital abundant countries, the HME increase in industries exhibiting high trade cost and more differentiated products. This is driven by increasing proportions of extensive margins (new varieties) in these sectors. For large labor abundant countries, the HME rise in sectors with high trade costs and less differentiated products. This is driven by increasing proportions of intensive margins (quantity per variety) in these sectors. I confirm the predictions of the model from bilateral exports data using Hanson and Xiang's difference-in-difference gravity specification. I find strong evidence that rich and poor countries exhibit HME in mutually exclusive sectors and that these effects are driven by different degrees of extensive and intensive margins.(JEL F1, R1)

1 Introduction

International trade theory predicts that industries which produce differentiated goods and are subject to increasing returns tend to concentrate in larger economies when trade is costly. This is known as the home market effect (henceforth, HME; Krugman, 1980). HME occurs because firms gain from scale economies by producing in a single location and locating in the larger economy

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minimizes their transportation costs. Understanding the true nature of industry expansion across growing economies is important in planning for growth and for related expansionary policies.

Most of the literature looking at home market effects uses a model with a single factor (labor), a freely traded homogeneous product industry and a single monopolistically competitive, increasing returns to scale manufacturing industry facing trade costs (see Krugman and Venables (1995) for example). Free trade in the homogeneous sector and incomplete specialization ensure that wages are equal across countries. The single factor of production implies that HME are identical and independent of the countries' factor proportions. Hanson and Xiang (2004) develop a model with a continuum of differentiated goods' sectors with increasing returns, but ignore differences in factor proportions. In their model, the larger country has a higher wage and there is identical patterns of HME and industrialization in every growing country.

To the best of my knowledge there is no empirical or theoretical work on how factor endowment differences can affect the patterns of HME across countries. Davis and Weinstein (1999 and 2003) use a framework that nests an increasing returns model featuring HME with that of a Heckscher-Ohlin model to assess the relative importance of these two theories in accounting for production patterns and trade. They show that both HME and factor proportions play important roles in determining OECD production patterns. This paper advances our knowledge of HME by investigating how the patterns of HME across countries are affected by the factor endowment differences across countries. To undertake this analysis, this paper makes two changes to the standard literature. It extends the multi-sector framework of Hanson and Xiang (2004) to a two factor case and also assumes that fixed costs of starting businesses are more capital-intensive than variable costs.

Recent empirical research by Hummels and Klenow (2005) and Nayak (2011) show evidence respectively from countries' trade flows and industry data that output growth in capital and labor-abundant countries are driven by different rates of expansion of the number of new firms in the market (the extensive margin) and the increase of output of existing firms (the intensive margins). The literature using a two factor monopolistic competition model following Helpman and Krugman (1985) cannot match this empirical fact as it assumes a homothetic cost function with fixed costs and marginal costs having identical capital labor ratio in all countries. This implies that firm sizes are identical across all countries and it is only the growing number of firms that drives output growth.

The assumption of homothetic cost is highly stylized as Helpman and Krugman (1985) note: " ... it [the cost function] implies that the relative factor intensity in activities that generate fixed costs are the same as in activities that generate variable costs. Thus it does not allow for the existence of inputs, like buildings, sights, large scale equipment....which generate mainly fixed costs and contribute negligibly to variable costs." The model in this paper extends the Helpman and Krugman (1985) model of monopolistic competition by assuming that fixed costs are more capital-intensive than marginal costs.[1]

In a related paper using similar assumptions, Nayak (2011) shows this technology implies that capital-abundant countries have a comparative advantage in starting new businesses. Thus, capital-abundant countries expand output primarily through extensive margin growth. A panel data analysis on how firm sizes and number of firms change with capital accumulation across countries provides support for this theoretical conjecture. Nayak (2011) shows the implications of this technology assumption on patterns of trade and production when countries differ in relative factor endowments.

Similar to Nayak (2011), this paper shows that when fixed costs are more capital-intensive than marginal costs, countries with different endowments face *ex ante* identical technologies but choose different techniques of production driven by factor price differences. Factor endowment differences in the model also lead to differences in the extensive and intensive margins of output between countries and between different sectors within a country. Most importantly, factor price non-equalization leads to an interaction of comparative advantage forces with scale effects, predicting that HME is stronger in the more differentiated, high trade cost sectors in capital-abundant countries and it is stronger in less differentiated, high trade cost sectors in labor-abundant countries.

These predictions, are based on a model that integrates the Heckscher-Ohlin model with the multiple sector model by Hanson and Xiang (2004). In the one-factor model of Hanson and Xiang (HX henceforth), agglomeration forces raise demand, generating higher factor prices in larger countries. Since prices are a markup over costs in monopolistic competitive models, larger countries also have higher product prices in all sectors. More differentiable sectors being less sensitive to high prices, larger countries have more HME in more differentiable sectors. Integrating Heckscher

[1] Similar assumptions have been used by the 'footloose capital' (FC) models in the 'new economic geography' literature, though all Heckscher-Ohlin motives of trade are avoided in the FC model by incorporating a costlessly traded homogeneous good and identical factor proportions across countries.

Ohlin with the HX framework implies that the capital-abundance of a country exerts a second force on the relative wages of countries along with agglomeration forces. In this two-factor case, large capital-abundant countries always have higher wages than small labor-abundant countries as both capital-abundance and agglomeration forces raise wages. So the HME for large capital-abundant countries is identical to HME in the HX case. However, when a large labor-abundant country has a lower wage than a small capital-abundant country, its comparative advantage is no longer in the more differentiated sectors. Since labor-abundant countries also have a comparative disadvantage in starting new businesses as fixed costs are more capital-intensive, agglomeration forces are stronger in labor-abundant countries in less differentiated sectors with high trade costs. Therefore, the Hanson and Xiang model can be seen as a limiting case of the model in this paper when factor proportions are equal across large and small countries, and the two factors can be reduced to one.

The empirical verification of the HME relies on the difference-in-difference techniques developed by Hanson and Xiang (2004). The tests for HME are conducted separately for large capital-abundant and large labor-abundant countries, searching HME in different sectors in each case. Analyzing the HME in capital-abundant countries involves comparing bilateral exports of large capital-abundant countries such as the US, Germany and Japan, relative to those of smaller labor-abundant countries like Guatemala, Morocco and Peru. The large capital-abundant countries are expected to have greater HME in more differentiable, high trade cost sectors such as iron and steel and ceramics, relative to more homogeneous low trade cost sectors such as watches and radios. For HME in large labor-abundant countries, the difference-in-difference test involves comparing the exports of large labor-abundant countries, such as China and India, with exports of smaller capital-abundant countries, like Ireland and New Zealand. The large labor-abundant countries are expected to get more HME in less differentiable, high trade cost sectors such as textiles and yarns, than in more differentiable low trade cost sectors such as electronic diagnostic apparatuses and precision machine parts. Figure (1) summarizes this separation of countries and industries for testing HME in capital and labor-abundant countries into two cases. *Case I* in Figure (1) depicts the test for HME in capital-abundant countries. For labor-abundant countries, test strategy is represented in Figure (1) as *Case II.*

I test and confirm these predictions using countries' trade flows data following Hanson and Xiang's methodology. Crucially, not only do the tests confirm that capital-abundant and labor-abundant countries exhibit HME in the different industries as predicted by the model, but also when the industries are switched, they show no evidence of HME in sectors in which they are not predicted to have HME. This confirms the role played by factor endowments in determining the pattern of industry agglomeration as a country grows bigger.

To complete the analysis, I look at how the extensive and intensive margins differ for the labor and capital-abundant countries in the sectors in which they experience HME. Hummels and Klenow (2005) develop a methodology for measuring an index of a country's extensive (number of varieties) and intensive (quantity per variety) margins. Their aggregate measures of countries' extensive and intensive margins give us valuable insight into how rich and poor countries expand their aggregate production along these two margins. Extending their methodology to get estimates of sectoral extensive and intensive margins across countries, I analyze how capital and labor-abundant countries expand sectoral output along the two margins. I show that in capital-abundant countries, home market effects are driven by larger proportions of extensive margins (new varieties), whereas in labor-abundant countries, home market effects are driven by increasing proportions of intensive margins (quantity per variety). This confirms further the assumption that it is easier to expand the number of firms due to the ease of access to capital in richer countries and thereby industry agglomeration is also more conducive in these countries in more differentiable sectors.

The paper is organized as follows. In section 2, I develop a general equilibrium model which solves for the trade equilibrium across two countries differing in factor endowments. Section 3 defines HME and shows how the HME vary across countries differing in sizes and factor endowments. Section 4 tests all HME predictions separately for large labor-abundant and capital-abundant countries. Subsection 4.1 develops the difference-in-difference methodology, while sub-section 4.2 details the results for the test of HME in separate samples of capital and labor-abundant countries and various robustness exercises. Sub-section 4.3 tests the extensive and intensive margin predictions of HME in labor and capital-abundant countries. Section 5 concludes.

2 Two Factor Multi-Sector GE Model

The model assumes the world consists of a large and a small country and departs from the standard models of home market effects both in including a second factor and in its assumption of the cost function. The large country could be either relatively capital-abundant or it could be relatively labor-abundant. Depending on these two cases, I show how the sectors in which the large country experiences HME is different from the sectors in which a large labor-abundant country experiences HME.

I call the two countries North (N) and South (S, S's variables are denoted by *). N and S differ in size and factor abundance ($K/L > K^*/L^*$). I assume preferences and technologies are identical across N and S. Both labor and capital are allowed to move freely across the sectors in a given country, but not across countries.

This model is solved in two steps. First, I solve the partial equilibrium in each industry, focusing specifically on the relative firm sizes, number of firms, the extent and share of intra-industry trade, and how these variables depend on relative factor prices and country sizes. GE factor prices are solved subsequently, which enables us to analyze how home market effects vary in labor and capital-abundant countries.

2.0.1 Representative Consumer's problem

There is a continuum of monopolistically competitive differentiated goods industries denoted by $i \epsilon [0, 1]$. Each industry i faces a constant-elasticity-of-substitution (CES) demand curve with elasticity of substitution σ_i. The number of industry i varieties produced in N and S is given by n_i and n_i^*.

The representative consumer in each country has a two-tier utility function over the continuum of industries i on the interval $[0, 1]$. Each representative consumer has a Cobb Douglas upper-tier utility function with a constant fraction of income b_i being spent on the varieties of goods from industry i. Eqn (1) below denotes the upper-tier utility function where the aggregate shares b_i sums to one,

$$U = \int_0^1 b_i \ln Q(i) di; \qquad \int_0^1 b_i di = 1 \tag{1}$$

In (2), $Q(i)$ is the lower-tier CES sub-utility function denoting the composite consumption from all varieties in industry i from N and S,

$$Q(i) = \left(\sum_{j=1}^{n_i+n_i^*} q_{ij}^{\frac{\sigma_i-1}{\sigma_i}} \right)^{\frac{\sigma_i}{\sigma_i-1}}. \tag{2}$$

The quantity of each variety j consumed is denoted by q_{ij}. In equilibrium all firms are identical and each variety is produced by only one monopolistically competitive firm. Therefore, I drop the index j for each individual firm in an industry.

