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Abstract

This article focuses on two distinct faces of globalization: the decrease in trade costs of goods and the decline of affiliation costs of joint ventures by foreign firms with local firms. The decrease of affiliation costs drives relocation of firms from the North to the South. When the market size of the North is relatively small (resp. large), the growth rate monotonously decreases (resp. first decreases and rises after this) with a decline of affiliation costs. In the case of lowering trade costs, the firm share in the North evolves as a U-shaped curve (resp. monotonously increases) when the market size of the North is relatively small (resp. large). Growth rates are raised with agglomeration in the North. Finally, we present some welfare implications.

JEL Classification: F0, O31.
Key words: trade costs, affiliation costs, growth rates, innovation sector.

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1 Introduction

When firms operate in foreign countries, they affiliate and share their profits with local firms in many cases. For foreign firms, there are many reasons which induce them to affiliate with local firms to construct their own plants. We can classify these reasons into two: environmental and political. Regarding the environmental reasons, foreign firms face legal, cultural, and climatic differences between their host and home countries. Affiliation with local firms helps foreign investors fill those types of gaps. Foreign firms may require a large and uncertain number of permits in order to do business. Foreign firms may also be systematically subjected to greater pressures to directly or indirectly pay off local officials. Foreign firms may have much higher costs of acquiring information about local production conditions, legal systems, and local consumers.[1] In those cases, affiliation with local firms enables foreign firms to overcome country- specific difficulties. On the other hand, we can point out political reasons. There are equity share regulations for foreign investment in some countries. For example, in China, there is an equity share regulation in the automobile industry. There are also equity share regulations in Russia (insurance industry), Brazil (finance and transportation), and India (finance, insurance, and telecommunications) (JETRO 2012).

For example, in China, most foreign automobile firms affiliate with local firms and share profits when they start to operate in China. Wang (2003) reported that, between 1991-1998, of 604 foreign investment companies, 567 (or 93.8 percent) were joint ventures with local firms. The dominance of joint ventures is partly explained by the mandatory equity share regulations. In addition, foreign investors often find that, even without the institutional restraint, the joint venture is essential. In order to accomplish the goals of the Chinese system, Chinese partners are essential to help understand the functioning of the local market and the business norms. Managing the cross-cultural aspects of relationships is difficult if foreign firms want to exploit the market independently. This pattern of investment can also reduce initial risks. Wang (2003) pointed out that these reasons enhance joint ventures in the Chinese automobile industry.

In this paper, we study the influences of two types of "globalization." The decrease in trade costs of goods is the one aspect of globalization. The other aspect of globalization is the decline of "affiliation costs" which are associated with the operation of North firms in the South. In our paper, we assume that North firms should affiliate with local firms when they operate in the South. When they construct joint ventures in the South, North firms should share profits with local firms, which we call "affiliation costs." These two types of globalization, decline in trade costs and affiliation costs, influence firms' location and economic growth. For example, as shown in the present paper, a decline of affiliation costs drives the hollowing out of industries from the North to the South. Meanwhile, a sufficient decrease of trade costs manifests the agglomeration of manufactur-

[1] Baldwin et al. (2002: Chapter 12) and Yamamoto (2008) constructed static models in which location shifts of firms incur costs.

ing firms in the North. Such location behavior of firms has large impacts on economic growth.

Multilateral negotiations under General Agreement on Tariffs and Trade (GATT)/World Trade Organization (WTO) have fostered the liberalization of the trade in goods, and many countries have committed to maintain low levels of tariff rates. Although the General Agreements on Trade in Services (GATS) have been contributing toward expanding trade in services, the progress of expanding trade in services is still limited. Then, firms which operate in foreign countries should incur substantial extra costs, i.e., affiliation costs. However, the affiliation costs of foreign firms have decreased in recent years. The TPP (Trans-Pacific Strategic Economic Partnership) aims to standardize patent systems and copyrights among signatory countries. The standardization of the legal system (patents and copyrights) will lower the affiliation costs of multinational firms.

The decrease in affiliation costs raises the operation of firms in foreign countries. Fujita and Ishii (1998) reported that, from 1975 to 1994, the number of overseas plants of Japanese electronics firms located in East Asia increased from 40 to 143. Furthermore, Toyota (2011) reported that, in 2001, 9,777,191 vehicles were produced in Japan, 11,424,689 were produced in the U.S., and 2,334,440, were produced in China. In 2001, the U.S. was the largest producer of automobiles. In 2006, Japan produced 11,484,233 vehicles, the largest number in the world. On the other hand, in 2009, China became the largest producer of automobiles, producing 10,383,831, while Japan produced 7,934,057. In China, the number of vehicle products has monotonously increased year by year. In 2001, China entered the WTO, which lowers the affiliation costs in China, and foreign investments have progressed since then. For example, in 2008, over 80 percent of vehicles were produced by foreign-owned joint ventures (Kwan, 2009). This suggests that, in China, foreign-owned joint venture firms have increased with the decline in affiliation costs.

In this paper, a Grossman-Helpman (1991) and Romer (1990)-type endogenous growth model with two countries is developed, in which the operation of manufacturing firms in the South incurs some affiliation costs. This means that, when a manufacturing firm operates in the South, this firm should consign some of the product line to a local firm. Without local firms, manufacturing firms cannot produce their products in the South. Manufacturing firms should share their profits with local firms. Those profit sharing with local firms are affiliation costs for North manufacturing firms.

Intuitively, a decline in affiliation costs raises the profits of foreign firms in the South and, thus, encourages firms to relocate in the South. Then, manufactured goods market in the North becomes less competitive and the profits gained in the North increases. However, manufactured goods market in the South becomes competitive and the profits gained in the South decreases. If firms' profits are raised with this movement, innovation activities that produce patents to obtain profits are manifested, which results in higher growth rates. Meanwhile, if firms' profits are lowered, innovation activities are reduced and growth rates are lowered.

