Production Costs, Not Transport Cost Savings, Drive Trade Patterns: Revisiting Theories of Market Size

Takashi Onoda*

Japan Bank for International Cooperation and

TDB-CAREE, Graduate School of Economics, Hitotsubashi University

July 25, 2024

Abstract

I reconsider the notion that industries with high transport costs concentrate in large markets to save on transport costs. A restudy of the standard model reveals that the literature misinterprets the model result, overlooking the incentive to locate in smaller markets, in which trade barriers lessen competition. Higher transport costs reinforce this incentive, offsetting transport cost savings. Instead, firms with lower transport costs focus on reducing production costs to compete in international markets. Thus, they are concentrated in lower-wage countries, creating a base for exports. In simple models, the lower-wage country coincides with the smaller-market country, causing conflation.

Keywords: Home-market effect, Market size, Trade cost

JEL classification: F12, F16, R12

*Email: onoda.takashi@gmail.com

1 Introduction

Firms want to locate near large markets to reduce transport costs. This incentive is central to studies in which market size affects trade patterns, industrial concentration, and factor prices in international trade and economic geography (Krugman (1980, 1991)). Among them, Helpman and Krugman (1985), in their seminal work, show a differentiated-goods industry with increasing returns to scale concentrates in a large market to save transport costs, using a model of a single such industry. Subsequently, Hanson and Xiang (2004) build a model with many differentiated-goods industries that differ in transport costs, demonstrating that industries incurring higher transport costs are concentrated in larger countries. Hanson and Xiang (2004) attribute this result to the industry-specific transport cost savings, establishing the notion that industries with higher transport costs concentrate in large markets because they have stronger incentives to save on transport costs. Likewise, Amiti (1998), Laussel and Paul (2007), and Erhardt (2017) explain the same result in their models by using the same economic reasoning.

In this study, I reexamine the model of Hanson and Xiang (2004), revealing that the real driver of the industrial concentration pattern they found is the incentive to lower production costs rather than transport cost savings. Additionally, I interpret the model of Helpman and Krugman (1985) in a unified way, demonstrating the interpretation of the Helpman-Krugman model result—the transport-cost-saving incentive drives industrial concentration—is not "robust" to infinitesimal changes in the model assumptions; instead, production costs are predominantly the driver.

Previous studies have overlooked competition intensity as a factor in firms' locational choice. Indeed, the incentive for transport cost savings is greater in industries with higher transport costs. However, higher transport costs strengthen another, infrequently mentioned incentive: the incentive to locate in a smaller market to avoid intensive competition. Higher transport costs protect a small market more significantly from competition with an outsized number of firms in a large market, thus reinforcing the incentive to locate in a small market. Consequently, these two effects offset each other, nullifying the power of market size in directly driving industrial concentration.

The third effect—the only remaining effect—arises from wages. A lower wage reduces production costs, attracting firms and, subsequently, the resulting intensive local competition counters this attraction.

The strength of this countering force depends on the transport costs. Firms with lower transport costs make relatively more operating profits from sales in international markets, which implies insensitivity of their aggregate operating profits to the local competitive environment. Thus, the countering force is relatively weak; firms in industries with lower transport costs have a relatively stronger incentive to reduce production costs. Consequently, these industries gravitate toward a country that offers a lower wage, creating a base for exports. Conversely, industries with higher transport costs tend to locate in the country with a higher wage.

Market size influences the industrial concentration pattern of Hanson and Xiang (2004) only through wages. Transport cost savings in a large country dominate the relaxed competition in a small country for luring firms, generating the market-size effect on factor prices—a higher wage in a larger market. Consequently, the larger-market country coincides with the higher-wage country, which hosts industries with high transport costs relatively more.

Critically, this production-cost-driven explanation is the uniquely accurate interpretation of the model result, not another explanation from a different angle. In the Hanson-Xiang model (Hanson and Xiang, 2004), the higher-wage country coincides with the larger country owing to strong assumptions, causing conflation. To avoid any doubt regarding my argument, I break this link by introducing country-specific expenditure compositions into the Hanson-Xiang model. As Onoda (2024) shows, a country with greater expenditures on industries with lower transport costs, conditional on the country size, commands a higher wage; thus, this assumption allows the larger country to command a lower wage depending on expenditure compositions. In this modified model, the result of the wage-driven industrial concentration holds, regardless of the size of the higher-wage country, verifying the production-cost-driven explanation.

Furthermore, I show that the transport-cost-saving-driven explanation of Helpman and Krugman (1985) is not applicable once the model assumptions marginally change. In their model, a freely traded, homogeneous good exists as well as the single differentiated-goods industry, guaranteeing factor price equalization; thus, the transport-cost saving motive is the only possible explanation for the differentiated-goods industry's concentration. Nevertheless, this model can be considered as a limiting case of the Hanson-Xiang model with two industries, in which one industry's transport costs, degree of increasing returns, and elasticity of substitution are zero, zero, and infinity, respectively. Marginally changing these three parameters alters it to the Hanson-Xiang model. Subsequently, on the one hand, the (more) differentiated-goods industry with (higher) transport costs remains concentrated in the larger country, showing the robustness of the model result. On the other hand, transport cost savings are no longer the driver of industrial concentration, superseded by production costs. Thus, the transport-cost-driven explanation is not "robust." Instead, the production-cost–driven explanation captures the predominant force behind industrial concentration.

The findings of this study extend beyond those of Hanson and Xiang (2004) and Helpman and Krugman (1985). By using models similar to the one in Hanson and Xiang (2004), Amiti (1998), Laussel and Paul (2007), and Erhardt (2017) explain the distribution of industries and trade patterns by industry-specific strengths of two forces: transport cost savings and production costs. However, they overlook the industry-specific strength of competition intensity, leading Amiti (1998) and Erhardt (2017) to attribute the concentration of high-transport-cost industries to the transport-cost-saving motive, similar to the conclusion drawn by Hanson and Xiang (2004).[1] This paper revises the explanations for these studies.