2.0.2 Equilibrium in an Industry i

From the utility function (equations 1 and 2), the demand facing each North country firm is the sum of the domestic and foreign demands,

$$q_i^D = b_i p_i^{-\sigma_i} \left(\underbrace{Y G_i^{\sigma_i - 1}}_{\text{Home Demand}} + \underbrace{Y^* \tau_i^{1-\sigma_i} G_i^{*\sigma_i - 1}}_{\text{Demand from } S} \right), \tag{3}$$

where τ_i is 'iceberg' trade cost in industry i between N and S and the terms G_i and G_i^* are respectively the industry i price indexes in the N and S and are defined as,

$$G_i^{1-\sigma_i} = n_i p_i^{1-\sigma_i} + n_i^* p_i^{*1-\sigma_i} \tau_i^{1-\sigma_i}, \text{ and } G_i^{*1-\sigma_i} = n_i^* p_i^{*1-\sigma_i} + n_i p_i^{1-\sigma_i} \tau_i^{1-\sigma_i}. \tag{4}$$

Representative Firm Problem and Technology: There are two factors of production, *labor* and *fixed capital.* F_i units of capital is used as investment in fixed production assets per firm in an industry i and c_i is the variable labor input required to make each unit of output in sector i. The rental rate for capital is r and the wage is w. This implies the cost function,[2]

$$C_i = \underbrace{c_i w q_i}_{\text{Variable Costs}} + \underbrace{r F_i}_{\text{Fixed Costs}}. \tag{5}$$

[2] Non-homotheticity of the two factor cost function of the type assumed here has also been used in the 'new economic geography' literature. The footloose capital (FC) model by Martin and Rogers (1995) assumes a technology in the increasing returns sector identical to the one assumed here. Baldwin and Okubo (2006) extend the (FC) model to include firm heterogeneity assuming that fixed costs comprise capital only and variable production costs and fixed export costs use only labor. However, these models assume factor price equalization due to the presence of a costlessly traded homogeneous product industry and free capital mobility. Heckscher-Ohlin motives for trade is avoided by assuming that countries have same factor proportions, but differs only in size. Flam and Helpman (1987) also assumes a non homothetic cost function in a Dixit Stiglitz model.

For analytical tractability, I have assumed the simplest cost function that makes the fixed costs more capital-intensive and the variable costs labor-intensive. The resulting differences with the standard homothetic cost function assumption on equilibrium variables of the model, including the predictions on HME, are highlighted in appendix (A.1). Note also that none of the HME results derived below depend specifically on this simplified cost assumption and I show in the appendix (A.2) that all the HME results derived below continue to hold even when fixed and variable costs include both factors, while maintaining that fixed costs are more capital-intensive than marginal costs.[3]

Given this cost function, a representative firm sets its price to maximize profits,

$$Max\ \pi_i = p_i q_i - c_i w q_i - rF_i. \tag{6}$$

As in the Dixit-Stiglitz (1977) model of monopolistic competition, each identical firm takes the industry price index G_i as given while maximizing (6) subject to the demand (3). The optimized price is a constant mark-up over marginal costs, $p_i = \frac{\sigma_i}{\sigma_i - 1} c_i w$ and reflects closely the cost of labor in a country.

Zero Profits and Free Entry: Replacing the optimal price from the first order condition, the operating profit, which is the total revenue minus the variable costs of production, is,

$$(p_i q_i - c_i w q_i) = \frac{p_i q_i}{\sigma_i}. \tag{7}$$

Free entry and exit implies that profits (6) for all firms in the industry must be zero in equilibrium. Then from (6) and (7) the quantity supplied by each producer is,

$$q_i^s = (\sigma_i - 1) \frac{F_i}{c_i} \frac{r}{w}. \tag{8}$$

As expected, firm scale in (8) increases in fixed costs and falls in variable costs.

[3] The simplified cost structure helps in solving the general equilibrium conditions analytically under cost non-homotheticity.

Production Techniques: The capital intensity of a firm (or its technique) is defined as the ratio of the amount of capital used by a firm per unit of labor it uses, i.e. $\frac{F_i}{c_i q_i^s}$. Substituting the optimal quantity supplied from (8) we get firm technique in industry i as,

$$\frac{K_i}{L_i} = \frac{w}{(\sigma_i - 1)\, r}. \tag{9}$$

Because fixed and variable cost components differ in factor intensities, optimal technique depends on firm scale, and firm scale depends on factor prices through equation (8).

Equilibrium Number of Firms and Industry Output Share of N and S: Quantity supplied (8) by each firm must be equal to quantity demanded (3) from each firm for markets to clear. Equating free entry (zero profit) level of output for a firm, q^s, to its aggregate demand,[4]

$$p_i q_i^s = b_i Y \left(\frac{p_i}{G_i}\right)^{1-\sigma_i} + b_i Y^* \left(\frac{p_i \tau}{G_i^*}\right)^{1-\sigma_i}. \tag{10}$$

Replacing the equilibrium quantity supplied by each firm in N and S from equation (8) into equation (10) and dividing gives,

$$\frac{p_i q_i^s}{p_i^* q_i^{s*}} = \widetilde{r} = \frac{\widetilde{p_i}^{1-\sigma_i} \widetilde{Y} \left[1 + \left(\frac{G_i}{G_i^*}\right)^{1-\sigma_i} \tau_i^{1-\sigma_i} \frac{1}{\widetilde{Y}}\right]}{\left(\frac{G_i}{G_i^*}\right)^{1-\sigma_i} \left[1 + \left(\frac{G_i^*}{G_i}\right)^{1-\sigma_i} \tau_i^{1-\sigma_i} \widetilde{Y}\right]}. \tag{11}$$

where a tilde ('~'), represents the ratio of a N's variable relative to its Southern counterpart.

Simplifying the value of $\left(\frac{G_i}{G_i^*}\right)^{1-\sigma_i}$ using (4) yields,

$$\left(\frac{G_i}{G_i^*}\right)^{1-\sigma_i} = \frac{\widetilde{n}_i \widetilde{p_i}^{1-\sigma_i} + \tau^{1-\sigma_i}}{1 + \widetilde{n}_i \widetilde{p_i}^{1-\sigma_i} \tau^{1-\sigma_i}}. \tag{12}$$

Solving (11) and (12) simultaneously we get $\frac{n_i}{n_i^*}$ as,

$$\frac{n_i}{n_i^*} = \widetilde{n}_i = \frac{\frac{\widetilde{p_i}^{1-\sigma_i}}{\widetilde{r}} (\tau^{2-2\sigma_i} + \widetilde{Y}) - \tau^{1-\sigma_i}(1 + \widetilde{Y})}{\widetilde{p_i}^{1-\sigma_i}(1 + \tau^{2-2\sigma_i}\widetilde{Y}) - \frac{\widetilde{p}^{2-2\sigma_i}}{\widetilde{r}} \tau^{1-\sigma_i}(1 + \widetilde{Y})}. \tag{13}$$

[4] This open economy solution of number of firms and industry shares follows the analysis by Romalis (2004) of the equilibrium without factor price equalization under the changed cost function.

Using (13) we can derive conditions when intra-industry trade exists in industry i. We can also find N's share of production in that industry. Notation is simplified by defining the expression $\widetilde{p_i}^{\sigma_i-1}\widetilde{r}$ as $\widetilde{\rho_i}$. First, using (13), we can get the condition for $n_i^*=0$,[5]

$$\widetilde{\rho_i}=\widetilde{p_i}^{\sigma_i-1}\widetilde{r}\leq\underline{\rho_i}=\left(\frac{\tau_i^{1-\sigma_i}(\widetilde{Y}+1)}{\widetilde{Y}\tau_i^{2-2\sigma_i}+1}\right). \tag{14}$$

This happens when North is the sole producer in the sector and the aggregate world expenditure in the sector $b_i(Y+Y^*)$ goes fully to North's producers. Equation (14) shows that if the elasticity of substitution σ_i, N's relative price $\widetilde{p_i}$ (or relative wage $\widetilde{w}$) and relative rental rate $\widetilde{r}$ are not too high, then North could become the sole producer in the industry. Similarly $n_i=0$ and S captures the entire market if,

$$\widetilde{\rho_i}=\widetilde{p_i}^{\sigma_i-1}\widetilde{r}\geq\overline{\rho_i}=\frac{\widetilde{Y}+\tau_i^{2-2\sigma_i}}{\tau_i^{\sigma_i-1}(\widetilde{Y}+1)} \tag{15}$$

i.e., if N's relative price is high enough, its rental rate is high enough and the industry is less differentiable (i.e. σ_i is high), then S becomes the sole producer in an industry.

Therefore when $\underline{\rho}<\rho<\bar{\rho}$, both North and South produce in a sector and we have intra-industry trade in the sector. Assuming intra-industry trade exists between N and S, the next subsection derives the share of each country in a sector. The appendix (A.3) further proves that $\underline{\rho_i}<\overline{\rho_i}$ when $\sigma_i>1$ and $\tau_i>1$.

North Firms' Share of World Revenues : The North's share in total world output in any industry i is $v_i=\frac{n_ip_iq_i^s}{\left(n_ip_iq_i^s+n_i^*p_i^*q_i^{s*}\right)}$, where each N firm's revenue is p_iq_i and n_i is the total number of firms in N. Dividing the numerator and denominator by $n_i^*p_i^*q_i^{*s}$ and replacing the ratio of the equilibrium quantities supplied by each N and S firm using (8), $\widetilde{q_i^s}=\frac{\widetilde{r}}{\widetilde{w}}$, North's share of total world production in an industry is,

$$v_i=\frac{\widetilde{n_i}\,\widetilde{p_i}\widetilde{q_i^s}}{(1+\widetilde{n_i}\widetilde{p_i}\widetilde{q_i^s})}=\frac{\widetilde{n_i}\widetilde{r}}{(1+\widetilde{n_i}\widetilde{r})}. \tag{16}$$

Substituting the value of $\widetilde{n_i}$ from (13), using the conditions for incomplete specialization from above, denoting $\widetilde{p_i}^{\sigma_i-1}\widetilde{r}=\widetilde{\rho_i}$ and $Y^*+Y=W$, where W is the aggregate world income, North's

[5]This is derived from (13) so that $\frac{n_i}{n_i^*}\longrightarrow\infty$.

share of world revenues can be represented as,

$$v_i = \begin{cases} 1 & \text{if } \widetilde{\rho}_i \leq \underline{\rho_i} \\ \frac{Y}{W}\left[\frac{-\widetilde{\rho}_i \tau_i^{1-\sigma_i}(\frac{Y^*}{Y}+1)+1+\frac{Y^*}{Y}\tau_i^{2-2\sigma_i}}{-\left(\widetilde{\rho}_i+\frac{1}{\widetilde{\rho}_i}\right)\tau_i^{1-\sigma_i}+\tau_i^{2-2\sigma_i}+1}\right] & \text{if } \widetilde{\rho}_i \in \left[\underline{\rho_i}, \overline{\rho_i}\right] \\ 0 & \text{if } \widetilde{\rho}_i \geq \overline{\rho_i}. \end{cases} \tag{17}$$

Therefore, N's share of industry production is a function of its relative size, trade costs and factor prices. Given the equilibrium relative wage and rental rate $\tilde{w}$ and $\tilde{r}$, one can determine a country's share of world production across industries as the relative country size changes and the substitution elasticity (σ_i) of the industry (i) changes. In general equilibrium N's relative wage must be greater than its relative rental rate ($\tilde{w} > \tilde{r}$) for market clearance. I prove this next and use (17) to derive how N's industry share of world production varies across sectors as N's relative size changes and the sector's product differentiability changes.

2.0.3 Equilibrium Factor Prices under Positive Trade Cost:

The factor market clearance conditions in this model for N and S are,

$$\int\limits_{i\epsilon[0,1]} n_i F_i di = \overline{K} \qquad \text{and} \qquad \int\limits_{i\epsilon[0,1]} n_i c_i q_i di = \overline{L} \tag{18}$$

$$\int\limits_{i\epsilon[0,1]} n_i^* F_i^* di = \overline{K}^*, \qquad \text{and} \qquad \int\limits_{i\epsilon[0,1]} n_i^* c_i q_i^{*s} di = \overline{L}^*. \tag{19}$$

When trade is costly, the general equilibrium of this model generates the following results for factor prices in the two countries:

Lemma 1 *When trade is costly, factor markets are cleared if and only if the relatively capital-abundant N has a higher wage rental ratio, i.e. $\tilde{w} > \tilde{r}$.*

Proof. *See the appendix (A.4).* ■

The result derives from the fact that factor price equalization gives identical techniques of production across N and S, so the larger country demands proportionately larger quantities of both factors under costly trade. So factor price equalization cannot clear factor markets in both countries and the only way the factor markets can clear is when the abundant factor is relatively cheaper in both countries in equilibrium.