In fact, the present paper shows that a decline in affiliation costs can monotonously reduce the growth rates of the economy. In this case, the negative effect of decline in affiliation costs on growth rates overcomes the positive effect. On the other hand, growth rates may first decrease and increase after this, with a decline in a firm's affiliation costs. This suggests that the positive effect of a decline in affiliation costs on growth rates might overcome the negative effect when affiliation costs are small. The pattern that emerges depends on the relative market size. When the market size of the North is relatively small, a decline in affiliation costs reduces growth rates of the economy. Meanwhile, when the market size of the North is relatively large, the growth rate follows a U-shaped curve as affiliation costs decrease. Thus, our paper offers richer implications about the relationship between economic growth and globalization.

We also study the effect of trade costs. A decline in trade costs affects industrial location by changing the balance of the effects of market size and affiliation costs. Generally, a large market country attracts more firms than a small market country. This tendency is manifested by a decline in trade costs when trade costs are high. However, the tendency is weakened when trade costs are sufficiently low. Instead, the effect of affiliation costs becomes dominant, and, thus, firms avoid operating in the South.

If the population of the North is small enough relative to that of the South, the number of firms in the North first decreases and then increases after a decline in trade costs. On the other hand, if the population in the North is relatively large, the number of firms in the North monotonously increases with a decline in trade costs since the two effects reported above work for agglomeration in the North and are manifested by a decline in trade costs. In the former case, the growth rate follows a U-shaped curve, while, in the latter case, the growth rate monotonously increases with a decline in trade costs.

We also present the welfare implications of the model. In a case in which the population in the North is small enough relative to the South, the welfare of both countries would follow U-shaped curves with a decline of affiliation costs. In this case, the value of patents increases with a decline of affiliation costs, since the market size of the South is large. This asset value effect raises the welfare of the North. On the other hand, growth rates monotonously decrease with a decline in affiliation costs, which reduces the welfare of both countries. These two effects (asset value and growth rate) create a U-shaped curve of welfare movements.

In a case in which the population in the North is relatively large, the welfare of the North would monotonously decrease, and the welfare of the country would follow a U-shaped curve. In this case, the asset value effect is weak, which makes the welfare decrease monotonously. On the other hand, since growth rates increase when affiliation costs become low, the welfare in the South follows a U-shaped curve. In both cases, the welfare of the whole economy also follows a U-shaped curve. Thus, our research shows that globalization in terms of a firm's affiliation costs reduces the welfare of the economy in many cases, since the effect of a reduction in growth rates is large.

Finally, our numerical simulations show that a decline in trade costs raises growth rates in a wide range of parameters. With this movement, the welfare of the North, the South, and the whole economy improves. Thus, our study shows that globalization of international goods trade raises the welfare of the economy.

According to Gao (2007), the recent global shifting of manufacturing from the North to the South received significant attention from researchers. In addition, Hatch and Yamamura (1996) reported that many manufacturing goods in East Asia were developed in Japan. The firms that produce manufactured goods agglomerated in Japan, which support the rapid growth of Japan. In recent years, manufacturing firms relocated from Japan to other countries, such as Korea, Chinese Taipei, Singapore, Hong Kong, and China, and the growth rates of Japan decreased with these movements. Our model explains the mechanism behind the spread of firms to some countries near Japan. Furthermore, in our paper, we emphasize the importance of studying the parameters of market size, trade costs, and affiliation costs of firms in the analysis of the effects of globalization on the growth rates.

The literature makes evident the many aspects of the relationship of economic geography, international trade, and growth.[2] Baldwin, Martin, and Ottaviano (2001), Martin and Ottaviano (1999, 2001), Yamamoto (2003), and Gao (2007) are studies in which the endogenous growth model of Grossman and Helpman (1991) and Romer (1991) (GHR) is integrated with New Economic Geography (NEG) models à la Fujita, Krugman, and Venables (1999). These researchers studied the relationship between growth and agglomeration and show that agglomeration raises economic growth as trade costs decrease. Minitti and Parello (2011) constructed a model of GHR with NEG in which trade integration has no effects on economic growth. Our model in this paper is also a GHR-type model with NEG, which involves the affiliation costs of firms. In our paper, we show that affiliation costs influence the relationship between growth and economic geography.

Section 2 is a presentation of the model and some propositions derived from the analysis. An analysis of the welfare levels in both countries is presented in Section 3. Section 4 is the conclusion of the paper.

2 The model

There are two countries, the North and the South. We assume that patents can be produced exclusively in the North. Variables referring to the North have the subscript N, and those referring to the South, S. Each country is endowed with a fixed amount of labor, L_N and L_S, respectively. Labor can be used to produce homogeneous agricultural goods and differentiated manufactured goods. While labor can be mobile between sectors in the same country, it cannot be mobile between different countries.

The intertemporal utility function of the consumer in country i ($i = N, S$)

[2]See Kuznets (1966) and Long and Wong (1997).

is as follows:

$$U_i = \int_0^{\infty} e^{-\rho t} \left(Y_{it} + \mu \log M_{it}\right) dt, \tag{1}$$

where

$$M_{it} = \left[\int_0^{n_{Nt}} m_{Nit}\left(\omega\right)^{\frac{\sigma-1}{\sigma}} d\omega + \int_0^{n_S} m_{Sit}\left(\omega^{'}\right)^{\frac{\sigma-1}{\sigma}} d\omega^{'}\right]^{\frac{\sigma}{\sigma-1}}, \ \sigma > 1. \tag{2}$$

