Developed and Developing Economies: A Synthesis of First and Second Natures*

Lili Tan† Dao-Zhi Zeng‡

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Abstract

This paper investigates the joint impact of two different kinds of first-nature forces, Ricardian comparative advantage and the Heckscher-Ohlin advantage, and the second-nature forces on industry location and income inequality. We extend a new economic geography model without a traditional sector so that the wage is endogenous in our framework. We find that, interacting with the second nature, the impact of the first nature related to technology and that related to capital endowment are unequal and nonuniform along with the integration process. Moreover, by combining these three kinds of trade causes, we generate various patterns of relationship between spatial income inequality and trade integration, providing a better explanation for the diverse empirical studies.

Keywords: First nature, Second nature, Developing economy, Developed economy, Inequality, Globalization

JEL classification: F12, F15, R12

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†Center for Research of Private Economy, Zhejiang University, Zhejiang 310027, China. E-mail: tanlili@zju.edu.cn

‡Corresponding auther. Graduate School of Information Sciences, Tohoku University, Sendai 980-8579, Japan. E-mail: zeng@se.is.tohoku.ac.jp

1 Introduction

The occurrence of international and interregional trade is mainly attributed to three causes. Ricardian comparative advantage is the earliest one, focusing on productivity differential across countries. The second is the Heckscher-Ohlin (H-O) theory, concluding that countries will export products that use their abundant and cheap factor(s) of production and import products that use the countries' scarce factor(s). Both of them are natural advantages, referred to as "first nature" in the literature. They are closely related because relative endowments of the production factors (land, labor, and capital) determine a country's comparative advantage. These two theories can explain inter-industry trade well. The third explanation is the New Economic Geography (NEG) or New Trade Theory (NTT). NEG/NTT explains intra-industry trade by economic force ("second nature") resulting from imperfect competition, differentiated products, and increasing returns.

Although the theoretical studies cited above separately examine the trade features one by one, the real world is evidently a mixture of them all. For example, many developing countries are abundant in labor but have a lack of capital. Furthermore, the production technology in developed countries differs from that in developing countries, in the sense of more capital but less labor inputs. Therefore, analyzing intra-industry trade among developed countries and developing countries requires a model that incorporates more features.

Such a research direction is observed in the current literature. An early work of Davis (1995) develops the Heckscher-Ohlin-Ricardo model. Interestingly, combining them provides an explanation of intra-industry trade. Meanwhile, the so-called standard trade model (Krugman and Obstfeld 2006) shows a framework in which the Ricardian model and H-O model can be regarded as special cases. However, this extension is limited to the case of constant returns to scale and free trade.

Furthermore, there are some papers that introduce Ricardian comparative advantage into NEG/NTT frameworks. In models with multiple industries, NEG/NTT has some indeterminacy of location equilibria. Venables (1999) then describes the Ricardian comparative advantage as a mechanism that allows a reduction (but not the elimination) of this level of equilibrium indeterminacy. Meanwhile, Ricci (1999) reports that an increase in the comparative advantage may reduce agglomeration or even reverse the agglomeration pattern. Forslid and Wooton (2003) introduce the Ricardian comparative advantage into a multiple-industry version of Krugman's core-periphery model. The comparative advantage works as a dispersion force, deriving a redispersion process with international specialization of the industries. Finally, Picard and Zeng (2010) find that absolute location advantages are associated with a smooth agglomeration process, while comparative advantages are related with a catastrophic process. Their results suggest that the first-nature force might beat the second-nature force.

On the other hand, there are some papers that incorporate the H-O comparative advantage into NEG/NTT models. Epifani (2005) reports that, if two countries are not too dissimilar in terms of factor ratios, the process of trade integration involves an overshooting of specialization and relative factor prices with respect to the free trade level. By considering manufacturing firms that are vertically linked and differ in factor intensities, Amiti (2005) shows that trade liberalization can lead to the agglomeration of two industries in one country; hence, industries may locate in the "wrong" country from a comparative advantage viewpoint. Therefore, this first-nature force is beaten by the second-nature force in their frameworks, which is in contrast to the previous Ricardian case.

The primary purpose of this paper is to clarify how all three causes interact with each other and to demonstrate their roles in different phases of the trade integration process. For this purpose, we extend an NTT model of Takahashi et al. (forthcoming) by incorporating important features among developed and developing economies. They are different in technology and factor endowments. Specifically, our space consists of two countries or regions, the North and the South. There are two production factors: immobile labor and mobile capital. The production is under increasing returns to scale. As a developed country, the North has a technology inputting more fixed cost of capital but less marginal cost of labor than the South, the developing country. Meanwhile, to exhibit the different capital endowment, we assume that the North has a higher per capita stock endowment.

Traditional H-O models assume immobile capital. However, given the liberalization of capital flows in previous decades, modeling capital as a mobile factor is more appropriate. The comparative advantage can also be derived from more complicated models including capital mobility. As early as the 1960s, Kemp (1966) and Jones (1967) introduced perfect capital mobility across countries into the H-O model. Their models explain the enormous expansion of both international trade and capital movements in that time very well. Our model also assumes mobile capital, even when we consider the effect of an endowment difference. It is noteworthy that the capital return is repatriated to the owner, such as in Kemp (1966) and Jones (1967).

An important feature of our model is that there is only one industry without a homogeneous-good sector. The technical (dis)advantage appears to be absolute rather than relative. However, the Dixit-Stiglitz monopolistic competition framework contains infinite differentiated firms, and there are two factors. Therefore, we can show the rich features of the technology differential.

Previewing our results, we note that the impact of the first nature related to technology and the impact of the first nature related to capital endowment are unequal and nonuniform along with the integration process, in other words, along with the level of trade costs. When trade costs are high, it is hard to serve the foreign market, the higher marginal efficiency in the North can only make the local labor produce more and consume more at lower prices. The return to capital will not rise in the North, and thus no firm wants to immigrate. As a result, the impact of the first nature related to technology is weak. On the other hand, since market access is important, the impact of the first nature related to the capital endowment plays a leading role in the income distribution. Therefore, the H-O advantage is relatively stronger than the Ricardian one. When trade costs are low, the higher marginal efficiency in the North gives the Northern firms a higher return by exporting to the Southern market. More firms will locate in the North, and the impact of the first nature related to technology becomes large. On the other hand, local factor access is more important while the endowment of the mobile factor is less important. Therefore, the first nature related to the capital endowment becomes weaker.

Without the homogeneous-good sector, the wages in the two countries are not fixed. This helps us reach our second goal, which is to clarify how spatial income inequality evolves in the trade integration process. Indeed, the existing literature says little about regional inequality and, in particular, about the income inequality. Krugman (1991) and Forslid and Ottaviano (2003) generate a regional divergence in the process of integration, while Venables (1996), Puga (1999), Picard and Zeng (2005), Amiti (2005), Epifani (2005), and Tabuchi and Thisse (2002) derive an inverted-U pattern of geographic concentration in which regional inequality first rises and then falls. Most of them refer to regional inequality in terms of firm share rather than income. In contrast, our model is able to exhibit spatial inequalities in terms of both income and economic activity. From the interaction of three kinds of trade causes, we generate various patterns of relationships between the spatial inequality and trade integration.

Turning to the empirical studies on spatial income inequalities, we have many mixed results. Some studies show an inverted-U pattern relationship between regional inequality and development (Williamson 1965; Kim 1995), while others present fluctuating patterns. By analyzing the evolution of regional inequalities in China and Brazil, respectively, Kanbur and Zhang (2005) and Azzoni (2001) find the fluctuating patterns with three and two peaks. Furthermore, based on some relative short time series data (10, 20, or 30 years), Naude and Krugell (2003) and Balisacan and Fuwa (2006) show a decline of regional inequality in South Africa and the Philippines. With data of 30 years from 1970 to 2000, Rodriguez-Pose and Sanchez-Reaza (2005) report a U pattern of regional inequality evolution in Mexico. As previously reported, the existing theoretical studies do not clearly explain the rich evolution patterns. However, by combining the second nature and two different kinds of first nature into one framework, we are able to derive various evolution patterns of spatial inequality: inverted-U-shaped, decreasing, increasing and even U-shaped. They provide a better and more general explanation for the diverse empirical studies. In addition, although the wage ratio is given by an implicit function, propositions are all shown analytically in our model.