3 The Home Market Effect

To test for a country's home market effects in an industry, we need to compare the relative industry sizes to the relative size of the country. The relative size of the industry i in a country is described by the country's share of the product i in the world market v_i in equation (17). As seen from this equation, N's share in an industry depends on its size, the trade costs in the industry and the relative factor prices. Controlling for trade costs and other forces of comparative advantage; if a country's output share in a sector is larger than its share of world GDP, the country is defined to exhibit HME in the sector. Using $v_i = \frac{n_i p_i q_i}{b_i(Y+Y^*)}$, i.e. N's share of total world output in the sector from (16), N is said to experience HME in a sector if $v_i > \frac{Y}{Y+Y^*}$ and S will have HME in the sector i if $(1 - v_i) > \frac{Y^*}{Y+Y^*}$.[6]

Depending on whether N or S is the larger country, we can separate the conditions for the larger country's having HME as two distinct cases. The left hand panel A of Figure (1) classifies the possible sizes and per capita capital endowments of countries. It divides countries into large and small (along the Y axis) and capital and labor-abundant (along the X axis). Panel B of the same figure classifies industries by product differentiability and by the degree of trade costs faced. in the following analysis I show that large capital-abundant countries experience higher HME relative to small, labor-abundant countries in *more differentiable, high trade cost sectors.* Large labor-abundant countries experience higher HME than small capital-abundant countries in *high trade cost, less differentiable* sectors. These two cases are depicted in panels A and B of Figure (1) as '*Case I*' and '*Case II*' respectively.

3.1 *Case I* : HME for K-abundant N

Noting that N's share of world exports in industry i is $v_i = \frac{n_i p_i q_i}{b_i(Y+Y^*)}$, its income can be written as the sum of revenues from all sectors,

[6]This definition also matches the definition of 'revealed comparative advantage' (Balassa 1965) of a country in a given sector. Here, however, the test of HME will control for all endowments driven comparative advantages to separate out only the role of a larger market drawing the industries.

$$Y = \int_0^1 n_i p_i q_i di = \int_0^1 v_i b_i (Y + Y^*) di. \tag{20}$$

Writing $\tau_i^{\sigma_i - 1} = x_i$ to simplify notation, we can substitute the value for v_i from (17) to rewrite (20) as,

$$\int_0^1 b_i g_i di = 0, \text{ where, } \quad g_i = \left(\frac{Y}{(x_i \tilde{\rho}_i - 1)} - \frac{Y^* \tilde{\rho}_i}{(x_i - \tilde{\rho}_i)} \right). \tag{21}$$

The appendix A.5 shows the steps in deriving (21) from (20). Given Y and Y^*, a solution to above the equation always exists and we can solve for the equilibrium $\tilde{\rho}_i$ and derive the following result.

Lemma 2 *When N is the larger country, i.e. $Y > Y^*$, equation (21) provides a unique solution for $\tilde{\rho}_i$, such that $1 < \tilde{\rho}_i < \min [x_i]$.*

Proof. *See appendix (A.6).* ■

Since $\tilde{\rho}_i = \tilde{w}^{\sigma_i} \tilde{r}$, and from Lemma (1) and Lemma (2) we know that $\tilde{w} > \tilde{r}$ and $\tilde{\rho}_i > 1$, wages must be higher in the larger capital-abundant N, i.e. $\tilde{w} > 1$. This is the standard result that large capital-abundant countries have higher absolute wages than small labor-abundant countries, since both its larger size and its capital-abundance pushes wages up in N. We can now derive conditions under which the larger N will face HME.

When N is the larger country than S, N exhibits HME in the sector i if, $v_i > \frac{Y}{Y^* + Y}$. This condition can be written as,

$$[v_i (Y + Y^*) - Y] > 0. \tag{22}$$

Using (20) and (21), the condition in (22) holds when $g_i > 0$ (see appendix (A.5)). Given $\tilde{\rho}_i = \tilde{w}^{\sigma_i} \tilde{r}$ and $x_i = \tau_i^{\sigma_i - 1}$, the distribution of g_i will depend on the parameters σ_i, τ_i and b_i, and it is not possible to solve for analytical conditions about the distribution of g_i without defining these distributions. However, we can compare the values of g_i across industries and determine conditions under which industries located in the capital-abundant N is more likely to exhibit HME. Note that we can rewrite the condition $g_i > 0$ in the following form,

$$g_i = \left(\frac{Y}{(x_i \tilde{w}^{\sigma_i} \tilde{r} - 1)} - \frac{Y^* \tilde{w}^{\sigma_i} \tilde{r}}{(x_i - \tilde{w}^{\sigma_i} \tilde{r})} \right) > 0 \tag{23}$$

$$\Leftrightarrow Y \left[\frac{x_i}{\tilde{w}^{\sigma_i} \tilde{r}} - 1 \right] > Y^* \left[x_i \tilde{w}^{\sigma_i} \tilde{r} - 1 \right] \tag{24}$$

$$\Leftrightarrow Y > \tilde{w}^{2\sigma_i} \tilde{r}^2 Y^* + \frac{\tilde{w}^{\sigma_i} \tilde{r}}{x_i} (Y - Y^*). \tag{25}$$

Given that N is the larger country, i.e. $Y > Y^*$ and from Lemma (1) and (2) that the larger N has a higher relative and absolute wage, i.e. $\tilde{w} > \tilde{r}$ and $\tilde{w} > 1$, we can see that the left hand side of (25) rises relative to the right hand side as we move to lower σ_i and higher trade cost x_i industries. Therefore from (25) we can say that as we move to more differentiable sectors, with lower σ_i, and higher trade costs x_i, we should see the larger N exhibiting increasing degrees of HME in that industry. The following proposition summarizes this.

Proposition 3 *When N is larger than S, N will see increasing Home Market Effects in industries which are more differentiated (lower σ_i) and have higher trade costs (x_i).*

These conditions for HME in a large capital-abundant country from proposition (3) are summarized in Figure (1) as '*Case I*'. It shows that countries which are large and capital-abundant (the upper right quadrant of *Panel-A*) would show more agglomeration effects than smaller labor-abundant countries (the lower left quadrant of *Panel-A*) in sectors which are more differentiable and face high trade costs (the upper left quadrant of *Panel-B*) than in sectors which are less differentiable and facing low trade costs (the lower right quadrant of *Panel-B*).

This prediction for HME in large capital-abundant countries is identical to the Hanson and Xiang's (2004) prediction for HME in all large countries when factor proportion differences are absent. As *Case II* below shows, including factor proportion differences however, changes the HME across N and S. Therefore, the current model nests the HX predictions as a special case when factor proportion are equal across countries differing only in size.

3.2 *Case II* : HME for L-abundant S

The S's share of world exports in industry i is $v_i^* = (1 - v_i)$. Its income can be written as the sum of revenues from all sectors,

$$Y^* = \int_0^1 n_i^* p_i^* q_i^* di = \int_0^1 v_i^* b_i (Y + Y^*) di. \tag{26}$$

$$\Leftrightarrow W - Y = W - \int_0^1 v_i b_i (Y + Y^*) di. \tag{27}$$

Again writing $\tau_i^{\sigma_i - 1}$ as x_i, we can see that this equilibrium condition is identical to the N's equilibrium as expected in a two-country world and therefore we can write S's equilibrium identically to (21) as,

$$\int_0^1 b_i g_i di = 0, \text{ where, } \quad g_i = \left(\frac{Y}{(x_i \tilde{\rho}_i - 1)} - \frac{Y^* \tilde{\rho}_i}{(x_i - \tilde{\rho}_i)} \right). \tag{28}$$

Given Y and Y^*, a solution to above the condition always exists. However, since we are interested in learning about HME in the S, we now need to assume that the S is the bigger country and solve for the equilibrium $\tilde{\rho}_i$ that clears all markets. Solving for the equilibrium $\tilde{\rho}_i$ in this case gives the following result.

Lemma 4 *When S is the larger country, i.e. $Y^* > Y$, equation (28) provides a unique solution for $\tilde{\rho}_i$, such that* $\max \left[x_i^{-1} \right] < \tilde{\rho}_i < 1$.

Proof. *See appendix (A.7).* ∎

From Lemma (1) we know that $\tilde{w} > \tilde{r}$. Combining with Lemma (4) that $\tilde{\rho}_i = \tilde{w}^{\sigma_i} \tilde{r} < 1$ implies that relative wage rental ratio is higher in the smaller capital-abundant N, i.e. $\tilde{w}/\tilde{r} > 1$, but absolute wages need not necessarily be higher. This result arises because now the effect of size on wages partially dampens the smaller N's wages relative to the larger S. Absolute wages could still be higher in the N , i.e. $\tilde{w} > 1$, if the N's relative cost of capital $\tilde{r}$ is less than one and the condition $\tilde{w} < (1/\tilde{r})^{1/\sigma_i}$ is satisfied.

The definition of the HME for the S is $v_i^* > \frac{Y^*}{Y^* + Y}$, so when S is larger, to reveal HME in a sector it should have a greater share of the industry output than its GDP share. In this two-country world, this is identical to N's share of the industry's output being less than its GDP share,

$v_i < Y/Y+Y^*$. This is satisfied when $g_i < 0$. Therefore from (28) $g_i < 0$ implies,

$$Y^* > \frac{Y}{\tilde{w}^{2\sigma_i}\tilde{r}^2} + \frac{Y^*-Y}{x_i\tilde{w}^{\sigma_i}\tilde{r}}. \tag{29}$$

Assuming that the smaller capital-abundant country is also richer, so that ($\tilde{w} > 1$), the RHS of (29) decreases as σ_i increases and the trade cost x_i in a sector rises. Therefore when comparing a large L-abundant country with a smaller but richer capital-abundant country, the large S will experience increasing degrees of HME in more homogeneous sectors with rising σ_i and rising trade costs x_i. We can summarize this in the following proposition.

Proposition 5 *When S is larger than N, S will experience higher degrees of home market effects in industries which are less differentiated (higher σ_i) and have high trade costs(x_i), as long as N has higher absolute wages.*

The conditions for HME for a labor-abundant country are summarized in Figure (1) as '*Case II*'. It shows that countries which are large and labor-abundant (the upper left quadrant of *Panel-A*) would show more agglomeration effects than smaller, but richer capital-abundant countries (the lower left quadrant of *Panel-A*)[7] in sectors which are less differentiable and face high trade costs (the upper right quadrant of *Panel-B*) than in sectors which are more differentiable and face low trade costs (the lower left quadrant of *Panel-B*). When implementing this in the empirical testing of HME for L-abundant countries, care is taken to choose the sample in such a way as to satisfy the clause that absolute wage is higher in the smaller capital-abundant countries.

4 Empirics

The theory describes two distinct cases for identifying HME in capital and labor-abundant countries. These two cases are summarized in Figure (1) as *Case I* and *Case II*. Large capital-abundant countries expect to see increasing HME relative to small labor-abundant countries in more differentiable sectors with high trade costs. Large labor-abundant countries expect to see increasing HME relative to small capital-abundant countries in sectors which are decreasingly differentiable and

[7] *Panel-A* of figure (1) depicts the capital abundance but not the absolute wage differential. The empirical section incorporates the wage condition explicitly.

have increasing trade costs. I follow Hanson and Xiang's [HX] difference-in-difference strategy for implementing the theoretical predictions from the two-country world to the empirical case where there are multiple countries. I first describe briefly the HX empirical methodology of using bilateral trade flows to measure industry production shares across countries and using these measures to test HME.