Here, Y_{it} is the consumption of agricultural goods at time t in country i, M_{it} is the consumption of the composite of manufactured goods at time t in country i, ρ is the subjective discount rate, and μ is a positive parameter. $m_{jit}\left(\omega\right)$ denotes the consumption of manufactured variety ω produced by a firm in country j ($j = N, S$). n_{jt} is the number of varieties produced by a firm in country j at time t. n_{jt} is also the number of operating firms in country j at time t. $n_t \equiv n_{Nt} + n_{St}$ denotes the total number of varieties at time t. σ represents the elasticity of substitution among differentiated goods. Following Grossman and Helpman (1991), the market is characterized by free financial movements between two countries. Thus, the interest rate of both countries is the same at all times ($r_{Nt} = r_{St} = r_t$). The intertemporal optimization behavior of the consumer results in the next equation

$$r_t = \rho. \tag{3}$$

We derive the following instantaneous demand functions (we take homogeneous goods as the numeraire),

$$M_{it} = \frac{\mu}{P_{it}}, \tag{4}$$

$$P_{it} = \left(\int_0^{n_{Nt}} p_{Nit}(\omega)^{1-\sigma} d\omega + \int_0^{n_{St}} p_{Sit}(\omega^{'})^{1-\sigma} d\omega^{'}\right)^{\frac{1}{1-\sigma}}, \tag{5}$$

$$Y_{it} = E_{it} - \mu, \tag{6}$$

$$m_{jit}\left(\omega\right) = \frac{\mu {P_{it}}^{\sigma-1}}{p_{jit}\left(\omega\right)^{\sigma}}, \tag{7}$$

where P_{it} is called the 'price index' in country i at time t. $p_{jit}\left(v\right)$ is the consumer price of variety ω, which is produced in j and consumed in i, and E_{it} represents the instantaneous expenditure of a consumer in country i at time t.

Here, we describe the production structure of the agricultural sector. The agricultural good market is perfectly competitive. We assume that in both countries, one unit of agricultural goods is produced with one unit of labor. We assume that the international trade of homogeneous goods incurs no trade costs. Therefore, the equilibrium wages in the two countries are both one: $w_N = w_S = 1$.[3]

[3] If $\left(E_{Nt} - \mu\right) L_N + \left(E_{St} - \mu\right) L_S \geq L_N$, agricultural goods are produced in both countries at the equilibrium. Here, $E_{st} \geq 1$, in this model. We, then, assume that $\left(1-\mu\right) L_N + \left(1-\mu\right) L_S \geq L_N$ to ensure that the agricultural sector exists in both countries.

In the manufacturing sector, manufacturing firms operate under a Dixit-Stiglitz (1977)-type monopolistic competition. Each firm produces differentiated goods, and each variety is produced by one firm. To start a production activity, a firm in country j is required to buy one unit of patent produced by the innovation sector at market price V_{jt}, which plays the role of fixed costs for the firms. Moreover, a firm locating in a country uses one unit of labor in its country as the marginal input to produce one unit of manufactured goods. Potential firms can freely enter a production activity as long as the pure profits are positive and can choose to locate in a country where profits are higher. We assume that, when a manufacturing firm produces in the North, it does not incur affiliation costs. When a manufacturing firm operates in the South, the firm should consign some of its product line to a local firm. Without local firms, manufacturing firms cannot produce their products in the South. Manufacturing firms should share their profits with local firms. Consignation costs would then represent affiliation costs for manufacturing firms. Under this production structure, each manufacturing firm sets the following constant markup (mill) price:

$$p_N = p_S = \frac{\sigma}{\sigma - 1}. \tag{8}$$

The international trade of manufactured goods incurs 'iceberg'-type trade costs. If a firm sends one unit of its good to a foreign country, it must dispatch T units of the good. $T - 1 > 0$ represents the trade costs. Thus, consumer prices are $p_{ji} = p_j$ if $j = i$, and $p_{ji} = Tp_j$ if $j \neq i$. The price index in country i can be written as,

$$P_{it} = \frac{\sigma}{\sigma - 1} \cdot (n_{it} + n_{jt}\tau)^{\frac{1}{1-\sigma}}, \ i, j \in \{N, S\}, \ i \neq j, \tag{9}$$

where $\tau \equiv T^{-(\sigma-1)}$ and τ represent the freeness of trade. $\tau = 0$ describes the case of autarky, whereas $\tau = 1$ implies free trade. From (7) and (8), instantaneous profits of firms in the North and South can be expressed as follows:

$$\pi_{Nt} = \left(\frac{\mu}{\sigma}\right)\left[\frac{L_N}{n_{Nt} + n_{St}\tau} + \frac{L_S\tau}{n_{Nt}\tau + n_{St}}\right], \tag{10}$$

$$\pi_{St} = \left(\frac{\mu}{\sigma}\right)\left[\frac{L_N\tau}{n_{Nt} + n_{St}\tau} + \frac{L_S}{n_{Nt}\tau + n_{St}}\right]. \tag{11}$$

Furthermore, the output of a firm in country i is expressed as

$$q_{it} = (\sigma - 1)\pi_{it}. \tag{12}$$

We assume that innovation activities occur exclusively in the North. In the innovation sector, we assume that l_R units of labor for R&D activities for a time interval dt produce a new variety of final goods according to the following:[4]

[4]If we assume local knowledge spillovers and $dn_t = l_R(n_{Nt} + \phi n_{St})dt/\eta$, where $0 < \phi < 1$, all results in this paper are qualitatively unchanged.

$$dn_t = \frac{l_R n_t}{\eta} dt. \tag{13}$$

The cost of the R&D activities is $w_N l_R dt$ because the R&D sector is located only in the North. Producing the patent creates a value for the manufacturing firms in country i of $V_{it} dn_t$. We assume that there is free entry into the R&D race. Therefore, the following free-entry condition must hold:

$$V_{it} \leq \frac{\eta}{n_t}, \quad \text{with equality whenever } \dot{n}_t \equiv \frac{dn_t}{dt} > 0,\ i \in \{N, S\}. \tag{14}$$