The rest of this paper is organized as follows. In Section 2, we present the model. Section 3 is an equilibrium analysis. In it, we characterize the basic properties of the equilibrium evolution path of spatial inequality, report the different impacts of the two kinds of first natures, and illustrate the diversity of the evolution path, showing how it provides a better explanation for the mixed empirical studies. Finally, Section 4 is the conclusion.

2 Model

As shown in Figure 1, there are L people in the world, consisting of two countries, the North and the South. The labor endowment share in the North is θ, and that in the South is $(1-\theta)$. While the total capital is K, the capital endowment share in the North is γ, and that in the South is $(1-\gamma)$. It is noteworthy that the capital held by each country can be employed in either one.

The capital share γ is not always equal to the population share θ. Inequalities $\gamma > \theta > 1/2$ mean that the developed country that enjoys a higher per capita stock and higher marginal efficiency is also the larger one, similarly to the relationship between the United States and Mexico. On the other hand, inequalities $\theta < \gamma < 1/2$ mean that the developed country is the smaller one, as in the relationship between Japan and China. It is noteworthy that γ is related to the so-called Heckscher-Ohlin comparative advantage.

The production functions in two countries differ. In the North, a firm employs one unit of capital as the fixed cost and $\eta(\sigma-1)/\sigma$ units of labor as the marginal cost, where $\eta \in (0,1)$. Meanwhile, in the South, a firm employs $\kappa \in (0,1)$ units of capital as the fixed

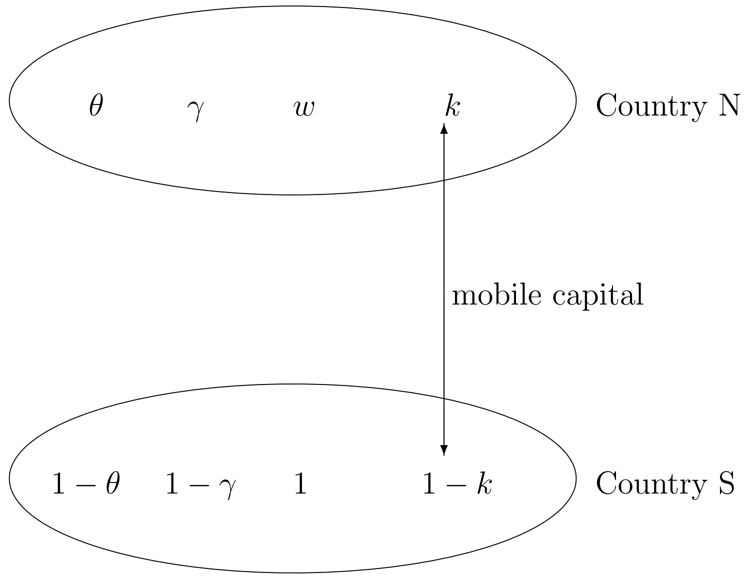


Figure 1: The economy space of two countries

cost and $(\sigma-1)/\sigma$ unit of labor as the marginal cost. η and κ are related to the so-called Ricardian comparative advantage.

Let the capital investment share of the North be k. The capital employed in the North is then kK, and that in the South, $(1-k)K$. Take the labor in the South as the numéraire. Then, the wage in the South is 1. Denote the wage in the North by w.

The Marshallian demand functions are

$$d_{nn} = \frac{(p_{nn})^{-\sigma}}{(P_n)^{1-\sigma}} Y_n, \quad d_{sn} = \frac{(p_{sn})^{-\sigma}}{(P_n)^{1-\sigma}} Y_n, \tag{1}$$

$$d_{ss} = \frac{(p_{ss})^{-\sigma}}{(P_s)^{1-\sigma}} Y_s, \quad d_{ns} = \frac{(p_{ns})^{-\sigma}}{(P_s)^{1-\sigma}} Y_s, \tag{2}$$

where d_{ij} is country j's demand for a variety made in country i, Y_i is the national income in country i, and p_{ij} is the price of a variety made in country i and sold in country j. Assume Samuelson's iceberg international transportation costs: $\tau \geqslant 1$ units of a manufactured good must be shipped for one unit to reach the other country.

A firm located in the North (resp. the South) sets prices to maximize its profit

$$\pi_n = p_{nn} d_{nn} + p_{ns} d_{ns} - \frac{\sigma-1}{\sigma} \eta w (d_{nn} + \tau d_{ns}) - r_n,$$
$$\pi_s = p_{ss} d_{ss} + p_{sn} d_{sn} - \frac{\sigma-1}{\sigma} (d_{ss} + \tau d_{sn}) - \kappa r_s.$$

The first-order condition gives

$$p_{nn} = \eta w, \quad p_{ns} = \tau \eta w, \quad p_{ss} = 1, \quad p_{sn} = \tau.$$

The price indices are then

$$P_n = \left[(\eta w)^{1-\sigma} kK + \frac{\phi(1-k)K}{\kappa}\right]^{\frac{1}{1-\sigma}}, \quad P_s = \left[\phi(\eta w)^{1-\sigma} kK + \frac{(1-k)K}{\kappa}\right]^{\frac{1}{1-\sigma}}, \tag{3}$$

where $\phi \equiv \tau^{1-\sigma} \in [0,1]$ is the trade freeness.

By the free-entry condition of firms, the profit of firms is zero in a long-run equilibrium. We then obtain the capital rent as

$$r_n = \frac{1}{\sigma K}\left[\frac{(\eta w)^{1-\sigma} Y_n}{(\eta w)^{1-\sigma} k + \frac{\phi(1-k)}{\kappa}} + \frac{\phi(\eta w)^{1-\sigma} Y_s}{\phi(\eta w)^{1-\sigma} k + \frac{(1-k)}{\kappa}}\right], \tag{4}$$

$$r_s = \frac{1}{\kappa\sigma K}\left[\frac{\phi Y_n}{(\eta w)^{1-\sigma} k + \frac{\phi(1-k)}{\kappa}} + \frac{Y_s}{\phi(\eta w)^{1-\sigma} k + \frac{(1-k)}{\kappa}}\right]. \tag{5}$$

Next, the national incomes are

$$Y_n = \gamma K[kr_n + (1-k)r_s] + w\theta L, \tag{6}$$

$$Y_s = (1-\gamma)K[kr_n + (1-k)r_s] + (1-\theta)L. \tag{7}$$

The first terms in the RHS are capital incomes, and the second terms are wage incomes.

3 Equilibrium

It is easy to conclude that we have no corner equilibrium in this model, and our analysis is, therefore, focused on the interior equilibrium, in which $r_n = r_s$. Equations (4) and (5) imply

$$kr_n + (1-k)r_s = \frac{1}{\sigma K}(Y_n + Y_s) \text{ and } r_n = r_s \Longrightarrow r_n = r_s = \frac{1}{\sigma K}(Y_n + Y_s) \equiv r.$$

Substituting the above equalities to (6) and (7), we obtain

$$Y_n = \frac{L[\gamma - \gamma\theta + \theta w(\gamma + \sigma - 1)]}{\sigma - 1}, \tag{8}$$

$$Y_s = \frac{L[w(\theta - \gamma\theta) + (\theta - 1)(\gamma - \sigma)]}{\sigma - 1}, \tag{9}$$

$$r = \frac{L[w\theta + (1-\theta)]}{K(\sigma - 1)}. \tag{10}$$

Meanwhile, by use of $r_n = r_s = r$, Equations (4) and (5) imply

$$\frac{\alpha w^{1-\sigma} Y_s (1-\phi^2)}{\phi \alpha w^{1-\sigma} k + (1-k)} = r\sigma K(\alpha w^{1-\sigma} - \phi),$$
$$\frac{\alpha w^{1-\sigma} Y_n (1-\phi^2)}{\alpha w^{1-\sigma} k + \phi(1-k)} = r\sigma K(1 - \phi\alpha w^{1-\sigma}),$$

where $\alpha = \eta^{1-\sigma}\kappa \in (0, +\infty)$ for $\eta \in (0,1)$ and $\kappa \in (0,1)$ describes the Ricardian comparative advantage of the North over the South. A large α means that less labor is necessary in the North and/or more capital is necessary in the South, since it increases in the Southern relative fixed cost κ and decreases in the Northern relative marginal cost η.