This study contributes to the literature on the patterns of trade with increasing returns and trade costs by elucidating the mechanism commonly found in the literature. Interaction between the three factors exists behind the pattern of trade from relative demand, called the "home-market effect"—a location becomes a net exporter in a sector for which it has relatively large demand.[2] Recent works in this line of research include Fajgelbaum et al. (2011), Costinot et al. (2019), and Matsuyama (2019). In these models, sector-specific trade cost savings in a given location generate sector-specific competition intensities. Further, the aforementioned results of Onoda (2024) show the link between sector-specific trade cost savings and wages.

The restudy of Helpman and Krugman (1985) in this paper differs from previous studies in its focus. Strong assumptions—particularly, the zero transport cost—in Helpman and Krugman (1985) lead to many extensions and robustness checks on the pattern of trade (e.g., Davis (1998); Head et al. (2002); Crozet and Trionfetti (2008); Behrens et al. (2009); Barbero et al. (2018)). These studies investigate the relationships between variables in different settings. In contrast, my study focuses on the economic reasoning behind them, thereby providing new insights.

[1] Laussel and Paul (2007) discuss this pattern only in the introduction because it is a replication of Amiti (1998)'s result.

[2] Helpman and Krugman (1985) and Hanson and Xiang (2004) also call their effects the "home-market effect." This paper does not use this term hereafter to avoid confusion.

Finally, this accurate understanding better informs empirical studies. The relationship between market size and the pattern of trade within industries with different transport costs—the theoretical predictions by previous works—encompasses two channels: one from market sizes to factor prices and another from factor prices to industrial concentration. This suggests a weak relationship in the data. Although Hanson and Xiang (2004) and Erhardt (2017) find an empirical pattern consistent with the relationship in international trade flow data, Pham et al. (2014) report that the one found by Hanson and Xiang (2004) is not robust to different data handling, sampling, and estimation procedures, potentially revealing a limitation.

The rest of this paper is organized as follows. Section 2 reexamines the economic forces in the model of Hanson and Xiang (2004), uncovering the real driver of the pattern of industrial concentration. Section 3 revisits the model of Helpman and Krugman (1985) as a limiting case of the Hanson-Xiang model. Finally, Section 4 concludes the paper.

2 Revisiting Hanson and Xiang (2004)

This section examines the Hanson-Xiang-based model that has country-specific inter-industry expenditure distributions and is, otherwise, identical to that of Hanson and Xiang (2004). The insight derived can also be applied to Amiti (1998), Laussel and Paul (2007), and Erhardt (2017).[3]

Set Up

Two countries, indexed by $n \in \{1, 2\}$, are identical except for their population size and expenditure distributions. There is a continuum of industries, indexed by $z \in [0, 1]$. Industries differ in iceberg transport costs τ_k, elasticity of substitutions $\sigma(z)$, and linear production parameters. Labor is the only factor of production, and country n is endowed with a mass of L_n workers who are freely mobile between industries but immo-

[3] Amiti (1998) assumes two industries and two factors of production. One factor is considered to be mobile between countries. However, relative factor endowments are identical, and industries' factor intensities are also identical when the author discusses the pattern of trade with different transport costs, thereby nullifying the difference with Hanson and Xiang (2004). Laussel and Paul (2007) use a model of Amiti (1998) with one factor. Erhardt (2017) employs a model with firm heterogeneity *à la* Melitz (2003) that nests the Hanson-Xiang model.

bile between countries. Workers have Cobb-Douglas preferences and inelastically provide one unit of labor supply. The representative household's problem in country n is given by

$$\max_{\{Q_{nz}\}_{z\in[0,1]},\{q_{nz}(\nu)\}_{\nu\in\Omega_{nz},z\in[0,1]}} \exp\left(\int_0^1 \alpha_n(z)\ln(Q_{nz})dz\right), \tag{1}$$

$$s.t.\ \forall z, Q_{nz} = \left[\int_{\Omega_{nz}} q_{nz}(\nu)^{\frac{\sigma(z)-1}{\sigma(z)}} d\nu\right]^{\frac{\sigma(z)}{\sigma(z)-1}},$$

$$E_n = \int_0^1 \int_{\Omega_{nz}} p_{nz}(\nu)q_{nz}(\nu)d\nu dz,$$

where $p_{nz}(\nu)$ and $q_{nz}(\nu)$ denote price and consumption, respectively, for variety ν of industry z in country n, Ω_{nz} is the set of available varieties of industry z in country n, and $E_n = w_n$ is the income level in country n. The expenditure density function $\alpha_n(z)$ captures country-specific expenditure distribution. I set the wage in country 1 as the numeraire ($w_1 = 1$). Consumption optimization yields the demand function for varieties in industry z: $q_{nz}(\nu) = p_{nz}(\nu)^{-\sigma(z)} P_{nz}^{\sigma(z)} Q_{nz}$, where $P_{nz} = \left[\int_{\nu\in\Omega_{nz}} p_{nz}(\nu)^{1-\sigma(z)}d\nu\right]^{1/(1-\sigma(z))}$ is the price index for industry z in country n. In the following part, I omit ν unless necessary.

Production is based on Krugman (1980). For all industries $z \in [0,1]$, there are free entry, endogenous sets of varieties, homogeneous firms, and monopolistic competition. Each firm in industry z must employ f_z and m_z units of labor as the fixed and marginal costs, respectively, to produce a unit of one variety. A shipment of a variety between two countries requires an industry-specific iceberg transport cost $1 < \tau_z < \infty$. Given the symmetry of varieties in each industry, p_{niz} and q_{niz} denote the price and quantity, respectively, of a variety produced in country n and sold in country i in industry z. The problem for a firm in country n in industry z is given by

$$\pi_{nz} = \max_{\{p_{niz},q_{niz}\}_{i\in\{1,2\}}} \sum_{i\in\{1,2\}} \left[p_{niz}q_{niz} - \{\tau_z + \mathbb{1}\{i=n\}(1-\tau_z)\}\, m_z q_{niz} w_n\right] - f_z w_n, \tag{2}$$

$$s.t. \forall i \in \{1,2\},\ q_{niz} = p_{niz}^{-\sigma(z)} P_{iz}^{\sigma(z)} Q_{iz},$$

where π_{nz} is the profit from optimized production, and $\mathbb{1}\{i = n\}$ is an indicator function that takes the value of one when $i = n$. If industry z in country n has non-zero production in equilibrium, π_{nz} must be zero such that there are no new entrants, which is the zero-profit condition. I focus on equilibria in which both countries have non-zero production in all industries, following Hanson and Xiang (2004). The definition of such an equilibrium is as follows.