A patent used in the North generates returns π_{Nt}, while a patent used in the South generates returns $\theta\pi_{St}$, where $0 < \theta < 1$. When a manufacturing firm operates in the South, it should consign some parts of the production lines to a local firm and share profits with the local firm. Without local firms, manufacturing firms cannot produce any manufactured goods in the South. Here, θ is the share of profits that a manufacturing firm obtains when it produces in the South. The affiliated local firm obtains the share of $1-\theta$ in profits. As is shown later, manufacturing firms determine θ endogenously to maximize their profits. We assume that there are risk-free assets and the interest rate is r_t. The value of the firm, which is the market price of the patent, is equalized to the present value of the sum of the discounted profit over time. ¿From (10) and (11), the values of the patent used in the North and the South are represented by

$$V_{Nt} = \int_t^\infty e^{-r(\tau-t)} \cdot \pi_{N\tau} d\tau, \tag{15}$$

$$V_{St} = \int_t^\infty e^{-r(\tau-t)} \cdot \theta\pi_{S\tau} d\tau, \tag{16}$$

respectively. Differentiating (15) and (16) with respect to t, we can obtain the no-arbitrage conditions for capital investment as follows:

$$\pi_{Nt} + \dot{V}_{Nt} = rV_{Nt}. \tag{17}$$

$$\theta\pi_{St} + \dot{V}_{St} = rV_{St}. \tag{18}$$

Next, we describe the behavior of local firms in the South. In the South, starting up a local production firm requires $\varkappa/n_t$ units of southern labor. When a local firm cooperates with a manufacturing firm, the cost at time interval dt is $(w_S\varkappa/n_t)\,dt$. We assume that the benefit of the local firm at time interval dt is $V_{Lt}dt$. The condition, then, that local firms in the South cooperate with manufacturing firms is as follows:

$$V_{Lt} \geq \frac{\varkappa}{n_t}. \tag{19}$$

Meanwhile, the value of an affiliated local firm is as follows:

$$V_{Lt} = \int_t^\infty e^{-r(\tau-t)} \cdot (1-\theta)\pi_{S\tau} d\tau. \tag{20}$$

Differentiating (20) with respect to t, we obtain the no-arbitrage condition of a local firm as follows:

$$(1-\theta)\pi_{St} + \dot{V}_{Lt} = rV_{Lt}. \tag{21}$$

Manufacturing firms that operate in the South must consign some parts of their production lines to local firms and share their profits. Without local firms, manufacturing firms operating in the South cannot produce any manufactured goods. A manufacturing firm presents a take-it-or-leave-it offer of θ to a local firm. If a local firm accepts this offer, the local firm and the manufacturing firm cooperate to produce their products. A manufacturing firm offers the share of θ, in which the benefit of a local firms equals the cost of theirs. Therefore, the value of the local firm satisfies the next equation:[5]

$$V_{Lt} = \frac{\varkappa}{n_t}. \tag{22}$$

If $n_{St} > 0$, from the free-entry conditions of manufacturing goods firms producing in the South, $V_{St} = \eta/n_t$ must be satisfied. Equations (16) and (20) mean that

$$V_{St} = \frac{\theta}{1-\theta} V_{Lt}. \tag{23}$$

Then, substituting (22) and (23) into (14), we obtain the following equation:

$$\frac{\theta}{1-\theta}\frac{\varkappa}{n_t} \leq \frac{\eta}{n_t}. \tag{24}$$

Manufacturing firms that operate in the South must determine θ, which satisfies (24). The left-hand side (LHS) of (24) represents the benefit of manufacturing goods firms locating in the South. The right-hand side (RHS) of (24) represents the cost of R&D investment. If LHS of (24) is smaller than RHS of (24), the operation of manufacturing firms in the South is not profitable, and the number of manufacturing firms locating in the South becomes zero. Therefore, when there are manufacturing firms locating in the South, the following equation must hold:

$$\theta = \frac{\eta}{\varkappa + \eta}. \tag{25}$$

Equation (25) shows that, when affiliation costs are high, θ becomes low. If $\varkappa = \infty$, $\theta = 0$. If $\varkappa = 0$, $\theta = 1$. When (25) is satisfied, (21) becomes the same equation to the (18). Thus, equilibrium conditions in the asset market are satisfied.

[5] We assume that the value of the outside option for local firms is zero. If a local firm requires a larger share than $1-\theta$, this firm is rejected by a manufacturing firm, and the manufacturing firm offers $1-\theta$ to other potential local firms.

3 Equilibrium

Let us define $s_t \equiv n_{Nt}/(n_{Nt} + n_{St})$ as the share of manufacturing firms in the North. In equilibrium, if $0 < s_t < 1$ holds, the following equation must hold:

$$\pi_{Nt} = \theta \pi_{St}. \tag{26}$$

This is because capital returns are equalized in equilibrium. From (10), (11), and (26), the equilibrium share of manufacturing firms in the North is

$$s^* = \frac{(1-\theta\tau)L_N + (\tau - \theta)\tau L_S}{(1-\tau)\left[(1-\theta\tau)L_N - (\tau-\theta)L_S\right]}. \tag{27}$$

Note that (27) is true only if the RHS is in $[0, 1]$. Otherwise, s^* is either 0 or 1. Differentiating s^* with respect to θ,[6] we can obtain the following proposition (See Appendix B for the proof):

Proposition 1 *For the interior equilibrium (i.e., $s^* \in (0, 1)$), an increase in θ decreases the share of manufacturing firms in the North.*

When $s_t = 1$ and $\pi_{Nt} \geq \theta\pi_{St}$ are satisfied, it holds that $s^* = 1$. From (10) and (11), when

$$\theta \leq \theta_N \equiv \frac{\tau(L_N + L_S)}{\tau^2 L_N + L_S}, \tag{28}$$

we have $s^* = 1$. In the case that $L_N/L_S \leq 1/\tau$, we have $0 < \tau < \theta_N \leq 1$. On the other hand, when $s_t = 0$ and $\pi_{Nt} \leq \theta\pi_{St}$ are satisfied, it holds that $s^* = 0$. From (10) and (11), when

$$\theta \geq \theta_S \equiv \frac{L_N + \tau^2 L_S}{\tau(L_N + L_S)}, \tag{29}$$

$s^* = 0$. In the case that $L_N/L_S \leq \tau$, we have $0 < \theta_S \leq 1$. Simple calculations show that $\theta_N < \theta_S$ (See Appendix A). For an interior equilibrium to exist for $\theta \in (0, 1)$, we present the following assumption:

Assumption 1 *It holds that $L_N/L_S \leq 1/\tau$.*

This suggests that the population in the North is not as large as that in the South. Under that assumption, we have $\theta_N \leq 1$, and, if $\theta \in (\theta_N, \min\{\theta_S, 1\})$, it holds that $s^* \in (0, 1)$.