Since the left-hand sides are all positive, we obtain a lower bound and an upper bound for wage w:

$$\alpha\phi < w^{\sigma-1} < \frac{\alpha}{\phi} \tag{11}$$

The above bounds imply that firms' relocation decreases the price index in the destination country and increases that in the origin country when the trade freeness ϕ and wages are fixed.[1]

Now, we turn to the labor markets. Because the Northern wage is w, the labor demand is equal to the total labor costs of firms there:

$$k\frac{\sigma-1}{\sigma}(Y_n + Y_s) = kL(\theta w + 1 - \theta),$$

where the equality is from (8) and (9). Meanwhile, the labor supply in the North is $\theta w L$. The labor balance suggests a simple relationship between the wage and firm share:

$$k = \frac{\theta w}{\theta w + 1 - \theta} \tag{12}$$

Note that the capital investment share k strictly increases in w.

[1] To see the details, assume that one unit of firms moves from the South to the North. Then, according to (3), $P_n^{1-\sigma}$ has an impact of $\frac{K}{\kappa}(\alpha w^{1-\sigma} - \phi) > 0$ while $P_s^{1-\sigma}$ has an impact of $\frac{K}{\kappa}(\phi\alpha w^{1-\sigma} - 1) < 0$, where the inequalities are from (11). Accordingly, P_n decreases and P_s increases

We rewrite expression (12) as

$$k - \theta = \frac{\theta(1-\theta)(w-1)}{\theta w + (1-\theta)},$$

which shows the equivalence between the spatial inequality in terms of firm share and that in terms of wage. This relationship is first obtained in Takahashi et al. (forthcoming). We find that it holds even in this more complicated situation. Therefore, our model makes it possible to study spatial inequality in these two terms simultaneously. It is noteworthy that most present empirical studies about spatial inequality focus on personal income (e.g., Williamson 1965; Azzoni 2011), while the mainstream of NEG/NTT emphasizes that in terms of firm share only.

To show how wage w is endogenously determined and to get wage equation, note that the production of each the Northern firm is $d_{nn} + \tau d_{ns}$ and the marginal cost in each firm is $\eta(\sigma - 1)/\sigma$. The market-clearing condition of labor in the North is written as:

$$\theta L = \eta \frac{\sigma - 1}{\sigma} k K (d_{nn} + \tau d_{ns}).$$

By use of (1), (2), (3), (8), (9), (10), and (12), the above equation immediately derives the wage equation

$$\mathcal{F}(w) \equiv \Psi_0(w) + \Psi_1(w)\phi + \Psi_2(w)\phi^2 = 0, \tag{13}$$

where

$$\begin{aligned}
\Psi_0(w) &\equiv \alpha[w\theta(1-\gamma) - \gamma(1-\theta)]w^{1-\sigma},\\
\Psi_1(w) &\equiv \sigma(1 - \theta - \alpha^2 w^{3-2\sigma}\theta),\\
\Psi_2(w) &\equiv \alpha w^{1-\sigma}[(1-\theta)(\gamma - \sigma) + w\theta(\sigma + \gamma - 1)].
\end{aligned}$$

Although we can not explicitly solve (13) to obtain a closed-form relationship between w and ϕ, the following lemma provides some important properties of the implicit function $w(\phi)$ defined by wage equation (13).

Lemma 1 (i) *Given any $\phi \in (0, 1)$, equation $\mathcal{F}(w) = 0$ has a solution in $(0, +\infty)$.*
(ii) *The solution w^* of $\mathcal{F}(w) = 0$ is unique in $(0, +\infty)$, and $\mathcal{F}(w)$ increases at w^*.*
(iii) *The implicit function $w(\phi)$ is continuous and differentiable (smooth).*

Proof: See Appendix A.

We discuss the "globalization" or "trade integration" process, where trade freeness ϕ increases from small to large values. In this paper, the presence of the different first natures weakens the case for endogenous asymmetries and catastrophic changes. Indeed, as trade freeness increases, the distribution of firms and personal income remain on a continuous path. As a consequence, this model of location advantages is consistent with Picard and Zeng (2010), who consider the advantage related to technology, and Epifani (2005), who considers the advantage related to capital endowment, and qualifies Krugman's (1991) or Ottaviano et al.'s (2002) ideas of endogenous asymmetries and catastrophic agglomeration in the distribution of firms that happen in the "globalization" or "trade integration" process. In such a scenario, if firms initially locate in the region offering some location advantages, they gradually agglomerate in that region in a smooth way. Therefore, small location advantages eliminate the possibility of catastrophic changes and of irreversible agglomeration processes. Our result also provide some perspective on the contribution of Davis and Weinstein (2002). They showed that Japanese cities consistently returned to their original positions in the city ranking after the Allied bombing in 1945 in World War II. In consequence, they conclude that the "theory of location fundamentals" is more relevant than the theory of increasing returns. Increasing returns are indeed expected to yield stronger randomness in the city ranking as they give rise to endogenous asymmetries. However, the present model shows that the recovery of Japanese cities is not inconsistent with the theory of increasing returns. The present model predicts that firms resume production in their former city and locational advantages can be preserved after the bombing.

Proposition 1 (i) *The wage in the North w increases in α for $\phi \in (0,1)$.*
(ii) *The wage in the North w increases in γ for all $\phi \in (0,1)$.*

Proof: (i) To explicitly include parameter α, we denote the equilibrium wage by $w(\phi,\alpha)$ and the wage equation by $\mathcal{F}(w,\phi,\alpha)$. At the equilibrium, the partial derivative of wage function with respect to α is

$$\begin{aligned} \left.\frac{\partial \mathcal{F}(w,\phi,\alpha)}{\partial \alpha}\right|_{w=w(\phi,\alpha)} &= \frac{1}{\alpha}\left[\mathcal{F}(w) - \sigma(1-\theta)\phi - \sigma\alpha^2 w^{3-2\sigma}\theta\phi\right]\Big|_{w=w(\phi,\alpha)} \\ &< \left.\frac{\mathcal{F}(w,\phi,\alpha)}{\alpha}\right|_{w=w(\phi,\alpha)} = 0. \end{aligned} \tag{14}$$

According to the implicit function theorem,

$$\frac{\partial w(\phi,\alpha)}{\partial\alpha} = -\frac{\dfrac{\partial\mathcal{F}(w,\phi,\alpha)}{\partial\alpha}}{\dfrac{\partial\mathcal{F}(w,\phi,\alpha)}{\partial w}}\Bigg|_{w=w(\phi,\alpha)} > 0,$$

where the inequality is from (14) and Lemma 1 (ii).

(ii) The conclusion follows from the implicit function theorem again since the partial derivative of wage function $\mathcal{F}(w)$ with respect to γ is

$$\frac{\partial\mathcal{F}}{\partial\gamma} = -\alpha w^{2-\sigma}(1-\phi^2)[\theta + w^{-1}(1-\theta)] < 0 \qquad \square$$

This proposition provides a natural conclusion: industry (or the increasing returns sector) as a whole agglomerates according to the advantage, which may be related to either technology or capital endowment. The stronger the advantage is, the more the industry agglomerates. Existing literature (Venables 1999; Ricci 1999; Picard and Zeng 2010; Epifani 2005; Amiti 2005) studies these two different kinds of first nature separately, focusing more on specialization. It is easy to see that our conclusions here are consistent with theirs.