Definition of Equilibrium

An equilibrium is w_2, $\{p_{niz}, q_{niz}\}_{(n,i,z)\in\{1,2\}^2\times[0,1]}$, and $\{\Omega_{nz}\}_{(n,z)\in\{1,2\}\times[0,1]}$ such that

1. workers optimize consumption as eq. (1) for $n \in \{1, 2\}$,
2. workers' income is given by $E_n = w_n$ for $n \in \{1, 2\}$,
3. producers optimize production as eq. (2) for all $z \in [0, 1]$ and $n \in \{1, 2\}$,
4. the zero-profit condition holds such that $\pi_{nz} = 0$ for all $z \in [0, 1]$ and $n \in \{1, 2\}$, and
5. the labor market clearing condition $\int_{z\in[0,1]} M_{nz} \left[\sum_{i\in\{1,2\}} \{\tau_z - \mathbb{1}\{i = n\}(\tau_z - 1)\} m_z q_{niz} + f_z\right] = L_n$,

where M_{nz} is the mass of firms in country n in industry z, which holds for all $n \in \{1, 2\}$.

Zero-Profit Condition

To identify economic forces in the model, I start by manipulating the zero-profit conditions. Given the well-known optimized prices $p_{nnz} = \sigma(z)m_z w_n/(\sigma(z) - 1)$ and $p_{niz} = \tau_z m_z w_n/(\sigma(z) - 1)$ for $i \neq n$, the profit for a firm in industry z in country n becomes

$$\pi_{nz} = \left(\frac{1}{\sigma(z) - 1} m_z q_{nnz} + \tau_z \frac{1}{\sigma(z) - 1} m_z q_{niz} - f_z\right) w_n, \tag{3}$$

where $i \neq n$. I set $m_z = (\sigma(z) - 1)/\sigma(z)$ and $f_z = 1/\sigma(z)$ without loss of generality by appropriately choosing the unit of measurement.[4] This normalization implies $p_{nnz} = w_n$ and $p_{niz} = \tau_z w_n$. Then, the

[4] This normalization is common in the "new trade theory" and "new economic geography." See box 2.2. of Baldwin et al. (2003) for an additional explanation of why this is without loss of generality.

zero-profit condition ($\pi_{nz} = 0$) becomes

$$1 = L_n w_n^{-\sigma(z)} P_{nz}^{\sigma(z)-1} \alpha_n(z) E_n + \tau_z L_i \left(\tau_z w_n\right)^{-\sigma(z)} P_{iz}^{\sigma(z)-1} \alpha_n(z) E_i.$$

I rewrite this equation as

$$1 = (1 - \phi_z) Y_n \alpha_n(z) P_{nz}^{\sigma(z)-1} w_n^{-\sigma(z)} + \left(\sum_{i \in \{1,2\}} \phi_z Y_i \alpha_i(z) P_{iz}^{\sigma(z)-1} \right) w_n^{-\sigma(z)}, \tag{4}$$

where $Y_i = L_i E_i$ and $\phi_z = \tau_z^{1-\sigma(z)}$. Appendix A provides the derivations of equations including eq. (4) and proofs of the following lemmas and corollaries. The variable ϕ_z, often called "freeness of trade" (Baldwin et al. 2003), measures the effective tradability of an industry considering the transport cost and its impact on sales.[5] Eq. (4) equates fixed cost, normalized to one, on the left-hand side to operating profit—profit before deducting fixed cost—on the right-hand side.

Eq. (4) decomposes a firm's operating profit into two sources. The first source is the market access exclusive to local firms, reflected in the first term on the right-hand side of eq. (4).[6] This term reflects transport cost savings that firms can achieve by locating in country n. The second source is the "global market," corresponding to the second term—the summation of a fraction ϕ_z of both markets, which firms can "access" from either country.

Three Factors in Locational Choice

The operating profit in eq. (4) can differ between the two countries through three country-specific variables—$Y_n \alpha_n(z)$, $P_{nz}^{1-\sigma(z)}$, and $w_n^{\sigma(z)}$—implying three factors in their locational choice. The first is market size. The size of the operating profit from exclusive market access increases with the industry's market size $Y_n \alpha_n(z)$; thus, firms prefer to locate in a large market to save on transport costs. The second factor is wages. A higher wage w_n translates into a higher production cost, and, subsequently, a higher price, eventually resulting in

[5] Hanson and Xiang (2004) define a variable $x(z) = \tau_z^{\sigma(z)-1}$, called the "effective trade cost."

[6] Foreign firms need to pay transport costs to sell their varieties in country n; they raise the price by a factor of τ_z and receive profits that decrease by a factor of $1 - \phi_z$. One can interpret this as firms selling varieties at the factory gate price ($\sigma(z) m_i w_i / (\sigma(z) - 1)$) have access to the fraction ϕ_z of the country n market.

lower revenues. Thus, it reduces profits from both profit sources in eq. (4). Conversely, a lower wage attracts firms.

Competition intensity is the last factor in locational considerations. The expression $P_{nz}^{1-\sigma(z)}$ measures this factor and can be rewritten as:

$$P_{nz}^{1-\sigma(z)} = (1-\phi_z)M_{nz}w_n^{1-\sigma(z)} + \sum\nolimits_{i\in\{1,2\}} \phi_z M_{iz} w_i^{1-\sigma(z)}. \tag{5}$$

On the right-hand side of eq. (5), only the first term differs between countries; thus, more competitors (larger M_{nz}) in the home market increase $P_{nz}^{1-\sigma(z)}$ relative to the other country and, consequently, reduce the first term of the operating profit in eq. (4). Conversely, firms prefer to locate in a market with fewer firms. Thus, a smaller country—a country generally with a smaller mass of firms—is preferable from this perspective. Eq. (4) holds for both countries, implying that their advantages and disadvantages in these three factors—market size, wages, and competition intensity—must offset each other in equilibrium.