Because the share of manufacturing firms in the North, s^*, is constant from (27), we differentiate s with respect to t as follows:

$$\frac{\dot{n}_t}{n_t} = \frac{\dot{n}_{Nt}}{n_{Nt}} = \frac{\dot{n}_{St}}{n_{St}} \equiv g. \tag{30}$$

[6] From (25), a higher θ corresponds to a lower $\varkappa$, which implies lower affiliation costs in the South.

If $\dot{n}_t > 0$, differentiating (14) with respect to t, we can obtain the following equation:

$$\frac{\dot{V}_{it}}{V_{it}} = -\frac{\dot{n}_t}{n_t} = -g. \tag{31}$$

Substituting (31) into (17), we obtain the value of a patent that is used in the North as follows:

$$V_{Nt} = \frac{\pi_{Nt}}{\rho + g}. \tag{32}$$

Then, substituting (10), (31), and (32) into (14), the growth rate is given by

$$g = \frac{\mu}{\eta\sigma}\left[\frac{L_N}{(1-\tau)s+\tau} + \frac{\tau L_S}{1-(1-\tau)s}\right] - \rho. \tag{33}$$

3.1 Effects of affiliation costs

Differentiating (33) with respect to θ, we can obtain the following equation:

$$\frac{\eta\sigma}{\mu}\frac{\partial g}{\partial\theta} = \left[-\frac{(1-\tau)L_N}{((1-\tau)s+\tau)^2} + \frac{(1-\tau)\tau L_S}{(1-(1-\tau)s)^2}\right]\frac{\partial s}{\partial\theta}, \tag{34}$$

where $\partial s/\partial\theta < 0$ from Proposition 1. The first term in the square bracket of (34) represents the effect of s on profits gained in the North. This effect is negative because an increase in the share of firms in the North exacerbates the market competition in the North and decreases the profits gained in the North. The second term in the square bracket of (34) represents the effect of s on profits gained in the South. This effect is positive because an increase in the share of firms in the North ameliorates the market competition in the South and increases the profits gained in the South. When L_N is very small (resp. large) relative to L_S, the absolute value of $-(1-\tau)L_N/((1-\tau)s+\tau)^2$ is small (resp. large) relative to the absolute value of $(1-\tau)\tau L_S/(1-(1-\tau)s)^2$. Then, when L_N is very small (resp. large) relative to L_S, the term in the square bracket becomes positive, and, thus, an increase in θ decelerates (resp. accelerates) the growth rates.

Substituting (27) into (34), we can obtain the following equation:

$$\frac{\mu}{\eta\sigma}\frac{\partial g}{\partial\theta} = -\frac{(1-\tau)\left[(1-\theta\tau)L_N - (\tau-\theta)L_S\right]^2}{(1+\tau)^2(1-\theta\tau)^2(\tau-\theta)^2 L_N L_S}F(\theta)\frac{\partial s}{\partial\theta}, \tag{35}$$

where

$$F(\theta) = (\tau-\theta)^2 L_S - \tau(1-\theta\tau)^2 L_N. \tag{36}$$

From Proposition 1 (i.e., $\partial s/\partial\theta < 0$), we know that $\partial g/\partial\theta \gtreqless 0$ is equivalent to $F(\theta) \gtreqless 0$. We denote that $\hat{\theta}$ is the unique solution of $F(\theta) = 0$ in (τ, ∞). To investigate the sign of $F(\theta)$, we have the following proposition (See Appendix C for the proof).

Proposition 2 *(Effects of affiliation costs on growth rates).*
i) When $L_N/L_S < \tau^3$*, it holds that* $\partial g/\partial\theta < 0$ *for* $\theta \in (\theta_N, \theta_S)$*.*
ii) When $L_N/L_S \in (\tau^3, \tau)$*, it holds that* $\partial g/\partial\theta < 0$ *for* $\theta \in (\theta_N, \hat{\theta})$ *and* $\partial g/\partial\theta > 0$ *for* $\theta \in (\hat{\theta}, \theta_S)$*.*
iii) When $L_N/L_S \in (\tau, 1/\tau)$*, it holds that* $\partial g/\partial\theta < 0$ *for* $\theta \in (\theta_N, \hat{\theta})$ *and* $\partial g/\partial\theta > 0$ *for* $\theta \in (\hat{\theta}, 1)$*.*

We can see the effect of θ on the growth rate in Figures 1, 2, and 3. In Figure 1, when $L_N/L_S < \tau^3$, a decrease in the affiliation costs decreases the growth rate. In Figures 2 and 3, when $L_N/L_S \in (\tau^3, 1/\tau)$, the relationship between the affiliation costs and the growth rate follows a U-shaped curve. We explain Proposition 2 intuitively. From Proposition 1, a decrease in the affiliation costs lowers the share of manufacturing firms in the North. From (34), the manufactured goods market in the North becomes less competitive, and its market in the South becomes competitive. The profits gained in the North, then, increase, and profits gained in the South decrease. If an increase in profits gained in the North is larger than a decrease in profits gained in the South, the profits of manufacturing firms increase. An increase in the profit pushes up the value of R&D investment, and the growth rate increases.

When L_N is small relative to L_S, the South has a large market relative to the North. The profits gained in the North are then smaller than profit losses in the South. Therefore, in this case, an increase in θ depresses the growth rate. It is noteworthy that the reverse could occur when L_N is relatively large. If the affiliation costs are sufficiently high, the manufactured goods market in the North is still competitive. Thus, the profits gained in the North are smaller than profit losses in the South, which lowers the growth rate again. However, if the affiliation costs are sufficiently low, the manufactured goods market in the North is less competitive. In this case, the profits gained in the North could dominate profit losses in the South, and, thus, the growth rate could be higher.

3.2 Effects of trade costs

Next, we study the effects of trade costs on growth rates. Before analyzing the effects of trade costs on growth rates, we investigate the relationship between trade costs and the share of manufacturing firms. From (27), we can rewrite the equilibrium share of manufacturing firms in the North as follows:

$$s^* = \frac{f_0(\tau)}{f_0(\tau) - f_1(\tau)}, \tag{37}$$

where

$$f_0(\tau) = (1 - \theta\tau)L_N + (\tau - \theta)\tau L_S, \tag{38}$$

and

$$f_1(\tau) = \tau(1 - \theta\tau)L_N + (\tau - \theta)L_S. \tag{39}$$

The denominator of (27) or (37) is positive for any interior equilibrium (i.e., $s^* \in (0, 1)$) since the numerator of (37), $f_0(\tau)$, is positive because of $\theta > \theta_N > \tau$.