4.1 Difference-in-Difference Technique for Identifying HME from Bilateral Trade Flows

For country j, the total exports in industry m to importer k is given as,

$$X_{mjk} = n_{mj}\left(b_m Y_k p_{mjk}^{1-\sigma_m} G_{mk}^{\sigma_m - 1}\right),$$

where $b_m Y_k$ is importer k's total expenditure in industry m and G_{mk} is the industry m price index in importing country k, which is a constant for all exporters to k. Therefore if we divide the exports of two countries, j and h, to the common importer k, we filter out these importer fixed effects and only the exporting country variates are left behind,

$$\frac{X_{mjk}}{X_{mhk}} = \frac{n_{mj} p_{mjk}^{1-\sigma_m}}{n_{mh} p_{mhk}^{1-\sigma_m}} = \frac{n_{mj}}{n_{mh}}\left(\frac{w_j.\tau_{jk}}{w_h \tau_{hk}}\right)^{1-\sigma_m}.$$

The exporter j specific term p_{mjk} denotes the delivery price of industry m products from country j to k, $p_{mjk} = w_j.\tau_{jk}$, where w_j is the marginal cost of production in j. τ_{jk} is the iceberg transportation cost of delivering each unit from j to country k. Following HX, I define this iceberg transportation cost as $\tau_{jk} = dist_{jk}^{\gamma_m}$, where $dist_{jk}$ includes both distance effects and effects of common border and language between j and k. Therefore, we can write the first differenced import shares of countries j and h as,

$$\frac{X_{mjk}}{X_{mhk}} = \frac{n_{mj} p_{mjk}^{1-\sigma_m}}{n_{mh} p_{mhk}^{1-\sigma_m}} = \frac{n_{mj}}{n_{mh}}\left(\frac{w_{mj}}{w_{mh}}\right)^{1-\sigma_m}\left(\frac{dist_{jk}}{dist_{hk}}\right)^{\gamma_m(1-\sigma_m)}. \tag{30}$$

Finally, we do not have a closed form solution for the exact number of producers in industry m in country j, n_{mj}, but we know from (13) that the ratio $\frac{n_{mj}}{n_{mh}}$ depends on the relative sizes of both countries, the relative product and factor prices between the countries, the trade cost in an industry, the substitution elasticity, and price indexes of both countries, which in turn depend on the relative number of firms in the two countries. Therefore we cannot predict how variations in Y_j/Y_h affect $\frac{n_{mj}}{n_{mh}}$ in a closed functional form. But from propositions 3 and 5 we can tell for which industries a large capital or labor-abundant country should face increasing HME and in which industries they should face decreasing amounts of HME. The set of industries in which a country faces increasing HME is termed '*treatment industries*' and the opposite set of industries in which a country faces least HME is termed '*control industries.*' The difference-in-difference equation from Hanson and Xiang (2004) compares the first difference equation from (30) with the same two countries' relative exports to the same importer k across *treatment* and *control* industries,

$$\frac{X_{mjk}/X_{mhk}}{X_{ojk}/X_{ohk}} = \frac{n_{mj}/n_{mh}}{n_{oj}/n_{oh}} \frac{(w_{mj}/w_{mh})^{-\sigma_m}}{(w_{oj}/w_{oh})^{-\sigma_o}} \left(\frac{dist_{jk}}{dist_{hk}}\right)^{\gamma_m(1-\sigma_m)-\gamma_o(1-\sigma_o)} \tag{31}$$

In this equation we want to test whether, controlling for differences in the two industries' factor costs and trade costs, increases in the relative size of exporter j compared to exporter h raises j's share in k's imports more than proportionally in the *treatment* sectors (m) than the *control* sectors (o). In logarithmic form,

$$\ln\left(\frac{X_{mjk}/X_{mhk}}{X_{ojk}/X_{ohk}}\right) = \alpha + \beta f\left(Y_j/Y_h\right) + \phi\left(\theta_j - \theta_h\right) + \ln\left(\frac{dist_{jk}}{dist_{hk}}\right) + \varepsilon_{mojhk}, \tag{32}$$

the function $f\left(Y_j/Y_h\right)$ captures a linear polynomial function of the countries relative sizes Y_j/Y_h. θ_j and θ_h are vectors of factor endowments that affect comparative advantage through the relative factor price terms in (w_{mj}/w_{mh}) and n_{mj}/n_{mh} in (31) and finally the $\frac{dist_{jk}}{dist_{hk}}$ term includes factors of geographic proximity between each of the two exporters and the importer k. Therefore, comparing exports in the right combination of *treatment* (m) and *control* (o) industries for the right combination of large and small countries, we can find out if HME is present.

Departure from Hanson and Xiang (2004): Hanson and Xiang (2004) use equation (32) to test if larger countries have HME in treatment industries. However, in their single factor model, absolute wage differences are driven solely by size and thereby all large countries experience HME in the same industries. This is exactly where the present model departs from HX's empirical strategy. Due to factor proportion differences in the current model, HME works in different industries for countries that differ in factor abundance. In fact, in the limiting case that factor proportions are identical for countries differing in size, the present model gives identical results for HME as in Hanson and Xiang (2004).

For the empirical analysis, I will separately use the double difference technique from equation (32) for large capital and labor-abundant countries and check if indeed the predictions from propositions 3 and 5 hold in bilateral exports data. Most importantly, the tests for HME are also conducted by swapping the industries in which the large capital and labor-abundant countries are predicted to have HME. If the theoretical analysis is correct, we should find no systematic evidence of HME when such switched treatment and control industries are used.

4.2 Testing HME for K-abundant ($Case\ I$) and L-abundant ($Case\ II$) Countries

The strategy for choosing the countries and industry pairs for testing HME in capital and labor-abundant countries is depicted respectively in Figure (1) as $Case\ I$ and $Case\ II$. From proposition 3, large capital-abundant countries should experience increasing HME relative to small labor-abundant countries in more differentiated (low σ_i) and high trade cost (x_i) industries. From proposition 5, large labor-abundant countries should experience increasing HME relative to smaller capital-abundant countries having higher absolute wages in less differentiated (high σ_i) and high trade cost x_i industries.

For the first differencing of $Case\ I$, large capital-abundant countries' (upper right quadrant of panel A in Figure (1)) exports are compared with exports from small labor-abundant countries (lower left quadrant of panel A in Figure (1)). The next step is to choose the '*treatment*' and '*control*' industries to compare in the second difference as explained above for $Case\ I$. Panel B of Figure (1) depicts the *treatment* (low σ_i and high trade cost x_i) and *control* (high σ_i and low trade cost x_i) industry for $Case\ I$. *Solid arrows* on Panel A and B of Figure (1) show the choice of countries and treatment and control industries respectively.

For testing HME in large labor-abundant countries ("$Case\ II$") I choose countries in the upper left quadrant of the left panel A in Figure (1) and difference these countries' exports from exports of the smaller capital-abundant countries in the lower right quadrant of panel A in the Figure (1). For the second differencing we need to compare the high σ_i and high trade cost (x_i) *treatment* industries to low σ_i and low trade costs x_i *control* industries. *Panel* B of Figure (1) depicts the *treatment* and *control* industries respectively on the upper right quadrant of the σ_i and x_i plot and control industries on the lower left quadrant. The choice of countries and industries for *Case II* is indicated by the *dashed arrows* on Panels A and B in the Figure.

Data: The data for the estimation of (32) comes from the World Trade Flows database (Feenstra et al. 1997) for the year 1994.[8] Data on per capita factor endowments and income is from the World Bank's WDI and the data on capital stock is generated using the gross fixed capital formation series from the WDI using a perpetual inventory method. Distances between countries and other geographic characteristics are obtained from the CEPII geography database.

For a sample of large capital-abundant countries I select the 20 largest countries having per capita capital stock above 75 percent of US per capita capital stock.[9] For the small labor-abundant countries I choose countries which have less than 25th percentile of the US per capita capital stock. The list of sample countries is tabulated in table (1). For a sample of the large L-abundant countries I select the 10 biggest countries having per capita capital stock below the 25 percentile of US per capita capital stock. From proposition 5, the small capital-abundant countries must also have higher absolute wages than all the L-abundant countries. I choose countries which have per capita GDP higher than all L-abundant countries and all have more than 50 percent of US per capita capital stock. The list of sample countries is tabulated in table (1).

Figure (2) plots estimates of elasticities of substitution and trade costs for different 3 digit SITC industries and shows the selection of treatment and control industries for testing HME in capital and labor-abundant countries based on the distribution of industry freight rates and substitution elasticities. Following Hanson and Xiang (2004), I use the Hummels (1999) estimates for elasticities of substitution at the SITC 3 digit level. For trade costs measures I also use Hanson and Xiang's methodology of estimating industries' distance elasticity of trade costs using the transport charges of US imports from different countries and using these measures to get a measure of freight rates for different industries. The first two columns of tables (2) and (3) lists respectively the treatment industries and the corresponding control industries in case I and the last two columns lists respectively the treatment industries and the corresponding control industries in Case II.

[8] Data is chosen for the year 1994 as it is the same data that Hanson and Xiang (2004) used.

[9] The sampling was also carried out using per capita GDP to proxy for capital abundance. TThe results are unaltered if per capita GDP is used instead of per capita capital stocks.

The sample of importers are the biggest 21 importers in the world. While this sample is small, selecting the largest importers nevertheless helps in avoiding a lot of missing observations. Total imports in these 21 biggest importers comprise more than 80 percent of world imports in the sample year.

Estimation Issues: Due to the level of disaggregation of the trade data (SITC 3 digit), a large percentage of all possible trade flows turn out to be zero. Following Hanson and Xiang (2005), I fill out these zeros with a 'one.' This could lead to biased estimates, however. Therefore, I also report the results of a truncated OLS estimation using just the first stage differencing and adding a dummy for the treatment industry, following Pham, Mitra and Lovely (2009). I always keep the larger country on the numerator while estimating (32) to avoid the kind of bias Pham, Mitra and Lovely (2009) talk about if the sample is not ordered thus.

Results: The left panel titled 'Case I' of table (4) shows the results for the test of HME in capital-abundant countries when I pool all the SITC 3 digit sector combinations of treatment and control industries and sample countries using the difference-in-difference techniques to estimate equation (32). Following Hanson and Xiang (2004), I estimate equation (32) with different functional forms for the relative GDP of the two exporters. The $f(Y_j/Y_h)$ measure is substituted by linear and polynomial functions of the difference in the GDP across the two exporters and each of the columns (1) through (3) lists results of using different measures of $f(Y_j/Y_h)$. The estimation includes a number of controls for country endowments that could drive comparative advantage across sectors and geographic factors, which includes the distances between the capitals of the two exporters and common importer and binary variables for common border and common language with the importer.[10]

The results show that β is positive and significant in all specifications of the relative GDP function $f(Y_j/Y_h)$. So, indeed, capital-abundant large countries get a larger share of world imports in more differentiable sectors which have high trade costs relative to the less differentiable low trade cost 'control' sectors.

[10] The estimation results reported do not show the controlling for human capital differences. The results of the estimation remain robust and significant when including human capital differences in the test of HME for capital abundant countries. However, due to scarcity of education data, the HME estimation for labor abundant countries could not be undertaken.

The right panel titled 'Case II' of table (4) shows the results for testing HME (equation 32) in labor-abundant countries using the same set of controls and independent variables as in case I, but a different set of *treatment* and *control* industries as explained above.

The results in the last three columns of table (4) also show a positive and significant effect of rising size for large labor-abundant countries on their export shares in treatment industries relative to control industries in all specifications of the relative GDP function $f(Y_j/Y_h)$. So, labor-abundant countries get a larger share of world imports in less differentiable, high trade costs sectors as predicted by the theory.

Thus the separate estimations of HME in case I and case II show that both N and S exhibit HME. As predicted by theory, they exhibit HME in different sectors, driven by their corresponding strengths in product differentiation and variable production costs. Since N has more fixed capital which is required to make new varieties, sectors that support a larger set of varieties tend to agglomerate in N. S countries like China and India also see HME or agglomeration, but it is not in sectors which are the most differentiable, but rather in sectors that face larger trade costs and that require more labor-intensive production processes.

Changing Treatment and Control Industries: The two tests predicted from theory do show HME for K and L-abundant countries in different sectors. But these tests do not confirm that these countries do not experience HME in sectors other than those predicted from theory. To confirm that labor and capital-abundant countries indeed experience HME in distinct sectors, I also conduct the tests for HME switching the industries in which the large capital and labor-abundant countries are predicted to have HME. If the theoretical analysis is correct, we should find no systematic evidence of HME when such switched treatment and control industries are used.