Industry Size

I translate competition intensity reflected in $P_{nz}^{1-\sigma(z)}$ into industry size. We have the zero-profit condition (4) for both countries. Combining them yields

$$(1-\phi_z)Y_n\alpha_n(z)P_{nz}^{\sigma(z)-1}w_n^{-\sigma(z)} = \frac{1}{1+\mu_{nz}}, \tag{6}$$

where

$$\mu_{nz} = \left[\frac{(\phi_z^{-1}+1)w_n^{\sigma(z)}}{\sum_{i\in\{1,2\}} w_i^{\sigma(z)}} - 1\right]^{-1} > 0. \tag{7}$$

The right-hand side $(1+\mu_{nz})^{-1}$ is the share of the market access exclusive to local firms as operating profit in equilibrium; thus, μ_{nz} measures the importance of the global market. After substituting eq. (5) into eq. (6), manipulations of the equation for both countries yield

$$M_{nz}w_n = (1+\mu_{nz})\alpha_n(z)Y_n - \frac{w_n^{\sigma(z)}}{\sum_{i\in\{1,2\}} w_i^{\sigma(z)}} \sum_{i\in\{1,2\}} \alpha_i(z)Y_i\mu_{iz}. \tag{8}$$

Normalization $f_z = 1/\sigma(z)$ makes labor demand by a firm equal one; subsequently, M_{nz} and $M_{nz}w_n$ equal the mass of workers and industry size in value, respectively. Given wages and market sizes, firms continue to enter an industry until the profit becomes zero and the industry size reaches $M_{nz}w_n$ in eq. (8).

Crucially, eq. (8) shows the direct economic forces distinctly from market size and wages; it does so by not reflecting the labor market clearing condition, which would otherwise relate the two variables and potentially introduce terms that capture indirect effects from market size through wages.[7] The two direct forces are as follows. First, industry size increases with the market size $\alpha_n(z)Y_n$ more than one-for-one because $\mu_{nz} > 0$, which is a common result for this type of model. A larger market attracts firms until the resulting intensive competition offsets it, requiring a disproportionate number of entrants. Second, industry size decreases with wages because wages decrease with μ_{nz} and increase with $w_n^{\sigma(z)}/\sum_{i\in\{1,2\}} w_i^{\sigma(z)}$, reflecting diminishing operating profits from the global market and exclusive market access, respectively.

Industries with Different Transport Costs

Remarkably, higher transport costs do not reinforce the large industry size from a large market; the factor $1 - \phi_z$ in eq. (4) is absent from eq. (8). To understand this absence, we consider how varying transport costs affect the share of exclusive market access in operating profit $(1-\phi_z)Y_n\alpha_n(z)P_{nz}^{\sigma-1}w_n^{-\sigma(z)}$. Higher

[7] The algebra of Hanson and Xiang (2004) imposes the condition for household income to equal the sum of sales from all industries—$Y = \int_0^1 n(z)p(z)q(z)dz$ in their notation, corresponding to the labor market clearing condition in my algebra—at an early stage. This manipulation makes the observation of direct economic forces difficult. Nevertheless, transforming the algebra (6) in their paper can lead to the conclusion that the higher-wage country becomes a net exporter in these industries, independent of the order of market sizes, as follows.

$$
\begin{aligned}
g(z) > 0 &\iff \\
\frac{Y}{w_1^{\sigma(z)}x(z) - 1} > \frac{w^{\sigma(z)}}{x(z) - w^{\sigma(z)}} &\iff \\
Y > \left(w^{\sigma(z)} + \frac{w^{2\sigma(z)} - 1}{x(z) - w^{\sigma(z)}} \right) w^{\sigma(z)},
\end{aligned}
$$

where I use their notation. The country with Y and w becomes a net exporter in industry z if and only if this inequality holds. The right-hand side decreases with $x(z)$ (ϕ_z^{-1} in my notation) if and only if the wage is higher than that of the other country ($w > 1$).

transport costs generate two opposing effects on this term. On the one hand, they raise $(1-\phi_z)Y_n\alpha_n(z)$, making locating in a large market a more significant advantage. This effect corresponds to the notion that higher transport costs reinforce the incentive to locate in a large market to save on transport costs (Hanson and Xiang (2004)). On the other hand, they also increase $(1-\phi_z)M_{nz}w_n^{1-\sigma(z)}$ in eq. (5), raising $P_{nz}^{1-\sigma}$ relative to the other market; higher transport costs protect a small market—a market with fewer competitors—more substantially. This second effect nullifies the first effect, removing $1-\phi_z$ from eq. (8). In other words, higher transport costs strengthen both the advantage and disadvantage of being located in a larger market to the same extent, generating no net effect.

Previous studies have overlooked this equally important and strengthening disadvantage of a larger market. Amiti (1998), Erhardt (2017), Hanson and Xiang (2004), and Laussel and Paul (2007) discuss the "trade-off" between transport cost savings and production costs, examining how this differs depending on industry transport costs and other characteristics. However, they do not consider the disadvantage of a large market, which is critical when comparing industries because it varies across industries.

Consequently, a difference in market sizes does not directly generate a trade pattern. Eq. (9), following from eq. (8), expresses the trade balance of industry z in country n.

$$M_{nz}w_n - \alpha_n(z)Y_n = \left(\frac{1}{1+\alpha_i(z)Y_i\mu_{iz}/\alpha_n(z)Y_n\mu_{nz}} - \frac{1}{1+w_i^{\sigma(z)}/w_n^{\sigma(z)}}\right)\sum_{i\in\{1,2\}}\alpha_i(z)Y_i\mu_{iz} \quad (9)$$

Thus, country n is a net exporter in industry z if and only if $\alpha_n(z)Y_n\mu_{nz}/\alpha_i(z)Y_i\mu_{iz}$ is greater than $w_n^{\sigma(z)}/w_i^{\sigma(z)}$. We can derive three patterns of trade from this equation. First, greater expenditure density $\alpha_n(z)$ makes the country more likely to be a net exporter in that industry because $\alpha_n(z)Y_n\mu_{nz}/\alpha_i(z)Y_i\mu_{iz} - w_n^{\sigma(z)}/w_i^{\sigma(z)}$ increases with $\alpha_n(z)/\alpha_i(z)$ conditional on $(w_n/w_i)^{\sigma(z)}$ and ϕ_z. This is the home-market effect from relative demand on trade (Krugman (1980)). Second, we compare industries with common relative expenditure $\alpha_n(z)/\alpha_i(z)$ and common elasticity of substitution $\sigma(z)$ but with different transport costs. The term $\alpha_n(z)Y_n\mu_{nz}/\alpha_i(z)Y_i\mu_{iz}$ increases with τ_z for the higher-wage country. In contrast, $(w_n/w_i)^{\sigma(z)}$ is invariant across these industries. These properties imply Lemma 1.