Thus, we know that $f_1(\tau) \geq 0$ is equivalent to $s^* = 1$. Substituting $\tau = 0$ and $\tau = 1$ into (39), we have

$$f_1(0) = -\theta L_S < 0,$$
$$f_1(1) = (1-\theta)(L_N + L_S) > 0.$$

Since $f_1(\tau)$ is a concave function of τ, we obtain the boundary of τ, where all firms agglomerate in the North:

Lemma 3 *There is a threshold value $\tau_1 \in (0, 1)$ of the trade freeness of manufactured varieties so that $s^* = 1$ if and only if $\tau \in [\tau_1, 1)$.*

This lemma suggests that all firms agglomerate in the North if trade costs are sufficiently small. The reason is as follows. In our model, two primary effects determine firm location, namely, market size and affiliation cost. The market size effect refers to the tendency in which manufacturing firms prefer to locate in the larger country to save trade costs. Meanwhile, the affiliation cost effect refers to the tendency in which manufacturing firms prefer to locate in the North to avoid affiliation costs. When trade costs are sufficiently small, the former effect is negligible, since firms can export their products cheaply. Thus, the affiliation cost effect dominates, which suggests that firms agglomerate in the North, where affiliation costs are not required.

From (27) or (37), we know that $f_0(\tau) > 0$ is equivalent to $s^* > 0$. If equation $f_0(\tau) = 0$ has two roots, they are denoted as τ_{01} and τ_{02} ($> \tau_{01}$). We then have the following lemma, which gives the conditions for all firms to agglomerate in the South (see Appendix D for the proof):

Lemma 4 *There is a threshold value $\overline{\lambda} \in (0, \theta^2)$ so that $s^* > 0$ for any τ if $L_N/L_S > \overline{\lambda}$; otherwise, $s^* = 0$ (resp. $s^* > 0$) for $\tau \in [\tau_{01}, \tau_{02}]$ (resp. $\tau \notin [\tau_{01}, \tau_{02}]$), where $0 < \tau_{01} < \tau_{02} < \tau_1$.*

This lemma suggests that all firms agglomerate in the South if the North is sufficiently small and trade costs are intermediate. The reason is as follows. From Lemma 3, we know that all firms agglomerate in the North if trade costs are sufficiently small. On the other hand, if trade costs are sufficiently large, firms are necessarily dispersed, since it is very costly for firms to export. In the case of intermediate trade costs, firm distribution depends on the balance of the market size effect and the affiliation cost effect. If the North is sufficiently small, the market size effect dominates the affiliation cost effect, which results in attracting all firms to the large country, the South.

For any interior equilibrium, Appendix E gives another expression of the growth rate:[7]

$$g = \frac{\mu\theta(L_N + L_S)}{\eta\sigma(\theta s + 1 - s)} - \rho. \tag{40}$$

[7]Substituting the equilibrium value of s (27) into (33) and (40), we know that the two expressions of g are equivalent.

Thus, we know that

$$\frac{\partial g}{\partial s} > 0 \text{ and } \frac{\partial g}{\partial \theta} > 0, \tag{41}$$

which suggests that *the growth rate increases if the firm share in the North increases (and affiliation costs are fixed) or if affiliation costs decrease*. The reason is as follows. First, if firms locate in the South, they have to produce more than firms in the North, since they must pay affiliation costs. Since the world output of manufactured goods is constant due to (E.1) in Appendix E, this suggests that both the output and the profit of a firm in the North decrease. Thus, if s increases or θ increases, the reverse occurs, i.e., the profit in the North becomes higher. From (32), a higher profit in the North implies a higher growth rate.

From (27), we obtain

$$\frac{\partial s}{\partial \tau} = \frac{(L_N + L_S)h(\tau)}{(1-\tau)^2(1+\theta L_S - (\theta L_N + L_S)\tau)^2},$$

where

$$h(\tau) \equiv (\theta^2 L_N - L_S)\tau^2 - 2(L_N - L_S)\tau + (L_N - \theta^2 L_S). \tag{42}$$

Thus, from (40) and (41), we have

$$\operatorname{sgn}\left(\frac{\partial g}{\partial \tau}\right) = \operatorname{sgn}\left(\frac{\partial s}{\partial \tau}\right) = \operatorname{sgn}\left[h(\tau)\right], \tag{43}$$

If equation $h(\tau) = 0$ has two roots in $(0, 1)$, the smaller root is denoted as τ_2. The next proposition is then derived (see Appendix E for the proof):

Proposition 5 *(Effects of trade costs on growth rates).*
i) When $L_N/L_S > \theta^2$, it holds that $\partial g/\partial \tau > 0$ for $\tau \in (0, \tau_1)$.
ii) When $L_N/L_S \in (\overline{\lambda}, \theta^2)$, it holds that $\partial g/\partial \tau < 0$ for $\tau \in (0, \tau_2)$ and $\partial g/\partial \tau > 0$ for $\tau \in (\tau_2, \tau_1)$.
iii) When $L_N/L_S < \overline{\lambda}$, it holds that $\partial g/\partial \tau < 0$ for $\tau \in (0, \tau_{01})$ and $\partial g/\partial \tau > 0$ for $\tau \in (\tau_{02}, \tau_1)$.

Figures 4, 5, and 6 correspond to the case of i), ii), and iii) in Proposition 5, respectively. This proposition suggests that the growth rate monotonously increases in τ if the North is large relative to the South; otherwise, the growth rate evolves in a U-shaped pattern when trade costs decline. From (43), we know that the growth rate and the firm share of the North co-evolve in the same direction. From Lemmas 3 and 4, if the North is sufficiently smaller than the South, firms first disperse and then agglomerate in the South and, finally, in the North when trade costs decline. This suggests that the growth rate follows a U-shaped curve. On the other hand, if the North is relatively large, the net effect of the two primary factors, the market size effect and the affiliation cost effect, accelerates agglomeration in the North when trade costs decline. Thus, the growth rate monotonously increases in τ.