Accordingly, I test whether large capital-abundant countries have HME in sectors in which theory predicts that larger labor-abundant countries should exhibit HME. I call this Case IA, where I take the theory predicted 'treatment' (high σ and high trade cost) and 'control' (low σ and low trade costs) industries for the large labor-countries and use these to test HME for large capital-abundant countries. Case IIA tests just the reverse case: whether the larger labor-abundant countries have HME in the sectors in which theory predicts the larger capital-abundant countries should exhibit HME (see Case IA and Case IIA in Figure 3).

The results of Case IA and Case IIA are represented in table (5). The left column of table (5) shows a positive but insignificant β coefficient for Case IA, whereas the coefficient for β for labor-abundant countries is negative and significant. That is, large capital-abundant countries have larger shares than smaller labor-abundant countries in sectors where labor-abundant countries are predicted to have HME, but the coefficient is very small and insignificant. Large labor-abundant countries on the other hand have a negative HME in sectors where large capital-abundant countries exhibit HME. Therefore, tests for Case IA and IIA confirm that large K and L-abundant countries do not experience HME in sectors other than the ones in which the theory predicts that they should experience HME.

Taking Zeros into Account: The difference-in-difference estimation makes it difficult to take care of the zero trade flows, as normal Tobit estimation cannot be used. To overcome this problem, I use a dummy variable, single difference methodology pooling both '*treatment' and 'control'* industries as suggested by Pham, Mitra and Lovely (2009). In the following regression, the first difference filters out the importer fixed effects and the difference in the levels of HME, if any, is captured by including a dummy variable for the treatment industry ($Treat_{dummy}$).

$$\ln\left(X_{mjk}/X_{mhk}\right) = \alpha + \beta_1 f\left(Y_j/Y_h\right) + \beta_2 f\left(Y_j/Y_h\right).Treat_{dummy} + \phi\left(\theta_j - \theta_h\right) + \ln\left(\frac{dist_{jk}}{dist_{hk}}\right) + \varepsilon_{mjhk}.$$

I estimate coefficients by allowing truncation of trade flows. As seen from table (6), the coefficient on the treatment dummy is positive and significant for both K and L-abundant countries. So both results from case I and case II from table (4) continue to hold even when we specifically adjust for truncation of trade flows at zero.[11]

4.3 Extensive and Intensive Margins of HME

Previous work on two factor models with increasing returns to scale in manufacturing mostly assume a homothetic cost function across fixed and marginal costs and thereby, even when factor prices are unequal across countries, firm sizes are identical.[12] So any increase in the world share

[11] In analysis not reported here, I also repeat the difference-in-difference estimations for both capital and labor abundant countries dropping all zeros. These estimations also give positive and significant coefficients on the HME coefficient in all the specifications reported in table (4).

[12] See appendix (A.1) for a comparison of the current model with the homothetic cost model.

of an industry's output must be due to the expansion of the number of firms in that industry (i.e. only the extensive margin can cause HME). In the current model, however, firm sizes vary by country due to variation in factor price ratios, $q_i^s = (\sigma_i - 1)\,\frac{F_i r}{c_i w}$. The preceding analysis identifies industries in which large capital and labor-abundant countries have increasing degrees of HME. Here I analyze the roles that extensive and intensive margins play in sectors where large labor and capital-abundant countries face HME.

We know from (13) that the ratio of extensive margins across N and S in a sector i ($\frac{n_i}{n_i^*}$) depends on the relative sizes in both countries, the relative product and factor prices between the countries, the trade cost in an industry, the substitution elasticity, and also the price indexes of both countries. Therefore we cannot predict how variations in Y/Y^* affect $\frac{n_i}{n_i^*}$ in a closed functional form. But we can again use the difference-in-difference technique to analyze how the relative extensive margins change between a large and a small country, as the large country experiences increasing HME in some sectors relative to other sectors where it faces least HME.

Given that the shares of N and S respectively in an industry i is $v_i = \frac{n_i p_i q_i}{b_i(Y+Y^*)}$ and $v_i^* = \frac{n_i^* p_i^* q_i^*}{b_i(Y+Y^*)}$, the relative shares of N and S can be written as, $\tilde{v}_i = \frac{n_i p_i q_i}{n_i^* p_i^* q_i^*} = \tilde{n}_i \tilde{p}_i \tilde{q}_i$ and substituting the relative quantities and prices we get $\tilde{v}_i = \tilde{n}_i \tilde{r}$. Taking a second difference for the ratio of the relative shares of N and S across two industries, we can write,

$$\frac{\tilde{v}_m}{\tilde{v}_o} = \frac{\tilde{n}_m}{\tilde{n}_o}. \tag{33}$$

That is, we see that when either a large N or a large S country experiences increasing HME in some industries m relative to industries o, the HME is driven by the relative extensive margin growth in that industry for the HME experiencing country. Therefore the coefficient β for relative GDP should closely match the growth of extensive margins due to HME in the difference-in-difference exports equation (32) we estimated earlier. Using estimates of sectoral extensive margins, we can further investigate whether the extensive margins of *treatment* industries grows relative to the extensive margins of *control* industries as a large country experiences more and more HME in its treatment sectors. Extending the methodology developed by Hummels and Klenow (2005) for measuring the extensive and intensive margins of aggregate exports to a sectoral measure of extensive and intensive margins, we can estimate the following difference-in-difference equation,[13]

$$\ln\left(\frac{EM_{mjk}/EM_{mhk}}{EM_{ojk}/EM_{ohk}}\right) = \alpha + \beta f\left(Y_j/Y_h\right) + \phi\left(\theta_j - \theta_h\right) + \ln\left(\frac{dist_{jk}}{dist_{hk}}\right) + \varepsilon_{mojhk}. \tag{34}$$

This is identical to the difference-in-difference HME estimation with a measure of relative GDPs, geographic and comparative advantage characteristics as dependent variables, but has differences across relative extensive margins across countries j and h in their treatment and control industries respectively.

The results of estimating this equation are summarized in table (7). The results show that the relative growth of HME in the treatment industries to control industries (industries in which we expect least HME for a country) is indeed driven by an increase in the number of firms. Even though the coefficient for the growth of relative EM in the treatment industries relative to control industries in labor-abundant countries is twice that of the same measure for capital-abundant countries, the measure also involves the relative EM in the control industries and therefore does not represent whether the extensive margin plays a greater or smaller role in capital or labor-abundant countries. To get a better measure of the split of the HME in capital and labor-abundant countries, I summarize the average proportions of extensive and intensive margins in the treatment industries for the large capital and labor-abundant countries in the sample in table (8).

80 percent of the growth of exports in the treatment industries for the capital-abundant countries is driven by the extensive margins, whereas the extensive margin drives 53 percent of the growth of the treatment industries in the labor-abundant countries. Therefore, extensive margins drive the HME in capital-abundant countries by a much higher degree. This is because of their abundance of capital resources which is required to start new businesses in the more differentiated product industries. Labor-abundant countries have a comparative advantage in making less differentiated products, and experience HME driven by higher intensive margins in their 'treatment' sectors.

[13] The estimation of the sectoral extensive and intensive margins from sector trade flows extending the Hummels and Klenow (2005) method is described in appendix (A.8).

5 Conclusion

When there are increasing returns to scale and trade is costly, firms locate in larger countries. This is known as the home market effect. Most of the literature looking at home market effects uses a single factor model, assuming cost functions are identical and homothetic across countries. These assumptions imply that rich and poor countries have HME in identical sectors. In this paper I take a closer look at these assumptions as well as their empirical relevance. I develop a two-country, two factor monopolistic competition model with a continuum of industries, where factor intensities of marginal cost and fixed cost are different. When trade costs are positive, this non-homothetic cost function allows countries to differ in technologies of production and predicts that rich and poor countries experience HME in different sectors. For capital-abundant countries, the HME increase in sectors with high trade costs and more differentiable products. For labor-abundant countries, the HME rise in sectors with high trade costs and less differentiated products. I test and confirm these predictions by using bilateral exports data, showing that capital and labor-abundant countries experience home market effects in distinct sectors as predicted by theory and not in any other sectors. I also decompose home market effects into extensive and intensive margins at the industry level for labor and capital-abundant countries. Even though the HME is driven by an increase in the number of firms in both capital and labor-abundant countries, extensive margins (new varieties) drive the HME in capital-abundant countries to a much larger extent than in labor-abundant countries, where home market effects are driven by increasing proportions of intensive margins (quantity per variety).

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A Appendix

A.1 Comparison of current and traditional IRS monopolistic competition models

Most of the literature using the Dixit Stiglitz (1977) model of monopolistic competition with two factors assumes a homothetic cost function of the Cobb Douglas type,

$$C_i = (c_i q_i + F_i)\, w^{\alpha_i} r^{1-\alpha_i},$$

where both fixed costs and marginal costs use labor and capital in the same proportion of $\frac{\alpha_i}{1-\alpha_i}$. This assumption helps to solve the general equilibrium, since labor and capital in each industry always get a fixed proportion of the revenues. The assumption however, is highly stylized.[14] The cost structure in (5) relaxes this problem, but at the same time keeps the model tractable for solving the general equilibrium.

The results comparing the equilibrium prices, number of firms and their scales in the traditional model with a homothetic cost function and the current paper's model with non-homothetic cost is given below.

$$p_i = \frac{\sigma_i \left(w^{\alpha_i} r^{1-\alpha_i}\right)}{(\sigma_i - 1)}; \quad n_i = \frac{b_i Y}{F_i \sigma_i}\left(\frac{1}{w^{\alpha_i} r^{1-\alpha_i}}\right); \quad q_i^s = (\sigma_i - 1)\frac{F_i}{c_i}. \tag{Traditional Model}$$

$$p_i = \frac{\sigma_i}{(\sigma_i - 1)} w; \quad n_i = \frac{b_i Y}{F_i \sigma_i}\left(\frac{1}{r}\right); \quad q_i^s = (\sigma_i - 1)\frac{F_i}{c_i}\frac{r}{w}. \tag{Present Model}$$

In the traditional model, firm size are exogenous and identical across countries. In the present model, it is endogenously determined by the factor price ratio in a country. Solving the traditional model further for N's share in an industry, $v_i = \frac{Y}{W}\left[\frac{-\widetilde{p_i}^{\sigma_i}\tau_i^{1-\sigma_i}(\frac{Y^*}{Y}+1)+1+\frac{Y^*}{Y}\tau_i^{2-2\sigma_i}}{-\left(\widetilde{p_i}^{\sigma_i}+\frac{1}{\widetilde{p_i}^{\sigma_i}}\right)\tau_i^{1-\sigma_i}+\tau_i^{2-2\sigma_i}+1}\right]$. Using which, the condition for HME in N, i.e. $v_i > \frac{Y}{Y+Y^*}$,can be simplified as,

$$\int_0^1 b_i \underbrace{\left(\frac{Y}{(x\widetilde{p_i}^{\sigma_i} - 1)} - \frac{Y^* \widetilde{p_i}^{\sigma_i}}{(x - \widetilde{p_i}^{\sigma_i})}\right)}_{\varrho_i} di = 0; \quad \widetilde{p_i} = \tilde{w}^{\alpha_i}\tilde{r}^{1-\alpha_i}$$

Therefore we can write the conditions for HME in N and S as $\varrho_i > 0$ and $\varrho_i < 0$ respectively. Therefore we can write the conditions for HME in N and S as,

$$Y > \tilde{w}^{2\sigma_i\alpha_i}\tilde{r}^{2\sigma_i(1-\alpha_i)}Y^* + \frac{\tilde{w}^{\alpha_i}\tilde{r}^{(1-\alpha_i)}}{x_i}(Y - Y^*) \text{ and } Y^* > \frac{Y}{\tilde{w}^{2\sigma_i\alpha_i}\tilde{r}^{2\sigma_i(1-\alpha_i)}} + \frac{Y^* - Y}{x_i w^{\alpha_i} r^{1-\alpha_i}}.$$

Comparing with the current model's condition for HME in the N and S, we can see that we must impose exogenous conditions between the capital intensity and the product differentiability of an industry to predict patterns of HME. The empirical viability of testing HME under such restrictions becomes quite difficult because both industry factor intensities and product differentiability are calculated from distinct supply and demand side factors and it would be very difficult indeed to get data on industry factor intensities for a large enough sample of countries. The empirical

[14] Please refer to section 1 for Helpman and Krugman's (1985) point of view on the starkness of this assumption.

predictions from the current model, however, is much simpler and easier to implement. Moreover, it also matches extensive and intensive margins of growth across countries that grow in size and have factor endowment differences.