Furthermore, by incorporating the two different kinds of first nature together, we find that the impact of the first nature related to technology and the impact of the first nature related to capital endowment are unequal and nonuniform along with the integration process, in other words, along with the level of trade costs.

Proposition 2 *When trade costs are high (ϕ is small), the impact of the first nature related to capital endowment $\frac{\partial w}{\partial\gamma}(\phi)$ is stronger than that related to technology $\frac{\partial w}{\partial\alpha}(\phi)$. When trade costs are low (ϕ is large), the impact of the first nature related to technology $\frac{\partial w}{\partial\alpha}(\phi)$ is stronger than that related to capital endowment $\frac{\partial w}{\partial\gamma}(\phi)$.*

Proof: Because $\frac{\partial\mathcal{F}}{\partial w}(\phi)$ and $\frac{\partial\mathcal{F}}{\partial\alpha}(\phi)$ are continuous, and $\frac{\partial\mathcal{F}}{\partial w}(\phi) \neq 0$ for $\phi \in [0,1]$; $\frac{\partial\mathcal{F}}{\partial w}(\phi)$ and $\frac{\partial F}{\partial\gamma}(\phi)$ are continuous, and $\frac{\partial\mathcal{F}}{\partial w}(\phi) \neq 0$ in $\phi \in [0,1]$, we know that

$$\frac{\partial w}{\partial\alpha}(\phi) = -\frac{\frac{\partial\mathcal{F}}{\partial\alpha}(\phi)}{\frac{\partial\mathcal{F}}{\partial w}(\phi)} \quad \text{and} \quad \frac{\partial w}{\partial\gamma}(\phi) = -\frac{\frac{\partial\mathcal{F}}{\partial\gamma}(\phi)}{\frac{\partial\mathcal{F}}{\partial w}(\phi)}$$

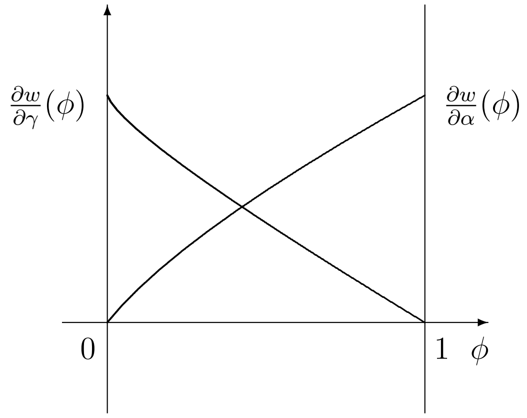


Figure 2: Curves of $\frac{\partial w}{\partial \gamma}(\phi)$ and $\frac{\partial w}{\partial \alpha}(\phi)$

are continuous in $\phi \in [0, 1]$. The conclusions follow from the following results:

$$\lim_{\phi \to 0} \frac{\partial w}{\partial \gamma}(\phi) = \frac{\partial w}{\partial \gamma}(0) = \frac{-\alpha[\theta w^{2-\sigma}(0) + (1-\theta)w^{1-\sigma}(0)]}{-\frac{\partial \mathcal{F}}{\partial w}(0)} > 0$$
$$\lim_{\phi \to 0} \frac{\partial w}{\partial \alpha}(\phi) = \frac{\partial w}{\partial \alpha}(0) = \frac{w^{2-\sigma}(0)(1-\gamma)\theta - w^{1-\sigma}(0)(1-\theta)\gamma}{-\frac{\partial \mathcal{F}}{\partial w}(0)} = 0$$
$$\lim_{\phi \to 1} \frac{\partial w}{\partial \gamma}(\phi) = \frac{\partial w}{\partial \gamma}(1) = \frac{\alpha(1-1)[\theta w^{2-\sigma}(1) + (1-\theta)w^{1-\sigma}(1)]}{-\frac{\partial \mathcal{F}}{\partial w}(1)} = 0$$
$$\lim_{\phi \to 1} \frac{\partial w}{\partial \alpha}(\phi) = \frac{\partial w}{\partial \alpha}(1) = \frac{-2\alpha w^{3-2\sigma}(1)\theta\sigma + w^{2-\sigma}(1)\theta\sigma - \sigma(1-\theta)w^{1-\sigma}(1)}{-\frac{\partial \mathcal{F}}{\partial w}(1)} > 0 \qquad \square$$

When trade costs are high, it is hard to serve the foreign market. The higher marginal efficiency in the North can only make the local labor produce more and consume more at lower prices. The returns to capital in the North are not high enough to attract a lot of firms in the South to immigrate. As a result, the impact of the first nature related to technology is weak. On the other hand, since market access is important, the impact of the first nature related to the capital endowment plays a leading role in determining income distribution. Therefore, the H-O advantage is relatively stronger than the Ricardian one. When trade costs are low, the higher marginal efficiency in the North gives the Northern firms a higher return by exporting to the Southern market. More firms will locate in the North, and the impact of the first nature related to technology becomes strong. On the other hand, local factor access is more important while the endowment of mobile factor is less important. Therefore, the first nature related to the capital endowment becomes weaker.

Resulting from the nonuniform relationship between the two first-nature shocks and the trade freeness ϕ, the form of $w(\phi)$ shows some diversity.

Since $\mathcal{F}(\cdot)$ is a quadratic function with respect to ϕ for all $w \in (0, +\infty)$, $w(\phi)$ intersects with any horizontal line at most twice in the ϕw–plane. For this reason, there are only 6 possible forms of function $w(\phi)$:

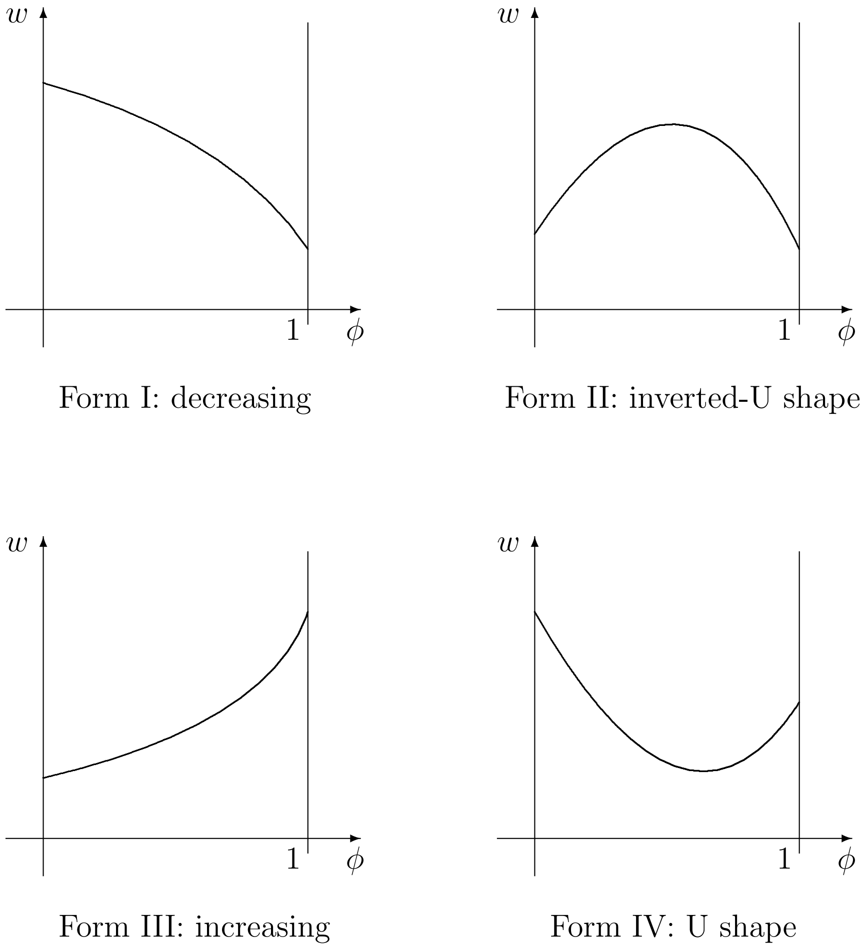
- Form I: $w(\phi)$ decreases in $(0, 1)$;
- Form II: $w(\phi)$ first increases and then decreases, forming an inverted-U shape;
- Form III: $w(\phi)$ increases in $(0, 1)$;
- Form IV: $w(\phi)$ first decreases and then increases, forming a U shape;
- Form V: $w(\phi)$ first decreases, then increases, and then decreases again, forming a U followed by an inverted-U shape.
- Form VI: $w(\phi)$ first increases, then decreases, and then increases again, forming an inverted U-shape followed by a U shape;

In Appendix B, we show that Forms V and VI are impossible. Therefore, even without a closed form of $w(\phi)$, we know that its forms are not too complicated.