4 Welfare analysis

In this section, we investigate the welfare level in both countries. From $r = \rho$ and $w_{it} = 1$, we can rewrite the intertemporal budget constraint as follows:

$$\int_0^\infty e^{-\rho t} E_{it} dt = a_{i0} + \int_0^\infty e^{-\rho t} dt, \tag{44}$$

where a_{i0} is the present value of assets owned by a worker in country i. Because the expenditure levels in both countries are constant in equilibrium, the expenditure level in each country is given by

$$E_{it} = 1 + \rho a_{i0}. \tag{45}$$

The total value of assets at the initial time is $[n_N V_{N0} + n_S(V_{S0} + V_{L0})]$. We assume that the ratio of assets held in the North at the initial time is ζ and the ratio of assets held in the South at the initial time is $1 - \zeta$. The assets held in both countries are represented by

$$a_{N0} = \frac{\zeta}{L_N} \left[\eta + (1 - s)\chi\right], \tag{46}$$

$$a_{S0} = \frac{1 - \zeta}{L_S} \left[\eta + (1 - s)\chi\right]. \tag{47}$$

Therefore, the expenditure levels in both countries are given by

$$E_{Nt} = 1 + \rho\frac{\zeta}{L_N} \left[\eta + (1 - s)\chi\right], \tag{48}$$

$$E_{St} = 1 + \rho\frac{1 - \zeta}{L_S} \left[\eta + (1 - s)\chi\right]. \tag{49}$$

Then, substituting (4), (5), (6), (48), and (49) into (1), we obtain the welfare levels in both countries as follows:

$$\begin{aligned} U_N = \int_0^\infty e^{-\rho t}\{1 + \frac{\rho\zeta}{L_N} \left[\eta + (1 - s)\chi\right] + \mu(\log\mu - 1) \\ + \frac{\mu}{\sigma - 1} \log[(\frac{\sigma - 1}{\sigma})^{1-\sigma}(n_N + \tau n_S)]\}dt, \end{aligned} \tag{50}$$

$$\begin{aligned} U_S = \int_0^\infty e^{-\rho t}\{1 + \frac{\rho(1 - \zeta)}{L_S} \left[\eta + (1 - s)\chi\right] + \mu(\log\mu - 1) \\ + \frac{\mu}{\sigma - 1} \log[(\frac{\sigma - 1}{\sigma})^{1-\sigma}(n_N\tau + n_S)]\}dt. \end{aligned} \tag{51}$$

Then, from $n_t = n_0 e^{gt}$, the welfare levels in both countries are given by

$$\begin{aligned} \rho U_N = 1 + \frac{\rho\zeta}{L_N} \left[\eta + (1 - s)\chi\right] + \mu(\log\mu - 1) + \frac{\mu}{\sigma - 1} \log n_0 \\ - \mu\log(\frac{\sigma - 1}{\sigma}) + \frac{\mu}{\sigma - 1} \log[(1 - \tau)s + \tau] + \frac{g}{\rho}, \end{aligned} \tag{52}$$

$$\rho U_S = 1 + \frac{\rho(1-\zeta)}{L_S}\left[\eta + (1-s)\chi\right] + \mu(\log\mu - 1) + \frac{\mu}{\sigma-1}\log n_0$$
$$- \mu\log(\frac{\sigma-1}{\sigma}) + \frac{\mu}{\sigma-1}\log[1-(1-\tau)s] + \frac{g}{\rho}. \quad (53)$$

Then, differentiating U_N and U_S with respect to θ, we obtain the following equations:

$$\rho\frac{\partial U_N}{\partial\theta} = -\frac{\rho\zeta\chi}{L_N}\frac{\partial s}{\partial\theta} + \frac{\mu}{\sigma-1}\left[\frac{1-\tau}{(1-\tau)s+\tau}\frac{\partial s}{\partial\theta} + \frac{1}{\rho}\frac{\partial g}{\partial\theta}\right]. \quad (54)$$

$$\rho\frac{\partial U_S}{\partial\theta} = -\frac{\rho(1-\zeta)\chi}{L_S}\frac{\partial s}{\partial\theta} + \frac{\mu}{\sigma-1}\left[-\frac{1-\tau}{1-(1-\tau)s}\frac{\partial s}{\partial\theta} + \frac{1}{\rho}\frac{\partial g}{\partial\theta}\right]. \quad (55)$$

We explain the relationship between θ and the welfare level in the North. The sign of the first term is positive. The sign of the first term in the square bracket is negative, and the sign of the second term in the square bracket is ambiguous. The first term is a positive effect in which a decrease in the affiliation costs increases the total value of the assets and increases the expenditure level. This effect then increases the welfare level in the North. The first term in the square bracket is a negative effect: when there is an increase in θ, the number of firms producing in the South increases, and the price level in the North increases. The welfare level in the North then decreases. At last, the second term in the square bracket is an ambiguous effect because the relationship between θ and the growth rates is ambiguous. In the same way, we explain the relationship between θ and the welfare level in the South.

In order to get some clear results, we present numerical examples. In this example, the number of population in both countries are $L_N = 0.3$ and $L_S = 1$ respectively. The subjective discount rate is $\rho = 0.05$ and the elasticity of substitution is $\sigma = 1.5$. The efficiency of R&D investment is $\eta = 1.3$. The initial number of the manufactured goods is $n_0 = 1$. The ratio of asset holding in the North at initial time is $\zeta = 1$. Figures 7, 8 and 9 represent the effect of θ on the welfare of the North and the welfare of the South. Figure 7 depicts the case that $L_N/L_S < \tau^3$, Figure 8 depicts the case that $\tau^3 < L_N/L_S < \tau$, and Figure 9 depicts the case that $L_N/L_S > \tau$. In Figure 7, from Proposition 2, a decline in affiliation costs lowers the growth rates monotonously and the welfare level in both countries are also lowered by a decline in affiliation costs. In Figures 8 and 9, from Proposition 2, the relationship between growth rates and the affiliation costs follows the U-shaped curve. Therefore, the welfare level of the South follows the U-shaped curve.