A.2 Generalized Cost Function with both Factors Entering Fixed and Variable Costs

In this section I generalize the assumption in the main model that marginal costs comprise labor costs only and fixed costs comprise capital expenditures only. All the results still continue to hold as long as the marginal cost is more labor-intensive than fixed costs and the relative wage-rental ratio is different enough.

Let us assume a non-homothetic cost function with fixed costs using capital more intensively than the variable cost in industry i,

$$C_i = \underbrace{c_i w r^{\alpha} q_i}_{\text{Variable Costs}} + \underbrace{w^{\alpha} r F_i}_{\text{Fixed Costs}}, \qquad \alpha < 1. \tag{36}$$

Define relative prices as,

$$\tilde{p}_i = \frac{c_i w r^{\alpha}}{c_i w^* r^{*\alpha}} = \tilde{w}\tilde{r}^{\alpha}.$$

Thus the N has a higher relative price if α is small, and $\tilde{w}$ is large and/or $\tilde{r}$ is not too small. The zero profit condition yields quantity supplied by each producer as,

$$q^s = (\sigma_i - 1)\frac{F_i}{c_i}\left(\frac{r}{w}\right)^{1-\alpha}. \tag{37}$$

As long as $\alpha < 1$, i.e. as long as the fixed costs are more capital-intensive, the intensive margin is smaller in the richer country where $\frac{r}{w}$ is relatively smaller.

Solving the equilibrium where the 'zero profit' quantity is also equal to the demand given a price, we can solve the equilibrium number of firms and also for N's share in an industry, $v_i = \frac{Y}{W}\left[\frac{-\widetilde{\rho}_i\tau_i^{1-\sigma_i}(\frac{Y^*}{Y}+1)+1+\frac{Y^*}{Y}\tau_i^{2-2\sigma_i}}{-\left(\widetilde{\rho}_i+\frac{1}{\widetilde{\rho}_i}\right)\tau_i^{1-\sigma_i}+\tau_i^{2-2\sigma_i}+1}\right]$. This expression is identical to the expression for N's share in an industry to the case in the simplified cost function in paper, but now $\widetilde{\rho}_i$ is defined as $\tilde{w}^{\sigma_i-1+\alpha}\tilde{r}^{(\sigma_i-1)\alpha+1}$ instead of the simpler term $\tilde{w}^{\sigma_i-1}\tilde{r}$. N's income can be written as the sum of revenues from all sectors, $Y = \int_0^1 n_i p_i q_i di = \int_0^1 v_i b_i (Y+Y^*) di$ and writing $\tau_i^{\sigma_i-1} = x_i$, we can write this condition by substituting N's share v_i to get,

$$\int_0^1 b_i g_i di = 0, \text{ where,} \quad g_i = \left(\frac{Y}{(x_i\tilde{\rho}_i - 1)} - \frac{Y^*\tilde{\rho}_i}{(x_i - \tilde{\rho}_i)} \right), \tag{38}$$

which again is identical to the simplified model in main text, but with the changed $\tilde{\rho}_i$. The condition for HME in N, i.e. $v_i > \frac{Y}{Y+Y^*}$, can be simplified in the present case as,

$$Y > Y^* \tilde{w}^{2(\sigma_i+\alpha)} \tilde{r}^{2(\sigma_i\alpha+1)} +^* \frac{\tilde{w}^{(\sigma_i+\alpha)} \tilde{r}^{(\sigma_i\alpha+1)}}{x_i} (Y - Y^*).$$

As long as $\alpha < 1$ and $\sigma_i > 1$ and the conditions that the large capital-abundant country also has higher relative and absolute wages than the S, we can show that as σ_i increases and x_i increases, the HME increases in the N. Using the same g_i function, we can also derive that if the large labor-abundant country has smaller relative and absolute wages than the smaller capital-abundant country, then it will see increasing degrees of HME in less differentiable and higher trade cost sectors.

A.3 Proof that $\bar{\rho} > \underline{\rho}$

Note that both $\underline{\rho} = \left(\frac{\tau^{1-\sigma}(1+\frac{Y^*}{Y})}{\tau^{2-2\sigma}+\frac{Y^*}{Y}} \right) > 0$ and $\bar{\rho} = \frac{\frac{Y^*}{Y}\tau^{2-2\sigma}+1}{\tau^{1-\sigma}(1+\frac{Y^*}{Y})} > 0$. Therefore, $\underline{\rho} < \bar{\rho}$ iff $\frac{\bar{\rho}}{\underline{\rho}} > 1$. But,

$$\begin{aligned} \frac{\bar{\rho}}{\underline{\rho}} &= \frac{\left(\frac{Y^*}{Y}\tau^{2-2\sigma}+1\right)\left(\tau^{2-2\sigma}+\frac{Y^*}{Y}\right)}{\left[\tau^{1-\sigma}(1+\frac{Y^*}{Y})\right]^2} \\ &= \frac{\tau^{2-2\sigma}\left(\frac{Y^*}{Y}\right)^2 + \tau^{2-2\sigma} + \left(1+\tau^{4-4\sigma}\right)\frac{Y^*}{Y}}{\tau^{2-2\sigma}\left(\frac{Y^*}{Y}\right)^2 + \tau^{2-2\sigma} + 2\tau^{2-2\sigma}\frac{Y^*}{Y}} \end{aligned} \tag{39}$$

The first two terms in the numerator and denominator are identical, therefore $\frac{\bar{\rho}}{\underline{\rho}} > 1$ iff $\left(1+\tau^{4-4\sigma}\right) > 2\tau^{2-2\sigma} \Rightarrow \left(1-\tau^{2-2\sigma}\right) > 0$. Given that costs trade are positive, i.e. $\tau > 1$, and given $\sigma > 1$, the last condition is always satisfied.

A.4 General Equilibrium, Factor Price Non-Equalization and Relative Factor Prices

Following Romalis (2004), I show that FPE cannot hold when trade costs are positive using the method of contradiction. Suppose factor price equalization (FPE) holds. Then firms' techniques in each sector are identical across N and S. Suppose country sizes are also identical; then, by symmetry of trade costs, the number of firms is equal across N and S, so clearly factor price equalization cannot clear factor markets. When relative country sizes differ, the bigger country has a larger number of firms. FPE implies that a bigger country demands more labor and capital in the same proportion irrespective of its factor endowments. Thus factor price equalization would not clear factor markets as long as relative factor abundance exists.

From equation (13) when factor prices are equal, we can write $\widetilde{n_i} = \frac{(\tau_i^{2-2\sigma_i}+\widetilde{Y})-\tau_i^{1-\sigma_i}(1+\widetilde{Y})}{(1+\tau_i^{2-2\sigma_i}\widetilde{Y})-\tau_i^{1-\sigma_i}(1+\widetilde{Y})}$. Note then $\widetilde{n_i} \lesseqqgtr 1$ if $\widetilde{Y} \lesseqqgtr 1$. In each of these cases FPE contradicts the factor market clearing conditions (18).

Case 1: When $\tilde{Y} = 1$, or $Y = Y^*$, under factor price equalization $\widetilde{n} = 1$ and $q_i^s = q_i^{s*}$ in each sector i. Therefore factor markets clear only when $K = K^*$ and $L = L^*$. But this contradicts the relative factor endowments.

Case 2: Under FPE, when $Y > Y^*$, $\tilde{n}_i > 1$ in all sectors. For tractability I assume that for $x_i = \tau_i^{\sigma_i - 1}$ is a constant (x) across all industries, so that $\tilde{n}_i = \frac{1}{\beta} > 1$ is a constant for all industries.[15] This implies,

$$\frac{L}{L^*} = \frac{\int\limits_{i\epsilon[0,1]} n_i q_i^s di}{\int\limits_{i\epsilon[0,1]} n_i^* q_i^{*s} di} = \frac{1}{\beta}, \text{ and } \quad \frac{K}{K^*} = \frac{\int\limits_{i\epsilon[0,1]} n_i F_i di}{\beta \int\limits_{i\epsilon[0,1]} n_i F_i di} = \frac{1}{\beta}. \tag{40}$$

Therefore, FPE and relative factor abundance cannot hold in this case.

Case 3: $\tilde{Y} < 1$. This is just the reverse of case 2 and factor price equalization can be identically rejected in this case too.

Factor Market Clearance Condition ($\frac{w^*}{r^*} < \frac{w}{r}$ when $\frac{K}{K^*} > \frac{L}{L^*}$): When FPE breaks down, factor markets clear only when the N has a higher wage rental ratio. This is because full employment

[15] This is just a simplifying assumption and is not necessary for the non-equalization of actor prices.

of factors in the North occurs if (i) North uses capital more intensively in each sector than South, (ii) it sells more varieties $n > n^*$ for a given size of each sector, and/or (iii) has larger shares of world exports in capital-intensive sectors. From equation (9) we know that condition (i) is satisfied only when N has a higher $\frac{w}{r}$ than S. For the number of firms to be larger in the N for a given amount of a sector's output, the firm size $q_i^s = (\sigma_i - 1)\frac{F_i r}{c_i w}$ must be smaller in the N, which happens if $\frac{w}{r} > \frac{w^*}{r^*}$. For N to export larger shares in more capital-intensive sectors the N must also have higher wage rental rates (proved in section 3.1 below). All of these results are reversed when $\frac{w^*}{r^*} > \frac{w}{r}$. Hence, only when $\frac{w^*}{r^*} < \frac{w}{r}$ can the factor markets clear in the N, given its relative capital-abundance.

A.5 Derivation of g_i function

The function g_i is derived as follows,

$$Y = \int_0^1 n_i p_i q_i di = \int_0^1 v_i b_i (Y + Y^*) di \tag{41}$$

But

$$v_i = \frac{Y}{(Y+Y^*)}\left[\frac{-\widetilde{\rho}x^{-1}\frac{(Y+Y^*)}{Y} + x^{-2}\frac{Y^*}{Y} + 1}{-\left(\widetilde{\rho} + \frac{1}{\widetilde{\rho}}\right)x^{-1} + x^{-2} + 1}\right] \tag{42}$$

$$v_i(Y+Y^*) = \frac{-\widetilde{\rho}x(Y+Y^*) + x^2 Y + Y^*}{-\left(\widetilde{\rho} + \frac{1}{\widetilde{\rho}}\right)x + x^2 + 1} \tag{43}$$

$$Y = \int_0^1 v_i b_i (Y+Y^*) di \tag{44}$$

$$\Leftrightarrow \int_0^1 b_i \left[v_i(Y+Y^*) - Y\right] di = 0$$

$$\Leftrightarrow \int_0^1 b_i \left[\frac{-\widetilde{\rho}x(Y+Y^*) + x^2 Y + Y^*}{-\left(\widetilde{\rho} + \frac{1}{\widetilde{\rho}}\right)x + x^2 + 1} - Y\right] di = 0 \tag{45}$$

$$\Longleftrightarrow \int_0^1 b_i \left(\frac{-\widetilde{\rho}x(Y+Y^*) + x^2 Y + Y^*}{-\left(\widetilde{\rho} + \frac{1}{\widetilde{\rho}}\right)x + x^2 + 1} - Y\right) = 0 \tag{46}$$

$$\Leftrightarrow \int_0^1 b_i \underbrace{\left(\frac{Y}{(x\tilde{\rho}-1)} - \frac{Y^*\tilde{\rho}}{(x-\tilde{\rho})} \right)}_{g_i} di = 0 \tag{47}$$

A.6 Proof of Lemma 2 :

Note that we assume Y and Y^* are given and that the N is larger (i.e. $Y > Y^*$) throughout this proof. Denote RHS of equation (21) by $\Gamma(\tilde{\rho})$. Taking derivatives of $\Gamma(\tilde{\rho})$, it is easy to show $\Gamma'(\tilde{\rho}) < 0$ for all values of $\tilde{\rho}$, Y and Y^*.