Proposition 3 *The possible forms of $w(\phi)$ are increasing, decreasing, U-shaped or inverted U-shaped, as shown in Figure 3.*

Without the homogeneous-good sector, wages in two countries are not fixed. This helps reach the second goal in Proposition 3, clarifying how spatial income inequality evolves in the trade integration process. It is noteworthy that the existing literature of spatial economics on regional inequality is quite limited. Focusing on the regional inequality in terms of firm share, Krugman (1991) and Forslid and Ottaviano (2003) generate a regional divergence in the process of integration, while Venables (1996), Puga (1999), Picard and Zeng (2005), Amiti (2005), Epifani (2005), and Tabuchi and Thisse (2002) derive an inverted-U pattern of geographic concentration in which regional inequality first rises and then falls. Takahashi et al. (forthcoming) first investigate the regional inequality in terms of wage and firm share, obtaining inverted-U patterns again. In contrast, resulting from the interaction of three kinds of trade causes, we are able to generate various patterns of relationship between the spatial inequality and integration, in both wage and firm share.[2]

[2]This because k increases in w according to (12).



Form I: decreasing

Form II: inverted-U shape

Form III: increasing

Form IV: U shape

Figure 3: Possible forms of $w(\phi)$

Our mixed results are consistent with the empirical literature on spatial income inequalities. Indeed, some studies show an inverted-U pattern relationship between regional inequality and development (Williamson 1965; Kim 1995), while others present fluctuating patterns. By analyzing the evolution of regional inequalities in China and Brazil respectively, Kanbur and Zhang (2005) and Azzoni (2001) report fluctuating patterns with three and two peaks. Furthermore, based on some relative short time series data (10, 20, or 30 years), Naude and Krugell (2003) and Balisacan and Fuwa (2006) show a decline of regional inequality in South Africa and the Philippines. With data of 30 years from 1970 to 2000, Rodriguez-Pose and Sanchez-Reaza (2005) report a U pattern of regional inequality evolution in Mexico.

Our model further allows us to examine how the evolution path depends on parameters α and γ. Because $w(\phi)$ is continuous, we can pin down the derivatives of it at 0 and 1.

$$w(0) = \frac{\gamma(1-\theta)}{\theta(1-\gamma)}, \quad w'(0) = -\frac{\sigma\left\{1-\theta-\alpha^2\theta\left[\frac{\theta(1-\gamma)}{\gamma(1-\theta)}\right]^{2\sigma-3}\right\}}{\alpha\theta(1-\gamma)\left[\frac{\gamma(1-\theta)}{\theta(1-\gamma)}\right]^{1-\sigma}}, \tag{15}$$

$$w(1) = \alpha^{\frac{1}{\sigma-1}}, \quad w'(1) = -\frac{(1-\theta)(2\gamma-\sigma)+\theta[\sigma-2(1-\gamma)]\alpha^{\frac{1}{\sigma-1}}}{(\sigma-1)\sigma[\theta+(1-\theta)\alpha^{\frac{1}{\sigma-1}}]}. \tag{16}$$

Forms I-IV of $w(\phi)$ can be characterized by the signs of $w'(0)$ and $w'(1)$. Let

$$\alpha_0(\gamma) \equiv \left(\frac{1-\theta}{\theta}\right)^{\sigma-1}\left(\frac{\gamma}{1-\gamma}\right)^{\sigma-\frac{3}{2}}, \quad \alpha_1(\gamma) \equiv \left\{\frac{(1-\theta)(\sigma-2\gamma)}{\theta[\sigma-2(1-\gamma)]}\right\}^{\sigma-1}.$$

They are solutions of $w'(0) = 0$ and $w'(1) = 0$, respectively, and are plotted as dashed and solid lines, respectively, in Figures 4–6. While $\alpha_1(\gamma)$ decreases in γ, $\alpha_0(\gamma)$ decreases if $\sigma \in (1, 3/2)$ and increases if $\sigma > 3/2$, and they intersect at $\gamma = 1/2$ (see Appendix C). As shown in Figure 4, Form I is featured by $w'(0) < 0$ and $w'(1) < 0$, which are equivalent to $\alpha_1(\gamma) < \alpha < \alpha_0(\gamma)$; Form II is featured by $w'(0) > 0$ and $w'(1) < 0$, which are equivalent to $\alpha > \max\{\alpha_0(\gamma), \alpha_1(\gamma)\}$; Form III is featured by $w'(0) > 0$ and $w'(1) > 0$, which are equivalent to $\alpha_0(\gamma) < \alpha < \alpha_1(\gamma)$; Finally, Form IV is featured by $w'(0) < 0$ and $w'(1) > 0$, which are equivalent to $\alpha < \min\{\alpha_0(\gamma), \alpha_1(\gamma)\}$.

Figure 4 illustrates how the forms of wage $w(\phi)$ depend on first-nature parameters γ and α. Takahashi et al. (forthcoming) reveal a U-shaped or inverted-U-shaped pattern of wage curve $w(\phi)$ when there is no first-nature advantage between two countries. At the intersection point of $\alpha_0(\gamma)$ and $\alpha_1(\gamma)$, the larger country has a first-nature disadvantage,

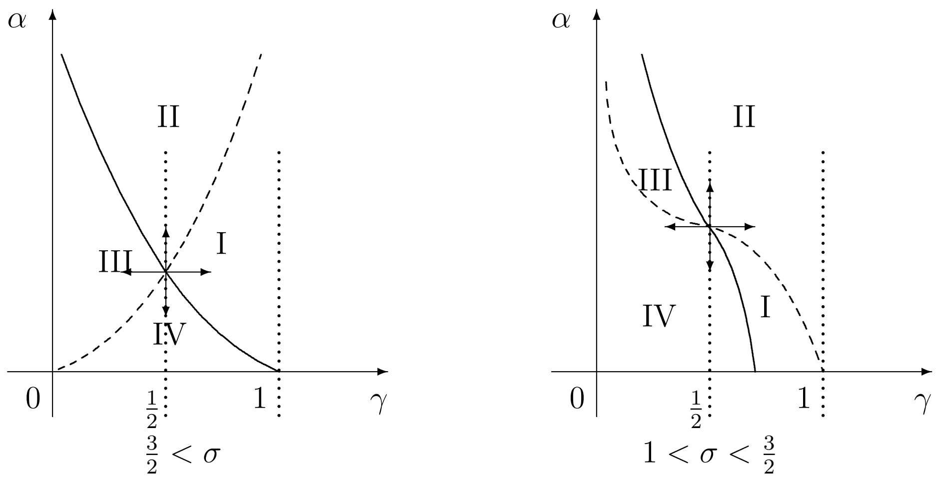


Figure 4: Dependence of patterns on α and γ

which is balanced with the second-nature advantage there, keeping equilibrium wage $w(\phi) = (1-\theta)/\theta$ and equilibrium firm share $k = 1/2$ constant for all ϕ. The left panel of Figure 4 shows the case of a large elasticity of substitution ($\sigma > 3/2$). When a Ricardian shock (a change of first nature along the α direction) is given at the intersection point, the U shape or the inverted U shape of the wage curve reappears. This is because both the Ricardian first-nature force and the second-nature force are weak for a small ϕ and strong for a large ϕ. In contrast, when a Heckscher-Ohlin shock (a change of first nature along the γ direction) is given at the intersection point, a monotone shape of the equilibrium wage curve $w(\phi)$ (Form I or Form III) appears. This is due to the fact that, different from the second-nature force, the Heckscher-Ohlin first-nature force is strong for a small ϕ and weak for a large ϕ. Therefore, the shape of the wage curve is mainly determined by the first-nature force when ϕ is small and by the second-nature force when ϕ is large.