Lemma 1. *Suppose that the higher-wage country is a net exporter in industry y. Then, it is a net exporter in any industry z with $\tau_z \geq \tau_y$, $\sigma(z)=\sigma(y)$, and $\alpha_n(z)/\alpha_i(z) = \alpha_n(y)/\alpha_i(y)$.*

The patterns of net exports and industry sizes are equivalent as long as countries have identical Cobb-Douglas preferences. In this generalized model, a greater $\alpha_n(z)$ increases M_{nz} conditional on net exports $(M_{nz}w_n - \alpha_n(z)Y_n)$. Thus, I condition the value of $\alpha_n(z)/\alpha_i(z)$ to state the pattern of industrial concentration in Corollary 1.

Corollary 1. *Suppose industry y with $\alpha_1(y) = \alpha_2(y)$ is concentrated in the higher-wage country n in the sense that $M_{ny}/M_{iy} > L_n/L_i$. Then, any industry z with $\tau_z \geq \tau_y$, $\sigma(z) = \sigma(y)$, and $\alpha_n(z) \geq \alpha_i(z)$ is concentrated in the higher-wage country n in the same sense.*

The real driver of these trade and concentration patterns is wages. For economic reasoning, we consider industries in the lower-wage country. A lower wage is an advantage, which requires intensive competition or a smaller market size as a counter in equilibrium. This trade-off exists in all industries, but the relative power of a lower wage against intensive competition differs across industries. As discussed, a lower wage boosts operating profits from both exclusive market access and the global market. In contrast, intensive competition tempers only the operating profit from exclusive market access, which accounts for $(1+\mu_{nz})^{-1}$ of aggregate profit (eq. (6)). Low transport costs increase the significance of the global market, shrinking the share of exclusive market access ($\partial(1+\mu_{nz})^{-1}/\partial\phi_z < 0$). Consequently, a given intensity of competition becomes a weaker disadvantage, requiring more intensive competition to offset the advantage. In other words, wages weigh relatively more, strongly incentivizing firms to locate in the lower-wage country. Conversely, the higher-wage country tends to become net exporters in industries with high transport costs, which have relatively weak incentives to pursue lower wages.

Industries with Different Elasticities of Substitution

Similarly, I compare industries with different elasticities of substitution, replicating the result of Hanson and Xiang (2004). In general, the trade pattern is not straightforward, unlike that of transport costs, because $\sigma(z)$ changes the values of ϕ_z as well as $w_n^{\sigma(z)}$.[8] Following Hanson and Xiang (2004), I condition the value of ϕ_z.[9] Then, for the higher-wage country, $\alpha_n(z)Y_n\mu_{nz}/\alpha_i(z)Y_i\mu_{iz}$ and $w_n^{\sigma(z)}/w_i^{\sigma(z)}$ decrease and increase,

[8] Laussel and Paul (2007) show a non-monotonic response of net exports to $\sigma(z)$ in one of two differentiated-goods industries.

[9] When I compare different values of $\sigma(z)$, τ_z changes in the background so that ϕ_z remains the same.

respectively, with $\sigma(z)$ conditional on $\phi(z)$. Thus, we obtain Lemma 2 and Corollary 2.

Lemma 2. *Suppose that the higher-wage country is a net exporter in industry y. Then, it is a net exporter in any industry z with $\phi_z = \phi_y$, $\sigma(z) \leq \sigma(y)$, and $\alpha_n(z)/\alpha_i(z) = \alpha_n(y)/\alpha_i(y)$.*

Corollary 2. *Suppose industry y with $\alpha_1(y) = \alpha_2(y)$ is concentrated in the higher-wage country n in the sense that $M_{ny}/M_{iy} > L_n/L_i$. Then, any industry z with $\tau_z \geq \tau_y$, $\sigma(z) \leq \sigma(y)$, and $\alpha_n(z)/\alpha_i(z) \geq \alpha_n(y)/\alpha_i(y)$ is concentrated in the larger country n in the same sense.*

This result on industries with different $\sigma(z)$ is the same as that of Hanson and Xiang (2004) and the driver is wages. Demand is sensitive to price differences when varieties are less differentiated, making lower wages a more significant advantage. Thus, firms in less-differentiated industries have a stronger incentive to locate in the lower-wage country.

Wages

Market size indirectly influences industrial concentration through wages. Aggregating eq. (8) with the labor market clearing condition ($\int M_{nz} dz = L_n$) yields

$$Y_n \int_0^1 \alpha_n(z) \left[\frac{(\phi_z^{-1} + 1) w_n^{\sigma(z)}}{\sum_{i \in \{1,2\}} w_i^{\sigma(z)}} - 1 \right]^{-1} dz = \sum_{i \in \{1,2\}} Y_i \left(\int_0^1 \frac{w_n^{\sigma(z)}}{\sum_{i \in \{1,2\}} w_i^{\sigma(z)}} \alpha_i(z) \mu_{iz} dz \right), \tag{10}$$

where I used $\int_0^1 \alpha_n(z) dz = 1$. As a common result in the literature, wages increase with market sizes. Suppose that two countries have identical expenditure distributions ($\forall z$, $\alpha_n(z) = \alpha_i(z)$) to isolate this force. Then, w_n increases with Y_n—the market-size effect on factor prices. This market-size-driven wage, in turn, generates the wage-driven industrial concentration in Corollary 2.

However, market size cannot perfectly predict the pattern of industrial concentration when $\alpha_n(z) \neq \alpha_i(z)$ for some z. Onoda (2024) shows that locations with higher expenditure shares in industries with lower transport costs command higher wages conditional on population size. This force is operative here; a greater Y_n does not necessarily imply a higher w_n. In contrast, the wage-driven industrial concentration pattern of Corollary 2 always holds, verifying the production-cost-driven explanation.