1. When $Y > Y^*$, it is easy to verify that $\Gamma(1) > 0$. If $\tilde{\rho} > 1$ and $\tilde{\rho}$ is rising towards $\min[x_i]$, $\Gamma(\tilde{\rho})$ approaches $-\infty$ (as the second term rises and the first falls). Therefore, equation (21) will always have a solution when $1 < \tilde{\rho} < \min[x_i]$.

2. When $\tilde{\rho} > \max[x_i]$, $\Gamma(\tilde{\rho}) > 0$ and $\Gamma(\tilde{\rho})$ is ill-defined between $\min[x_i] < \tilde{\rho} < \max[x_i]$ since $\exists$ an i for which $x_i - \tilde{\rho} = 0$. Therefore the only solution for $\Gamma(\tilde{\rho})$ is the one given in (1) above.

3. When $\tilde{\rho} < 1$, it is easy to see the $\Gamma(0) \leq 0$ (since when $\tilde{\rho} = 0,$ at least $\tilde{w}$ or $\tilde{r}$, or both are zero). As $\tilde{\rho}$ rises from 0 towards the $\min[x_i^{-1}]$, $\Gamma(\tilde{\rho})$ falls towards $-\infty$ and as $\tilde{\rho}$ falls from 1, towards $\max[x_i^{-1}]$, it goes from a positive number to $+\infty$. Between $\min[x_i^{-1}] < \tilde{\rho} < \max[x_i^{-1}]$, $\Gamma(\tilde{\rho})$ is again ill defined as $\exists$ an i for which $x_i\tilde{\rho} - 1 = 0$. Therefore, there is no $\tilde{\rho} < 1$ that solves equation (21).

A.7 Proof of Lemma 4

Note that we assume Y and Y^* are given and that the S is larger (i.e. $Y^* > Y$) throughout this proof. Denote RHS of equation (28) by $\digamma(\tilde{\rho})$. Taking derivatives of $\digamma(\tilde{\rho})$, it is easy to show $\digamma'(\tilde{\rho}) < 0$ for all values of $\tilde{\rho}$, Y and Y^*.

1. When $Y^* > Y$, it is easy to verify that $\digamma(1) < 0$. If $\tilde{\rho} > 1$ and $\tilde{\rho}$ is rising towards $\min[x_i]$, $\digamma(\tilde{\rho})$ approaches $-\infty$. Therefore, equation (21) will have no solution when $1 < \tilde{\rho} < \min[x_i]$.

2. When $\tilde{\rho} > \max[x_i]$, $\digamma(\tilde{\rho}) > 0 \; \forall \tilde{\rho}$ and $\digamma(\tilde{\rho})$ is ill defined between $\min[x_i] < \tilde{\rho} < \max[x_i]$ since $\exists$ an i for which $x_i - \tilde{\rho} = 0$. Therefore no solution for $\digamma(\tilde{\rho})$ exists for $\tilde{\rho} \geq 1$.

3. When $\tilde{\rho} < 1$, it is easy to see the $\Gamma(0) < 0$ (assuming both factor prices are not zero). As $\tilde{\rho}$ rises from 0 towards the $\min[x_i^{-1}]$, $\Gamma(\tilde{\rho})$ falls towards $-\infty$. Therefore no solution for $\Gamma(\tilde{\rho})$ exists when $0 < \tilde{\rho} < \min[x_i^{-1}]$. Between $\min[x_i^{-1}] < \tilde{\rho} < \max[x_i^{-1}]$, $\Gamma(\tilde{\rho})$ is again ill defined as $\exists$ an i for which $x_i\tilde{\rho} - 1 = 0$. but as $\tilde{\rho}$ falls from 1, towards $\max[x_i^{-1}]$, it goes from a negative number to $+\infty$. Therefore, there the only solution for $\Gamma(\tilde{\rho})$ exists when $\max[x_i^{-1}] < \tilde{\rho} < 1$ that solves equation (21).

A.8 Methodology for Measuring Sectoral Extensive and Intensive Margins

Here I adapt Hummels and Klenow's methodology to decompose sectoral exports of a country into its extensive and intensive margins. The world trade flows database allows us to see in how many of the HS6 categories a country exports in a 3 digit SITC sector to an importer h, how many HS6 products are in that sector in market h, and the aggregate quantities that the rest of world exports in each HS6 category to h. So it is easy to measure the extensive margin and intensive margin of a country j's exports to h in sector m as follows,

$$EM_{jhm} = \frac{\sum\limits_{i \epsilon I_{jhm}} X_{khmi}}{\sum\limits_{i \epsilon I_{hm}} X_{khmi}}; \quad IM_{jm} = \frac{\sum\limits_{i \epsilon I_{jhm}} X_{jhmi}}{\sum\limits_{i \epsilon I_{jhm}} X_{khmi}}; \quad EXP_{jhm} = EM_{jhm} IM_{jhm} = \frac{\sum\limits_{i \epsilon I_{jhm}} X_{jhmi}}{\sum\limits_{i \epsilon I_{hm}} X_{khmi}}$$

where, k denotes the rest of the world, I_{jhm} is the set HS6 varieties that country j sells to country h in sector m and I_{hm} is the total number of possible HS6 categories available in market h in the sector m. The numerator of the extensive margin of j, EM_{jhm} uses the rest of the world's exports to h as weights for the product categories in which j sells, and the denominator has the total rest of the world's sales in all categories in that sector. The intensive margin compares j's own sales to h, to the rest of the world sales in all categories that j exports to h. Once all the EM_{jhm} and IM_{jhm} measures are obtained for all export of j in sector m, j's overall extensive and intensive margin in the sector m is calculated as,

$$EM_{jm} = \prod_{h \epsilon H_{-j}} (EM_{jhm})^{\alpha_{jhm}}; \qquad IM_{jm} = \prod_{h \epsilon H_{-j}} (IM_{jhm})^{\alpha_{jhm}}$$

where α_{jhm} is the logarithmic mean (the sum is normalized to 1) of the shares of h in the overall exports of j and the rest of the world in sector m.

Table 1: List of Countries

Large K-Abundant	Large L-Abundant	Small K-Abundant	Small L-Abundant
Australia	Algeria	Bahrain	Bolivia
Austria	Columbia	Cyprus	Algeria
Belgium and Lux	China	Hungary	Ecuador
Canada	Egypt	Iceland	Guatemala
Denmark	Indonesia	Ireland	Jordan
Finland	India	Macao	Morocco
France	Pakistan	Malta	Peru
Germany	Philippines	New Zealand	Paraguay
Hong Kong	South Africa	Oman	El Salvador
Ireland	Thailand	Seychelles	Tunisia
Israel		Trinidad and Tobago	Sri Lanka
Italy			
Japan			
Netherlands			
Norway			
Singapore			
Sweden			
Switzerland			
UK			
USA			

A.9 Tables

Standard errors in parentheses

** $p<0.01$, * $p<0.05$, + $p<0.1$

Table 2: Treatment Industries

Treatment K-Abun	Industry Name	Treatment L-Abun	Industry Name
674	Iron Sheets	511	Hydrocarbon Deriv
671	Pig Iron and Ferro	512	Alcohols and Phenols
621	Rubber and Plastics	592	Starches and Insulin
679	Iron Castings	651	Textile Yarns
665	Glasswares	652	Cotton Fabrics
663	Mineral Manuf	653	Woven Fabrics
666	Pottery and Ceramics	786	Trailers and Semis
678	Iron Tubes	656	Ribbons, Embroidery
642	Paper Products	654	Non-Cotton Spl Fab
812	Sanitary & Plumbing	657	Special Textile Fab
625	Tires	658	Textile Material NES
676	Steel Rails	659	Carpets & Flr Cover
641	Paper and Paper Brd	711	Boilers Large
677	Iron Ware	532	Synthetic Tanning Mat
672	Iron Ingots		
635	Wood Manuf		
673	Iron Bars		
821	Furnitures		
634	Wood Panels		
661	Cement		

Table 3: Control Industries

Control K-Abun	Industry Name	Control L-Abun	Industry Name
541	Pharmaceuticals	774	Elec Diagnos Apprts
752	Computers	776	Thermionic Cathodes
761	Televisions	771	Electric Machinery
884	Optical Lenses	695	Machine Parts, Tools
764	Audio Speakers	696	Cutlery
762	Radios	524	Inorganic Chemicals
759	Computer Parts	675	Alloys, Steel Flat
514	Nitrogen Comps	772	Electrical Apprts
881	Cameras		
751	Office Machines		
882	Camera Supplies		
885	Watches, Clocks		
726	Printing Mach		

Table 4: Difference-in-Difference Estimation for Case I and Case II

Dep Var	**Case** I**:** HME in K-abun Countries‡ ‡Treatment Industry (Low σ, High trade cost) ‡Control Industry (High σ, Low trade cost)			**Case** II**:** HME in L-abun Countries$^{\perp}$ $^{\perp}$Treatment Industry (High σ, High trade cost) $^{\perp}$Control Industry (Low σ, Low trade cost)		
Diff-In-Diff Import Shares	(1)	(2)	(3)	(4)	(5)	(6)
ln(Diff in GDP)	0.0588**	0.0336**		0.0534**	0..0284**	
	(0.002)	(0.001)		(0.006)	(0.006)	
ln(Diff in GDP^2)	-0.0265**			–0.0534**		
	(0.002)			(0.007)		
Diff in GDP			0.0000**			0.0000**
			(0.000)			(0.000)
(Diff in GDP)^2			-0.0000**			-0.0000**
			(0.000)			(0.000)
ln(Diff in Dist)	-0.3430**	-0.3504**	-0.3137**	-0.2061**	-0.2096**	-0.2204**
	(0.002)	(0.002)	(0.003)	(0.010)	(0.010)	(0.010)
ln(Diff in Per Cap Land)	0.3938**	0.3897**	0.4154**	0.1627**	0.1646**	0.1343**
	(0.002)	(0.002)	(0.002)	(0.007)	(0.008)	(0.007)
ln(Diff in Per Cap K)	-0.0500**	-0.0549**	-0.0256**	-0.7738**	-0.7663**	-0.7539**
	(0.005)	(0.002)	(0.002)	(0.007)	(0.014)	(0.013)
Common_Lang	-0.1841**	-0.1840**	-0.1624**	-0.3958**	-0.4033**	-0.4131**
	(0.006)	(0.006)	(0.006)	(0.013)	(0.025)	(0.024)
Common_Border	0.6859**	0.6615**	0.7260**	0.1018**	0.0727	0.0634
	(0.012)	(0.012)	(0.012)	(0.058)	(0.058)	(0.059)
Constant	-0.3856**	-1.6839**	-1.5656*	2.4923**	-0.1292**	-0.3055**
	(0.075)	(0.013)	(0.012)	(0.346)	(0.039)	(0.037)
Observations	1,799,889	1,799,889	1,799,889	219,692	219,692	219,692
R-squared	0.05	0.05	0.05	0.03	0.03	0.03

Standard errors in parentheses
** p<0.01, * p<0.05, + p<0.1

Table 5: Reversing Treatment and Control Industries

Dependent Variable	Case IA: K-abundant†	Case IIA: L-abundant$^{\perp}$
	†Treatment Industry (High σ, High trade cost)	$^{\perp}$Treatment Industry (Low σ, High trade cost)
	†Control Industry (Low σ, Low trade cost)	$^{\perp}$Control Industry (High σ, Low trade cost)
Diff-in-Diff Imports	(1)	(2)
ln(Diff in GDP)	0.0023	-0.1934**
	(0.001)	(0.003)
ln(Diff in Dist to Importer)	-0.1111**	-0.0611**
	(0.003)	(0.006)
ln(Diff in Land per Capita)	0.1744**	0.0311**
	(0.002)	(0.004)
ln(Diff in Capital per Capita)	-0.0578**	-0.4287**
	(0.005)	(0.008)
Common_Lang	-0.0337**	0.1440**
	(0.006)	(0.014)
Common_Border	-0.1718**	0.3131**
	(0.012)	(0.034)
Constant	-1.1197**	0.0324**
	(0.013)	(0.021)
Observations	1,077,271	534,534
R-squared	0.07	0.023