The right panel of Figure 4 is the case in which the elasticity of substitution between the differentiated goods is small ($\sigma \in (1, 3/2)$). Curve $\alpha_0(\gamma)$ is now decreasing; thus, the scope of forms changes to some degree. Compared to that in the left panel, the scope of Forms II and IV is larger in the right panel. This is because, as indicated in Fujita et al. (1999, p.75), a low σ suggests a high degree of product differentiation and large price cost markups and, hence, strong forward and backward linkages; in other words, a small σ suggests a large second-nature force. Therefore, $w(\phi)$ is more likely to be the U or inverted-U pattern. For the same reason, in this small σ case, neither the H-O shock γ nor the Ricardian shock α can beat the second-nature force to form a monotone pattern. We then conclude the following:

Result 1 *From the intersection point, a first-nature shock related to capital endowment generates monotone patterns, while a first-nature shock related to technology retains a U or an inverted-U pattern.*

To be more specific and closer to the real world, we now assume that the developed country has both the advantages of technology and capital endowment (i.e., $\alpha > 1$, $\gamma > \theta$). We analyze how the wage curve form changes when the first-nature advantages increase.

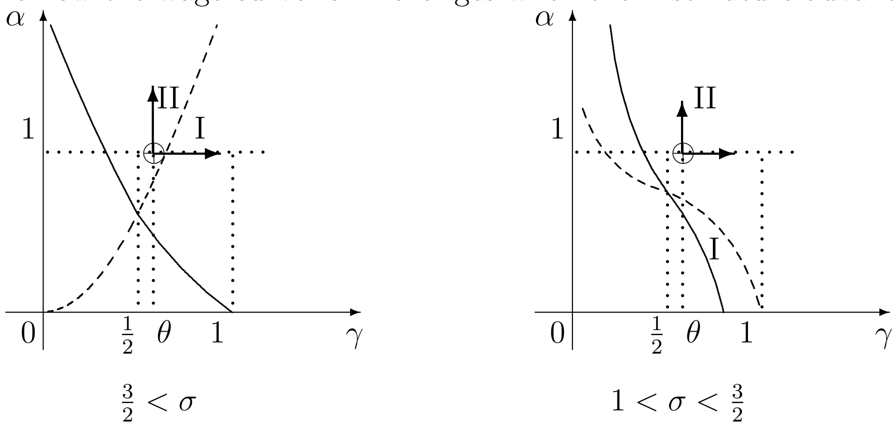


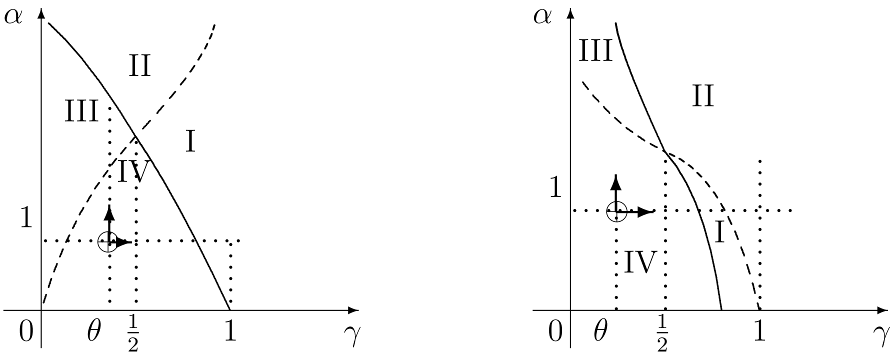
Figure 5: The developed country is larger ($1/2 < \theta < \gamma$)

Figure 5 illustrates a case in which the developed country is larger (i.e., $\gamma > \theta > 1/2$). It is noteworthy that, in this case, the first- and second-nature forces work in the same direction. When there is no first-nature advantage (represented by a mark of $\oplus$), we have Form II of a wage curve[3]. in which the second-nature force produces an inverted-U shape of $w(\phi)$, which is the result of Takahashi et al. (forthcoming). As shown in the figure, we have only Forms I and II. In the left panel of a large σ, increasing the capital endowment γ in the North results in Form I, while increasing the technology advantage α in the North keeps Form II. This occurs because, when the first-nature advantage comes from the capital endowment, its force becomes smaller than the second-nature force, leading to an increasing process of $w(\phi)$ when ϕ is small. Meanwhile, in the right panel of a small σ, increasing the first-nature advantage in the North keeps Form II. This is because a smaller σ derives a stronger second-nature force, which keeps the re-dispersion process and the inverted-U pattern. Furthermore, the increasing α keeps Form II, because, when ϕ is small, the strong impact of α can not beat the relatively stronger second-nature force. Therefore, we conclude the following:

Result 2 *When the developed country is also the larger one, with respect to the wage curve, from the point of no first-nature differential, while increasing α keeps Form II, increasing γ results in Form I when $\sigma > 3/2$ and keeps Form II when $\sigma \in (1, 3/2)$.*

[3]Since $\theta > 1/2$, it holds that $\alpha_0(1/2) = \alpha_1(1/2) = (\frac{1-\theta}{\theta})^{\sigma-1} < 1$

On the other hand, Figure 6 shows a case in which the developed country is smaller (i.e., $\theta < \gamma < 1/2$).



$\frac{3}{2} < \sigma$ $\quad\quad$ $1 < \sigma < \frac{3}{2}$

Figure 6: The developed country is smaller ($\theta < \gamma < 1/2$)

Since the first nature and the second nature work in the opposite direction in this case, we have many possible forms. Interestingly, when there is no first-nature advantage (represented by a mark of $\oplus$), we have Form IV, which is also consistent with Takahashi et al. (forthcoming). Furthermore, a strong second nature, which is derived by a small σ, makes the scope of Form IV larger in the right panel than in the left one.

4 Conclusion

Extending an NTT model with endogenous wage rates, this paper incorporates two different kinds of first nature and the second nature simultaneously. With all three causes of trade in a unified framework, we find that the impact of the first nature related to technology and that of the first nature related to capital endowment are unequal and nonuniform along with the integration process. When trade costs are high, the H-O advantage is relatively stronger than the Ricardian one, while when trade costs are low, the Ricardian advantage is stronger.

Resulting from this nonuniform relationship between the two first-nature shocks ($\frac{\partial w}{\partial \alpha}(\phi)$ and $\frac{\partial w}{\partial \gamma}(\phi)$) and the trade freeness ϕ, curves $w(\phi)$ and $k(\phi)$ have four possible forms. By contrast with the simple results of the existing theoretical papers, our diverse conclusions provide a better and more general explanation for the mixed empirical studies.