Implications for Empirical Tests

The indirect and imperfect link between market size and industrial concentration makes empirical tests of the market-size effect challenging. A test of the relationship between the two variables *à la* Hanson and Xiang (2004) or Feenstra et al. (2001) effectively tests the two channels jointly: one from market size to wages and another from wages to industrial concentration. Thus, there are two windows through which other factors disturb this relationship. One example of a disturbance is country-specific expenditure distributions, as this study demonstrates, and another example is influence from third countries (e.g., a large neighboring country). Any factor influencing the terms of trade between countries becomes noise by changing the relative wage.[10] Pham et al. (2014) reexamine the empirical evidence of the market-size effect on industrial concentration found by Hanson and Xiang (2004). They change the data handling, sampling, and estimation procedures, suggesting that the evidence is not robust. This weak evidence may be attributed to the fact that it tests the two effects jointly.

Furthermore, the proper interpretation implies an issue in the empirical evidence of the market-size effect that Hanson and Xiang (2004) obtain. The main difference-in-difference specification involves two groups of industries: those with high transport costs and low elasticities of substitution—those predicted to be concentrated in large markets—and those with low transport costs and high elasticities of substitution—those predicted to be concentrated in small markets. This analysis examines differences in export values between these two groups and between two exporting countries. The primary regressor is relative GDP, which serves as a proxy for the relative market size of the exporting-country pairs. Additionally, the specification includes covariates, controlling for "industry production costs." Among these, relative wage levels in low-skill industries (namely, apparel and textiles) are included, and this inclusion can be problematic. These relative wages reflect cross-country differences in overall wage levels as well as wages in these industries relative to other industries. The former reflects the market-size effect on factor prices—the direct or actual driver of the trade pattern they found. Thus, controlling for these relative wages complicates the interpretation of the coefficient for relative GDP.

[10] The relative wage in the model of this paper corresponds to the productivity-adjusted relative wage in a model in which the countries differ in productivity. Thus, relative productivity does not directly affect the (productivity-adjusted) relative wage, although it does so indirectly by changing relative market size (Onoda (2024)).

3 Revisiting Helpman and Krugman (1985)

This section reinterprets the model of Helpman and Krugman (1985) as a limiting case of the Hanson-Xiang model, discussing the robustness of the economic mechanism. The Helpman-Krugman model features one differentiated-goods industry under monopolistic competition with increasing returns to scale, labeled as "manufacturing" following Davis (1998), and one freely traded homogeneous-goods industry under perfect competition with constant returns to scale, labeled as "agriculture" again following Davis (1998). Two asymmetrically sized countries have identical Cobb-Douglas preferences. Similar to the Hanson-Xiang model, labor is the only factor of production and is freely mobile between industries but immobile between countries. The existence of freely traded homogeneous goods ensures factor price equalization—wages in the two countries are equal at equilibrium. Thus, there is no room for wage differences in driving industrial concentration. In equilibrium, firms in manufacturing are concentrated in the larger country because the incentive to save on transport costs by locating in the larger country dominates the incentive to reduce competition intensity by locating in the smaller country; firms in the agricultural industry have neither incentive.

However, this economic reasoning is not "robust" to infinitesimal changes in the model parameters. To align the Hanson-Xiang model with the Helpman-Krugman model, I replace the continuum of industries in the Hanson-Xiang model with two industries, m and a. All the theoretical results obtained above hold true. I make industry a resemble the agricultural industry in Helpman and Krugman (1985) by setting transport cost lower ($\tau_a < \tau_m$) and elasticity of substitution higher ($\sigma(a) > \sigma(m)$). Then, Corollary 2 implies that firms in industry m are concentrated larger country, similar to the manufacturing industry in the Helpman-Krugman model, although the economic reasoning is different. Subsequently, I make industry a almost identical to the agricultural industry by taking the limit of $\phi_a \to 1$ and $\sigma(a) \to \infty$, which implies $\tau_a \to 1$. The infinite $\sigma(a)$ converts monopolistic competition to perfect competition and the normalized fixed cost $f_z = 1/\sigma(z)$ to zero. Thus, industry a transforms into the agricultural industry at the limit, and the model itself becomes the Helpman-Krugman model. Throughout the convergence path, industry m is concentrated in the larger country and it remains so at the limit, as it becomes the manufacturing industry. In contrast, the economic reasoning behind the concentration does not stay the same. Until τ_a and $\sigma(a)$ converge to 1 and ∞, respectively, the reasoning is the pursuit of lower production costs. Once convergence is complete, firms in the agricultural industry never cease relocating to the smaller country until the factor price equalizes, eventually nullifying the reasoning of production costs. Conversely, the economic reasoning of transport-cost savings at the limit does not apply outside the limit—the case with marginally imperfect competition and marginally positive transport costs in the agricultural industry. In reality, assuming non-zero product differentiation and non-zero transport costs, even for agricultural goods, is plausible (Davis (1998)). Therefore, we can conclude that, unlike the suggestions drawn from the Helpman-Krugman model, the incentive to lower product costs contributes to the pattern of industrial concentration in the real world.[11][12]

4 Conclusion

This study demonstrates that the literature neglects to consider that higher transport costs protect a small market more significantly from competition. Thus, higher transport costs do not reinforce the advantages of a large market. Instead, the predominant force behind trade patterns between industries with different transport costs is the effect of production costs. When firms compete internationally with each other intensively at low trade costs, they choose a country with low wages as a base for exports.

This rediscovery poses a challenge for empirical works that study the relationship between market size and trade patterns because it effectively tests two effects: one from market size to wages and another from wages to trade. The former channel has seen "an apparent empirical success," as surveyed by Head and Mayer (2004), by considering the proximity to and size of other markets (Harris (1954); Hanson (2005); Redding and Venables (2004)). I would like to see studies that apply this perspective to the channel from wages to trade patterns in the future.

[11] Helpman and Krugman (1985) acknowledge the limitation of their model, stating "[w]e have been able to work only with a highly specialized example."

[12] Similarly, we can interpret the model of Davis (1998) as another limiting case of the Hanson-Xiang model. Davis (1998) demonstrates that the industrial concentration in the model of Helpman and Krugman (1985) disappears when the agricultural industry incurs the same transport costs as the manufacturing industry. The model corresponds to the limiting case of $\tau_a = \tau_m$ and $\sigma(a) \to \infty$, which implies $\phi_a \to 0$. Lemmas 1 and 2 imply two opposing trade patterns: $\sigma(m) < \sigma(a)$ and $\phi_m > \phi_a$ make the larger country a net exporter and importer, respectively, in the manufacturing industry. These two forces offset one another, generating no net exports.