Standard errors in parentheses
** p<0.01, * p<0.05, + p<0.1

Table 6: Considering Zeros and Truncation: HME Using a Single Diff Equiation

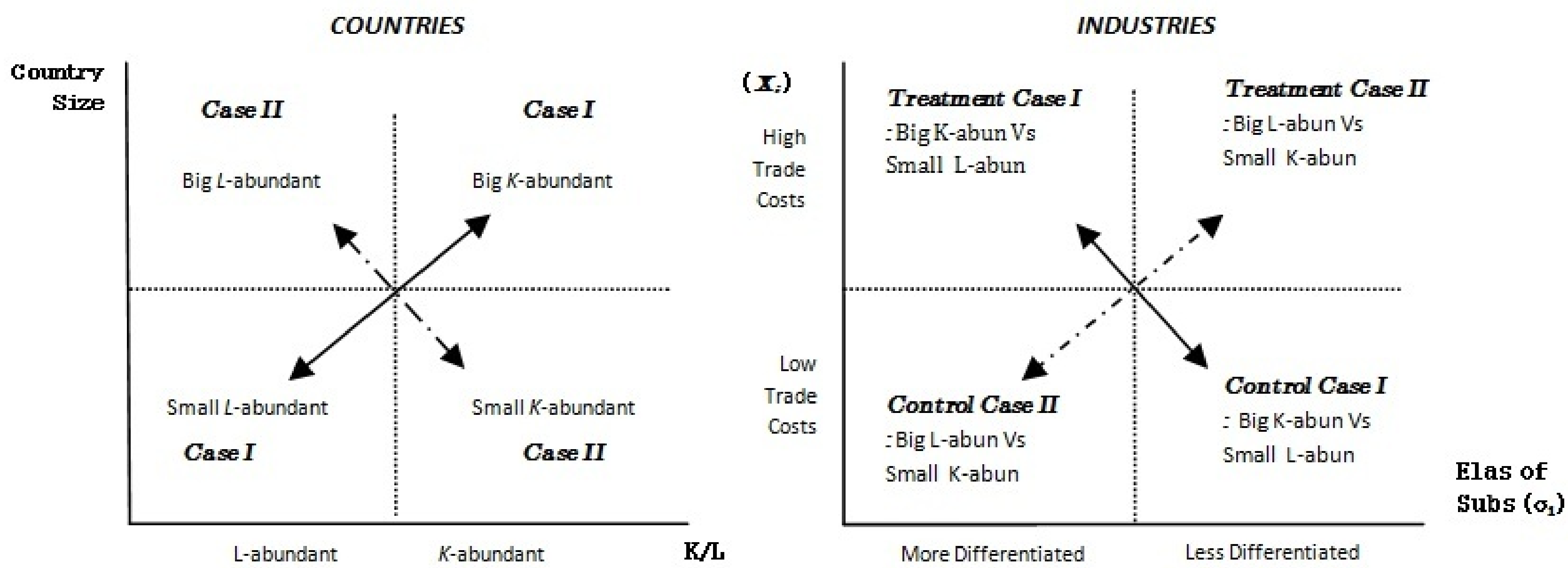
Dependent Variable	**Case** I**:** HME K-abun Cty‡ ‡Treatment Ind (Low σ, high trade cost) ‡Control Ind (High σ, low trade cost)	**Case** II**:** HME in L-abun Cty$^{\perp}$ $^{\perp}$Treatment Ind (High σ, High trade cost) $^{\perp}$Control Ind (Low σ, Low trade cost)
Single Diff Imports	(1)	(2)
ln(Diff in GDP)	0.9048**	1.4063**
	(0.013)	(0.039)
Treatment Dummy	1.9505**	1.0434**
	(0.047)	(0.124)
ln(Diff in Dist to Importer)	-0.8914**	-0.8884**
	(0.019)	(0.053)
ln(Diff in Land per Capita)	-0.2646**	-0.0485^{+}
	(0.012)	(0.024)
ln(Diff in Capital per Capita)	-0.4121**	0.3264**
	(0.042)	(0.057)
Common_Lang	0.6638**	0.6009**
	(0.042)	(0.103)
Common_Border	1.038**	1.056**
	(0.073)	(0.291)
Constant	2.7799**	-.07370
	(0.126)	(0.206)
Observations	33271	11592
Wald Chi2(7)	8908.42	1371.21

Table 7: Extensive and Intensive Margin of Sectoral trade

Dependent Variable	**Case** I**:** HME K-abun Cty[‡] ‡Treatment Ind (Low σ, high trade cost) ‡Control Ind (High σ, low trade cost)	**Case** II**:** HME in L-abun Cty[⊥] ⊥Treatment Ind (High σ, High trade cost) ⊥Control Ind (Low σ, Low trade cost)
Diff-In-Diff Extensive Margin	(1)	(2)
ln(Diff in GDP)	0.1239**	0.2879**
	0.013	0.033
ln(Diff in Dist to Importer)	-0.0577**	-0.0919*
	0.013	0.045
ln(Diff in Land per Capita)	0.0349**	0.0788
	0.008	0.062
ln(Diff in Capital per Capita)	0.2044**	-0.5955**
	0.041	0.080
Common_Lang	0.05407*	-0.0779
	0.0261	0.0803
Common_Border	-0.2135**	0.06323
	0.050	0.291
Constant	-1.0048**	-1.2729**
	0.110	0.125
Observations	22802	2864
R-squared	0.08	0.07

Table 8: Average Extensive and Intensive Margin in Industries exhibiting HME

Treatment Sector Export Margin (Percentage)	K-abun Cty HME Sectors[‡] ‡Treatment Ind (Low σ, high trade cost)	L-abun Cty HME Sectors[⊥] ⊥Treatment Ind (High σ, High trade cost)
Avg Extensive Margin	79.93	53.73
Avg Intensive Margin	20.06	46.26



Panel A: Country Pairs Selection ***Panel B***: Treatment and Control Industries Selection

Figure 1: Selection of Country and Corresponding 'Treatment' and 'Control' Industries for Testing HME in K-abundant Countries (Case I) and L-abundant Countries (Case II)

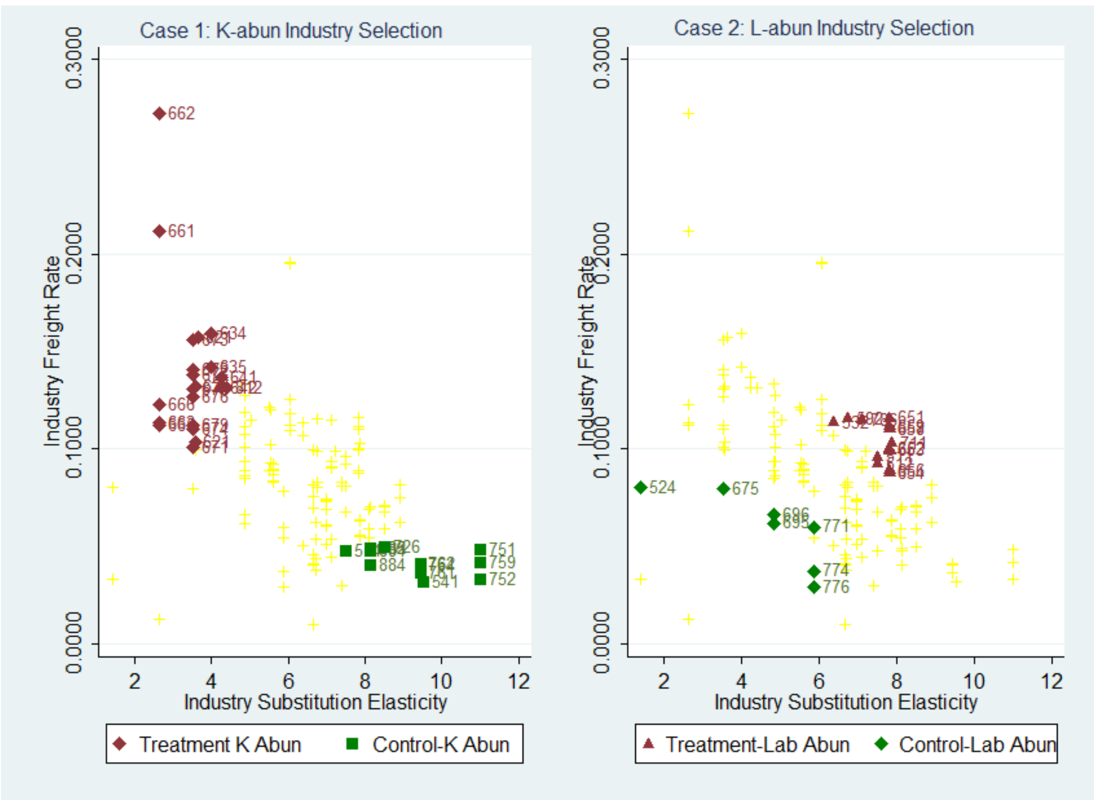


Figure 2: Selection of Treatment and Control Industries for Testing HME (Case I and Case II)

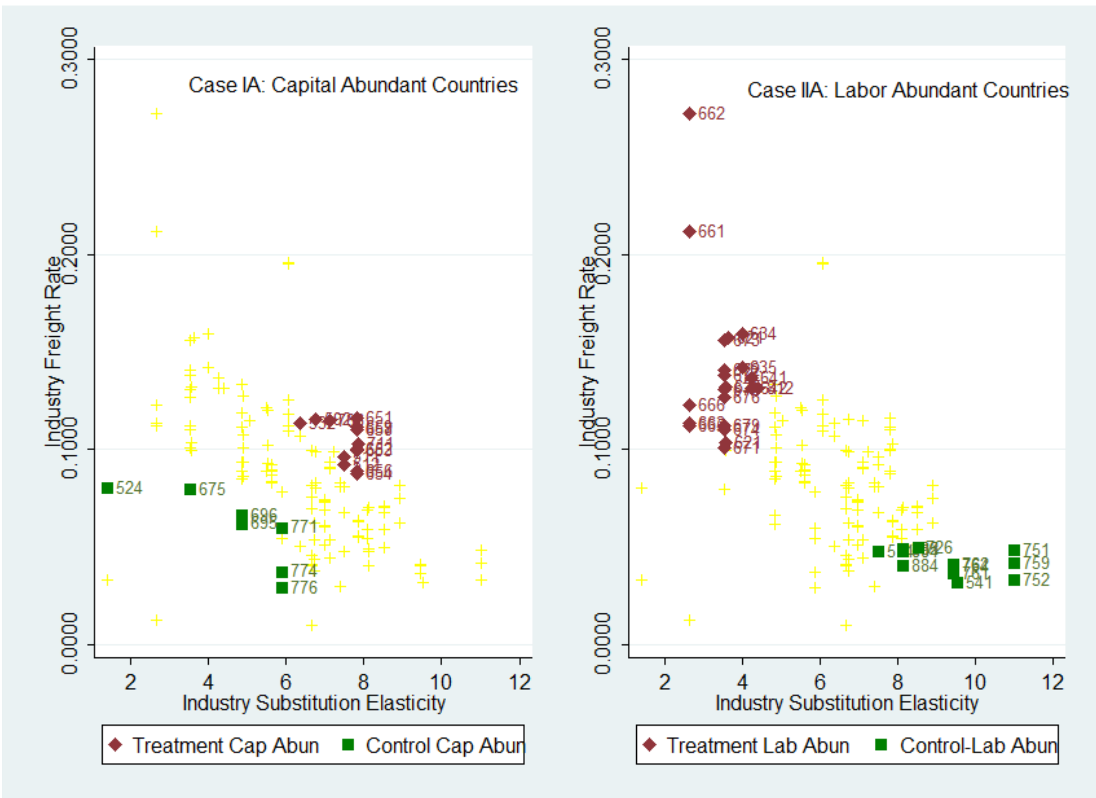


Figure 3: Testing HME with Treatment and Control Industries Reversed (Case IA and Case IIA)