Appendix A: Proof of Lemma 1

(i) We first show that

$$\lim_{w\to+\infty}\mathcal{F}(w)=\begin{cases}\sigma(1-\theta)\phi>0 & \text{if } \sigma>2\\ \alpha(\theta-\gamma\theta)+\sigma(1-\theta)\phi+\alpha(\sigma\theta-\theta+\gamma\theta)\phi^2>0 & \text{if } \sigma=2\\ +\infty>0 & \text{if } \sigma<2\end{cases}$$

We then prove that $\forall\phi\in(0,1)$, there exists $w^*>0$ such that $\mathcal{F}(w^*)<0$. Let

$$\begin{aligned}a&\equiv\alpha\theta(1-\gamma)+\alpha\phi^2\theta(\sigma-1+\gamma)\\ b&\equiv\alpha\phi^2(1-\theta)(\sigma-\gamma)+\alpha\gamma(1-\theta)\\ c&\equiv\theta\phi\sigma\alpha^2\\ d&\equiv(1-\theta)\sigma\phi.\end{aligned}$$

We have

$$\begin{aligned}&a>0,\quad b>0,\quad c>0,\quad d>0,\\ &\mathcal{F}(w)=aw^{2-\sigma}-bw^{1-\sigma}-cw^{3-2\sigma}+d.\end{aligned}$$

It is evident that $\mathcal{F}(w)<aw^{2-\sigma}-bw^{1-\sigma}+d$ and $\lim_{w\to0}aw^{2-\sigma}-bw^{1-\sigma}+d=-\infty$. Therefore, $\exists w^*>0$ s.t. $\mathcal{F}(w^*)<aw^{*2-\sigma}-bw^{*1-\sigma}+d<0$, and the continuity of function $\mathcal{F}(\cdot)$ ensures that equation $\mathcal{F}(w)=0$ has a solution in $(0,+\infty)$.

(ii) We prove the conclusion for two possible cases.

Case I: $\sigma\geq3/2$. We denote w^* as the largest solution of $\mathcal{F}(w)=0$ and let

$$\begin{aligned}&a_1=a\frac{bw^{*1-\sigma}}{bw^{*1-\sigma}+cw^{*3-2\sigma}},\quad a_2=a\frac{cw^{*3-2\sigma}}{bw^{*1-\sigma}+cw^{*3-2\sigma}},\\ &d_1=d\frac{bw^{*1-\sigma}}{bw^{*1-\sigma}+cw^{*3-2\sigma}},\quad d_2=d\frac{cw^{*3-2\sigma}}{bw^{*1-\sigma}+cw^{*3-2\sigma}},\\ &\mathcal{F}_1(w)=a_1w^{2-\sigma}-bw^{1-\sigma}+d_1,\quad \mathcal{F}_2(w)=a_2w^{2-\sigma}-cw^{3-2\sigma}+d_2.\end{aligned}$$

Then, we have

$$\begin{aligned}&a_1>0,\quad a_2>0,\quad d_1>0,\quad d_2>0,\\ &a=a_1+a_2,\quad d=d_1+d_2,\end{aligned}$$

$$a_1 w^{*2-\sigma} - bw^{*1-\sigma} + d_1 = 0, \quad a_2 w^{*2-\sigma} - cw^{*3-2\sigma} + d_2 = 0,$$
$$\mathcal{F}(w) = \mathcal{F}_1(w) + \mathcal{F}_2(w).$$

We prove that $\mathcal{F}_1(w)$ increases when $w < w^*$. In fact, since $\mathcal{F}(w^*) = 0$ and $d > 0$, we have $aw^{*2-\sigma} < bw^{*1-\sigma} + cw^{*3-2\sigma}$, which can be rewritten as

$$\frac{aw^{*1-\sigma}}{bw^{*1-\sigma} + cw^{*3-2\sigma}} < \frac{1}{w^*}.$$

Therefore, $a_1 < \frac{b}{w^*} < \frac{b}{w}$ holds when $w < w^*$, yielding

$$\mathcal{F}_1'(w) = w^{1-\sigma}\Big[(2-\sigma)a_1 - \frac{b}{w}(1-\sigma)\Big] > w^{1-\sigma}(1-\sigma)\Big(a_1 - \frac{b}{w}\Big) > 0.$$

Since $\sigma \geq 3/2$, we can similarly show that $\mathcal{F}_2(w)$ also increases when $w < w^*$. Accordingly, $\mathcal{F}(w) = \mathcal{F}_1(w)+\mathcal{F}_2(w) < \mathcal{F}_1(w^*)+\mathcal{F}_2(w^*) = 0$ holds for all $w < w^*$, excluding any solution of $\mathcal{F}(w) = 0$ in $(0, w^*)$. Note that $\mathcal{F}(0) < 0$, and we have only one solution in $(0, \infty)$ at which $\mathcal{F}(w)$ increases.

Case II: $1 < \sigma < 3/2$. We also let w^* be the largest solution of $\mathcal{F}(w) = 0$ and consider two subcases.

The first subcase assumes $d < bw^{*1-\sigma}$. In this subcase, we have

$$a_1 \equiv \frac{bw^{*1-\sigma} - d}{w^{*2-\sigma}} > 0, \quad \text{and} \quad a_2 \equiv a - a_1 = cw^{*1-\sigma} > 0.$$

Therefore, for $w < w^*$, it holds that

$$a_1 w^{2-\sigma} + d - bw^{1-\sigma} < a_1 w^{*2-\sigma} + d - bw^{1-\sigma} = b(w^{*1-\sigma} - w^{1-\sigma}) < 0,$$
$$a_2 w^{2-\sigma} - cw^{3-2\sigma} = cw^{2-\sigma}(w^{*1-\sigma} - w^{1-\sigma}) < 0.$$

The above two inequalities imply that $\mathcal{F}(w) = (a_1 w^{2-\sigma} + d - bw^{1-\sigma}) + (a_2 w^{2-\sigma} - cw^{3-2\sigma}) < 0$; thus, $\mathcal{F}(w) = 0$ has no solution smaller than w^*.

On the other hand, the second subcase is $d \geq bw^{*\sigma-1}$. We define

$$\mathcal{F}_1(w) = aw^{2-\sigma} - cw^{3-2\sigma}, \quad \mathcal{F}_2(w) = d - bw^{1-\sigma}.$$

Then

$$\mathcal{F}_1'(w) = (3-2\sigma)cw^{1-\sigma}\Big[\frac{a(2-\sigma)}{c(3-2\sigma)} - w^{1-\sigma}\Big], \quad \text{and} \quad \mathcal{F}_2'(w) > 0 \quad \text{for} \quad w > 0.$$

Evidently,

$$w_1 = \Big(\frac{a}{c}\Big)^{\frac{1}{1-\sigma}}, \quad w_2 = \Big(\frac{d}{b}\Big)^{\frac{1}{1-\sigma}}, \quad w_3 = \Big(\frac{2-\sigma}{3-2\sigma}\ \frac{a}{c}\Big)^{\frac{1}{1-\sigma}}$$

are the unique solution of $\mathcal{F}_1(w) = 0$, $\mathcal{F}_2(w) = 0$, and $\mathcal{F}_1'(w) = 0$ in $(0, \infty)$, respectively. We have $w_3 < \min\{w_1, w_2\}$ since $\sigma \in (1, 3/2)$ and

$$\begin{aligned}(2-\sigma)ab - (3-2\sigma)cd =& \alpha^2\theta(1-\theta)\{(2-\sigma)(1-\phi^2)^2\gamma(1-\gamma)\\ &+ \phi^2\sigma(\sigma-1)[(2-\sigma)\phi^2 + 2(\sigma-1)]\} > 0.\end{aligned}$$

Therefore, for all $w \le w_3$, we have $\mathcal{F}_1(w) < 0$ and $\mathcal{F}_2(w) < 0$ so that $\mathcal{F}(w) = \mathcal{F}_1(w) + \mathcal{F}_2(w) < 0$. Meanwhile, for all $w > w_3$, we have $\mathcal{F}'(w) > 0$ because $\mathcal{F}_1'(w) \ge 0$ and $\mathcal{F}_2'(w) > 0$. We then have the conclusion in both cases.

(iii) Since $\mathcal{F}(w)$ depends on ϕ, we now rewrite it as $\mathcal{F}(w, \phi)$. Denote the solution of $\mathcal{F}(w, \phi) = 0$ as $w(\phi)$. Because $\mathcal{F}(w, \phi)$, $\frac{\partial \mathcal{F}(w,\phi)}{\partial w}$, and $\frac{\partial \mathcal{F}(w,\phi)}{\partial \phi}$ are continuous, the implicit function theorem suggests that $w(\phi)$ is continuous and differentiable.