Appendix

A Derivation of Theoretical Results

A.1 Eq. (4) and (8)

I use a matrix R_z that is defined by

$$R_z = (1-\phi_z)\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \phi_z \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}.$$

The inverse matrix is

$$R_z^{-1} = \frac{1}{1-\phi_z}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - \frac{1}{(1-\phi_z)(\phi_z^{-1}+1)}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}.$$

Using R_z, eq. (4) for two countries can be summarized as

$$R_z \begin{bmatrix} Y_1 P_{1z}^{\sigma(z)-1}\alpha_1(z) \\ Y_2 P_{2z}^{\sigma(z)-1}\alpha_2(z) \end{bmatrix} = \begin{bmatrix} w_1^{\sigma(z)} \\ w_2^{\sigma(z)} \end{bmatrix}.$$

Premultiplying R_z^{-1} yields

$$Y_n P_{nz}^{\sigma(z)-1}\alpha_n(z) = \frac{w_n^{\sigma(z)}}{1-\phi_z} - \frac{1}{(1-\phi_z)(\phi_z^{-1}+1)}\sum_{i\in N} w_i^{\sigma(z)}$$

$$\iff (1-\phi_z)Y_n P_{nz}^{\sigma(z)-1}\alpha_n(z) w_n^{-\sigma(z)} = \frac{1}{1+\frac{\sum_{i\in N}(w_i/\lambda_i)^\sigma}{(1/\phi_k+N-1)(w_n/\lambda_n)^\sigma - \sum_{i\in N}(w_i/\lambda_i)^\sigma}},$$

from which eq. (4) follows. Substituting eq. (5) for $P_{nz}^{1-\sigma(z)}$ makes the matrix form be

$$
\begin{aligned}
\begin{bmatrix} Y_1\alpha_1(z) \\ Y_2\alpha_2(z) \end{bmatrix} &= diag\left(R_z \begin{bmatrix} M_{1z}w_1^{1-\sigma(z)} \\ M_{2z}w_2^{1-\sigma(z)} \end{bmatrix}\right) \cdot R_z^{-1} \begin{bmatrix} w_1^{\sigma(z)} \\ w_2^{\sigma(z)} \end{bmatrix} \\
\iff \begin{bmatrix} Y_1\alpha_1(z) \\ Y_2\alpha_2(z) \end{bmatrix} &= diag\left(R_z^{-1} \begin{bmatrix} w_1^{\sigma(z)} \\ w_2^{\sigma(z)} \end{bmatrix}\right) R_z \begin{bmatrix} M_{1z}w_1^{1-\sigma(z)} \\ M_{2z}w_2^{1-\sigma(z)} \end{bmatrix} \\
\iff \begin{bmatrix} M_{1z}w_1^{1-\sigma(z)} \\ M_{2z}w_2^{1-\sigma(z)} \end{bmatrix} &= R_z^{-1} diag\left(R_z^{-1} \begin{bmatrix} w_1^{\sigma(z)} \\ w_2^{\sigma(z)} \end{bmatrix}\right)^{-1} \begin{bmatrix} Y_1\alpha_1(z) \\ Y_2\alpha_2(z) \end{bmatrix} \\
&= \frac{R_z^{-1}}{1-\phi_z} \begin{bmatrix} \left(w_1^{\sigma(z)} - \frac{\sum_i w_i^{\sigma(z)}}{\phi_z^{-1}+1}\right)^{-1} & 0 \\ 0 & \left(w_2^{\sigma(z)} - \frac{\sum_i w_i^{\sigma(z)}}{\phi_z^{-1}+1}\right)^{-1} \end{bmatrix} \begin{bmatrix} Y_1\alpha_1(z) \\ Y_2\alpha_2(z) \end{bmatrix} \\
&= \begin{bmatrix} \frac{Y_1\alpha_1(z)}{w_1^{\sigma(z)} - \frac{\sum_i w_i^{\sigma(z)}}{\phi_z^{-1}+1}} - \frac{1}{\phi_z^{-1}+1} \sum_i \frac{Y_i\alpha_i(z)}{w_i^{\sigma(z)} - \frac{\sum_j w_j^{\sigma(z)}}{\phi_z^{-1}+1}} \\ \frac{Y_2\alpha_2(z)}{w_2^{\sigma(z)} - \frac{\sum_i w_i^{\sigma(z)}}{\phi_z^{-1}+1}} - \frac{1}{\phi_z^{-1}+1} \sum_i \frac{Y_i\alpha_i(z)}{w_i^{\sigma(z)} - \frac{\sum_j w_j^{\sigma(z)}}{\phi_z^{-1}+1}} \end{bmatrix}.
\end{aligned}
$$

Eq. (8) follows from this matrix form.

A.2 Proofs of Lemmas and Corollaries

Proof of Lemma 1. Plugging eq. (7) into $\alpha_n(z)Y_n\mu_{nz}/\alpha_i(z)Y_i\mu_{iz}$ yields

$$
\begin{aligned}
&\frac{\alpha_i(z)Y_i}{\alpha_n(z)Y_n} \cdot \frac{(\phi_z^{-1}+1)w_n^{\sigma(z)} - \sum_{i\in\{1,2\}} w_i^{\sigma(z)}}{(\phi_z^{-1}+1)w_i^{\sigma(z)} - \sum_{i\in\{1,2\}} w_i^{\sigma(z)}} \\
&= \frac{\alpha_i(z)Y_i}{\alpha_n(z)Y_n} \cdot \left[1 + \frac{(w_i^{-\sigma(z)} - w_n^{-\sigma(z)}) \sum_{i\in\{1,2\}} w_i^{\sigma(z)}}{(\phi_z^{-1}+1) - \frac{\sum_{i\in\{1,2\}} w_i^{\sigma(z)}}{w_i^{\sigma(z)}}}\right].
\end{aligned}
$$

In equilibrium, $(\phi_z^{-1}+1) - \frac{\sum_{i\in\{1,2\}} w_i^{\sigma(z)}}{w_i^{\sigma(z)}} > 0$; otherwise, the zero-profit conditions for an equilibrium with non-zero production in all industries in both countries cannot occur simultaneously, as presented in Appendix A.1 (Lemma 1 of Hanson and Xiang (2004)). Thus, this term increases with ϕ_z if and only if

$w_n > w_i$, implying Lemma 1. $\square$

Proof of Corollary 1. Aggregate revenue equals aggregate expenditure for an industry ($\sum_j M_{jy} w_j = \sum_j \alpha_j(y) Y_j$), implying country n is a net exporter as

$$\frac{M_{ny} w_n}{M_{iy} w_i} > \frac{L_n w_n}{L_i w_n} = \frac{\alpha_n(y) Y_n}{\alpha_i(y) Y_i} \implies M_{ny} w_n > \alpha_n(y) Y_n.$$

Subsequently, the same algebra as in the proof of Lemma 1 with $\alpha_n(z) \geq \alpha_i(z)$ implies that country n is a net exporter in industry z. Thus, I obtain the following inequality, which completes the proof.

$$\frac{M_{nz} w_n}{M_{iz} w_i} > \frac{\alpha_n(z) Y_n}{\alpha_i(z) Y_i} > \frac{Y_n}{Y_i}.$$

$\square$

Proof of Lemma 2. The term $\alpha_n(z) Y_n \mu_{nz} / \alpha_i(z) Y_i \mu_{iz}$ decreases with $\sigma(z)$ for the higher-wage country n as the main text states. It follows from

$$\frac{\alpha_i(z) Y_i \mu_{iz}}{\alpha_n(z) Y_n \mu_{nz}} = \frac{\alpha_i(z) Y_i}{\alpha_n(z) Y_n} \cdot \frac{(\phi_z^{-1} + 1) - \left(1 + (w_n/w_i)^{-\sigma(z)}\right)}{(\phi_z^{-1} + 1) - \left(1 + (w_n/w_i)^{\sigma(z)}\right)} \cdot \left(\frac{w_n}{w_i}\right)^{\sigma(z)}.$$

The other term $w_n^{\sigma(z)} / w_i^{\sigma(z)}$ increases with $\sigma(z)$, implying Lemma 2. $\square$

Proof of Corollary 2. The same steps as in the proof of Corollary 1 imply that country n is a net exporter in any industry z with $\tau_z \geq \tau_y$, $\sigma(z) = \sigma(y)$, and $\alpha_n(z)/\alpha_i(z) \geq \alpha_n(y)/\alpha_i(y)$. Subsequently, Lemma 2 implies that country n is a net exporter in any industry z with $\tau_z \geq \tau_y$, $\sigma(z) \leq \sigma(y)$, and $\alpha_n(z)/\alpha_i(z) \geq \alpha_n(y)/\alpha_i(y)$. The same last step as that in the proof of Corollary 1 completes the proof. $\square$

References

Amiti, M. (1998). Inter-industry trade in manufactures: Does country size matter? *Journal of International Economics 44*(2), 231–255.

Baldwin, R., R. Forslid, P. Martin, G. Ottaviano, and F. Robert-Nicoud (2003). Economic geography and public policy. In *Economic Geography and Public Policy*. Princeton University Press.

Barbero, J., K. Behrens, and J. L. Zofio (2018). Industry location and wages: The role of market size and accessibility in trading networks. *Regional Science and Urban Economics 71*, 1–24.

Behrens, K., A. R. Lamorgese, G. I. Ottaviano, and T. Tabuchi (2009). Beyond the home market effect: Market size and specialization in a multi-country world. *Journal of International Economics 79*(2), 259–265.

Costinot, A., D. Donaldson, M. Kyle, and H. Williams (2019). The more we die, the more we sell? a simple test of the home-market effect. *The Quarterly Journal of Economics 134*(2), 843–894.

Crozet, M. and F. Trionfetti (2008). Trade costs and the home market effect. *Journal of International Economics 76*(2), 309–321.

Davis, D. R. (1998). The home market, trade, and industrial structure. *The American Economic Review 88*(5), 1264–1276.

Erhardt, K. (2017). On home market effects and firm heterogeneity. *European Economic Review 98*, 316–340.

Fajgelbaum, P., G. M. Grossman, and E. Helpman (2011). Income distribution, product quality, and international trade. *Journal of Political Economy 119*(4), 721–765.

Feenstra, R. C., J. R. Markusen, and A. K. Rose (2001). Using the gravity equation to differentiate among alternative theories of trade. *Canadian Journal of Economics/Revue canadienne d'économique 34*(2), 430–447.

Hanson, G. H. (2005). Market potential, increasing returns and geographic concentration. *Journal of International Economics 67*(1), 1–24.

Hanson, G. H. and C. Xiang (2004). The home-market effect and bilateral trade patterns. *American Economic Review 94*(4), 1108–1129.

Harris, C. D. (1954). The, market as a factor in the localization of industry in the united states. *Annals of the Association of American Geographers 44*(4), 315–348.

Head, K. and T. Mayer (2004). The empirics of agglomeration and trade. In *Handbook of Regional and Urban Economics*, Volume 4, pp. 2609–2669. Elsevier.

Head, K., T. Mayer, and J. Ries (2002). On the pervasiveness of home market effects. *Economica 69*(275), 371–390.

Helpman, E. and P. Krugman (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT press.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review 70*(5), 950–959.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy 99*(3), 483–499.

Laussel, D. and T. Paul (2007). Trade and the location of industries: Some new results. *Journal of International Economics 71*(1), 148–166.

Matsuyama, K. (2019). Engel's law in the global economy: Demand-induced patterns of structural change, innovation, and trade. *Econometrica 87*(2), 497–528.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *econometrica 71*(6), 1695–1725.

Onoda, T. (2024). Cities' demand-driven industrial compositions and refined market-size effects. *Mimeo*.

Pham, C. S., M. E. Lovely, and D. Mitra (2014). The home-market effect and bilateral trade patterns: A reexamination of the evidence. *International Review of Economics & Finance 30*, 120–137.

Redding, S. and A. J. Venables (2004). Economic geography and international inequality. *Journal of International Economics 62*(1), 53–82.