Appendix B: The impossibility of Forms V and VI

Since $w(\phi)$ intersects any horizontal line at most twice in the $\phi - w$ plane, all of the following

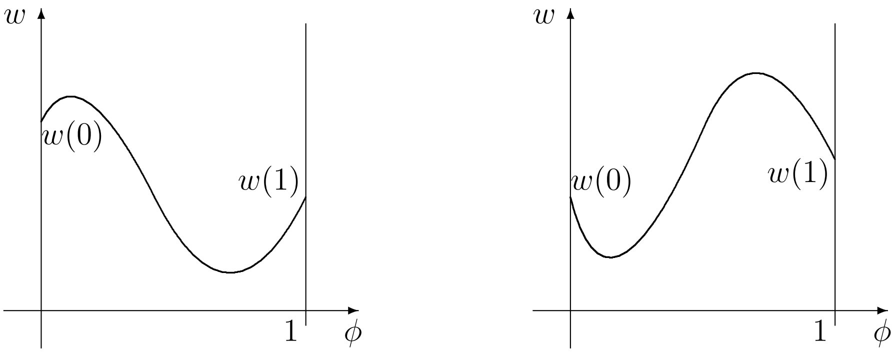
$$w(0) < w(1), \quad w'(0) < 0, \quad w'(1) < 0$$

need to be true in Form V. However, the facts of $w(0) < w(1)$, $w'(0) < 0$ and (15) imply that $\gamma < 1/2$. The facts of $w(0) < w(1)$, $w'(1) < 0$ and (16) imply that $\gamma > 1/2$. This contradiction excludes Form V. Form VI can be similarly excluded.

Appendix C: Properties of $\alpha_0(\gamma)$ and $\alpha_1(\gamma)$

Function $(\sigma - 2\gamma)/[\sigma - 2(1-\gamma)]$ decreases in γ because

$$\frac{d}{d\gamma}\Big[\frac{\sigma - 2\gamma}{\sigma - 2(1-\gamma)}\Big] = \frac{4(1-\sigma)}{[\sigma - 2(1-\gamma)]^2} < 0.$$



Form VI: inverted-U and U Form V: U and inverted-U

Figure 7: Impossible Forms V and VI

Since $\sigma > 1$, we know that

$$\alpha_1(\gamma) = \Big(\frac{1-\theta}{\theta}\Big)^{\sigma-1}\Big[\frac{\sigma-2\gamma}{\sigma-2(1-\gamma)}\Big]^{\sigma-1}$$

is a decreasing function.

On the other hand, $\gamma/(1-\gamma)$ increases in γ, so

$$\alpha_0(\gamma) = \Big(\frac{1-\theta}{\theta}\Big)^{\sigma-1}\Big(\frac{\gamma}{1-\gamma}\Big)^{\sigma-\frac{3}{2}}$$

decreases if $\sigma \in (1, 3/2)$ and increases if $\sigma > 3/2$.

Finally, it is obvious that $\alpha_0(\gamma)$ and $\alpha_1(\gamma)$ intersect at $\gamma = 1/2$, as

$$\alpha_0\Big(\frac{1}{2}\Big) = \alpha_1\Big(\frac{1}{2}\Big) = \left(\frac{1-\theta}{\theta}\right)^{\sigma-1}.$$

References

Amiti, M. 2005. Location of vertically linked industries: agglomeration versus comparative advantage. European Economic Review 49, 809-832.

Azzoni, C.R. 2001. Economic growth and regional income inequality in Brazil. Annals of Regional Science 35, 133-152.

Balisacan, A.M., Fuwa, N., 2006. Changes in spatial income inequality in the Philippines: an exploratory analysis, in: Kanbur, R., Venables, A., Wan, G. (Eds), Spatial Disparities in Human Development: Perspectives from Asia. United Nations University Press, Tokyo, pp. 207-232.

Davis, D.R. 1995. Intra-industry trade: A Heckscher-Ohlin-Ricardo approach. Journal of International Economics 39, 201-226.

Davis, D.R. and Weinsteini, D.E., 2002. Bones, bombs, and break points: the geography of economic activity. American Economic Review 92, 1269-1289.

Epifani, P., 2005. Heckscher-Ohlin and agglomeration. Regional Science and Urban Economics 35, 645-657.

Forslid, R. and Ottaviano, G.I.P., 2003. An analytically solvable core-periphery model. Journal of Economic Geography 3, 229-240.

Forslid, R. and Wooton, I., 2003. Comparative advantage and the location of production. Review of International Economics 11, 588-603.

Fujita, M., Krugman, P.R., Venables, A.J., 1999. The Spatial Economy: Cities, Regions, and International Trade, MIT Press, Cambridge (Mass.).

Jones, R.W., 1967. International capital movements and the theory of tariffs and trade. Quarterly Journal of Economics 81, 1-38.

Kanbur, R. Zhang, X.B., 2005. Fifty years of regional inequality in China: a journey through central planning, reform, and openness. Review of Development Economics 9, 87-106.

Kemp, M.C. 1966. The gain from international trade and investment: a neo-Heckscher-Ohlin approach." American Economic Review 56, 788-809.

Kim, S., 1995. Expansion of markets and the geographic distribution of economic activities: the trends in US regional manufacturing structure, 1860-1987. Quarterly Journal of Economics 110, 881-908.

Kim, S. 2009. Spatial inequality and economic development: theories, facts and policies, in: Spence, M., Annez, P.C., Buckley, R.M. (Eds), Urbanization and Growth, World Bank Publication, Washington, pp.133-166.

Krugman, P., Obstfeld, M., 2006. International economics: theory and policy. Pearson Education, Boston.

Krugman, P., Venables, A.J., 1995. Globalization and the inequality of nations. Quarterly Journal of Economics 110, 857-880.

Krugman, P., 1991. Increasing return and economic geography. Journal of Political Economy 99, 483-499.

Naude, W.A. and Krugell, W.F., 2003. An inquiry into cities and their role in subnational economic growth in South Africa. Journal of African Economies 12, 476-499.

Ottaviano, G.T., Tabuchi, T., Thisse, J.-F., 2002. Agglomeration and trade revisited. International Economic Review 43, 409-436.

Picard, P., Zeng, D.-Z., 2005. Agricultural sector and industrial agglomeration. Journal of Development Economics 77, 75-106.

Picard, P., Zeng, D.-Z., 2010. A harmonization of first and second natures. Journal of Regional Science 50, 973-994.

Puga, D. 1999. The rise and fall of regional inequalities. European Economic Review 43, 303-334.

Ricci, L.A. 1999. Economic geography and comparative advantage: agglomeration versus specialization. European Economic Review 43, 357-377.

Rodriguez-Pose, A., Sanchez-Reaza, J., 2005. Economic polarization through trade: trade liberalization and regional growth in Mexico. in: Kanbur, R., Venables, A. (Eds), Spatial Inequality and Development, Oxford University Press, Oxford, pp. 237-259.

Tabuchi, T. and Thisse, J.-F., 2002. Taste heterogeneity, labor mobility and economic geography. Journal of Development Economics 69, 155-177.

Takahashi, T., Takatsuka, H., Zeng, D.-Z. forthcoming. Spatial inequality, globalization and footloose capital. Economic Theory, DOI 10.1007/s00199-011-0686-7.

Venables, A.J. 1996. Equilibrium locations of vertically linked industries. International Economic Review 37, 341-359.

Venables, A. 1999. The international division of industries: clustering and comparative advantage in a multi-industry model. Scandinavian Journal of Economics 101, 495-513.

Williamson, J.G. 1965. Regional inequality and the process of national development: a description of the patterns. Economic Development and Cultural Change 13, 1-84.