We study the effect of trade costs on welfare. Differentiating U_N and U_S with respect to τ, we can obtain the following equation:

$$\rho\frac{\partial U_N}{\partial\tau} = -\frac{\rho\zeta\chi}{L_N}\frac{\partial s}{\partial\tau} + \frac{\mu}{\sigma-1}\left[\frac{1-\tau}{(1-\tau)s+\tau}\frac{\partial s}{\partial\tau} + \frac{1}{\rho}\frac{\partial g}{\partial\tau} + \frac{1-s}{1-(1-\tau)s}\right]. \quad (56)$$

$$\rho\frac{\partial U_S}{\partial\tau} = -\frac{\rho(1-\zeta)\chi}{L_S}\frac{\partial s}{\partial\tau} + \frac{\mu}{\sigma-1}\left[\frac{\tau-1}{1-(1-\tau)s}\frac{\partial s}{\partial\tau} + \frac{1}{\rho}\frac{\partial g}{\partial\tau} + \frac{s}{1-(1-\tau)s}\right]. \quad (57)$$

The first three terms in RHS of (56) and (57) are the same with respect to the effect of θ on U_N and U_S, which are expressed in (54) and (55). The last terms in RHS in both equations are positive, which represents the direct effect of decline in trade costs. Figures 10 , 11 and 12 depict the effect of trade costs on the welfare of the North and the welfare of the South. Figure 10 depicts the case that $L_N/L_S > \theta^2$. From Proposition 3, trade liberalization raises the growth rates monotonously. Then, trade liberalization raises the welfare level in both countries for $\tau < 0.4$ in Figure 10. On the other hand, when $\tau > 0.4$, all of firms locate in the North. Therefore, trade liberalization does not affect the welfare of the North and raises the welfare of the South monotonously. Figure 11 depicts the case that $\bar{\lambda} < L_N/L_S < \theta^2$. From Proposition 3, the relationship between trade liberalization and the growth rate follows the U-shaped curve. However, when trade costs are sufficiently high, the direct effect is larger than the indirect effect and trade liberalization raises welfare level of both countries. Figure 12 depicts the case that $L_N/L_S < \bar{\lambda}$. From Proposition 3, when $\tau_{01} < \tau < \tau_{02}$, the number of firms locating in the North is zero. Then, trade liberalization does not affect the welfare of the South and raises the welfare of North monotonously.

5 Conclusion

Throughout this paper, we constructed a model introducing affiliation costs of firms into the Grossman-Helpman-Romer-type growth theory with a New Economic Geography model. This paper focuses on two distinct faces of globalization: the decline of affiliation costs and the decrease in trade costs of goods. We investigated the effects of afilliation costs on growth rates. When the market size of the North is relatively small, a decline in affiliation costs reduces growth rates of the economy. On the other hand, when the market size of the North is relatively large, the growth rate follows a U-shaped curve as affiliation costs decrease.

We also studied the effects of trade costs on growth rates. If the population of the North is small enough relative to that of the South, the number of firms in the North first decreases and then increases after a decline in trade costs. On the other hand, if the population in the North is relatively large, the number of firms in the North monotonously increases with a decline in trade costs. In the former case, the growth rate follows a U-shaped curve, while, in the latter case, the growth rate monotonously increases with a decline in trade costs.

In this paper, we assume that equilibrium wages in two countries are constant and the same. We can construct a model in which wages are endogenously determined. We assume that innovation activities can be done in one country. We can extend the model to one in which innovation activities can be operated in both countries. These are problems for additional research.

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Appendix

A Proof of Proposition 1

Differentiating (16) with respect to θ, we can obtain the following equation:

$$\begin{aligned}\frac{\partial s^*}{\partial \theta} &= \frac{-\tau(L_N+L_S)[(1-\theta\tau)L_N-(\tau-\theta)L_S]-(-\tau L_N+L_S)[(1-\theta\tau)L_N+(\tau-\theta)\tau L_S]}{(1-\tau)[(1-\theta\tau)L_N-(\tau-\theta)L_S]^2}\\ &= \frac{(\tau L_N-L_S-\tau L_N-\tau L_S)(1-\theta\tau)L_N+[\tau(\tau L_N-L_S)+\tau(L_N+L_S)](\tau-\theta)L_S}{(1-\tau)[(1-\theta\tau)L_N-(\tau-\theta)L_S]^2}\\ &= -\frac{(1+\tau)\,[(1-\theta\tau)+(\theta-\tau)]\,L_N L_S}{(1-\tau)[(1-\theta\tau)L_N-(\tau-\theta)L_S]^2}<0, \end{aligned} \tag{A.1}$$

because $\theta > \tau$.

B Deviation of $\theta_N < \theta_S$

Subtracting θ_N from θ_S, we can obtain the following equation:

$$\begin{aligned}\frac{L_N+\tau^2L_S}{\tau(L_N+L_S)}-\frac{\tau(L_N+L_S)}{\tau^2L_N+L_S} &= \frac{(L_N+\tau^2L_S)(\tau^2L_N+L_S)-\tau^2(L_N+L_S)^2}{\tau(L_N+L_S)(\tau^2L_N+L_S)}\\ &= \frac{(\tau^2-1)^2L_NL_S}{\tau(L_N+L_S)(\tau^2L_N+L_S)}>0. \end{aligned} \tag{B.1}$$

Then, θ_S is larger than θ_N.

C Proof of Proposition 2

From Proposition 1 and (35), we know that the sign of $\partial g/\partial\theta$ is equivalent to the sign of $F(\theta)$. Then, we investigate the sign of $F(\theta)$. $F'(\theta)$ and $F''(\theta)$ are given by

$$F'(\theta) = -2(\tau-\theta)L_S + 2\tau^2(1-\theta\tau)L_N, \tag{C.1}$$

$$F''(\theta) = 2(L_S-\tau^3L_N) > 0, \tag{C.2}$$

where the last inequality is from Assumption 1. From $\theta > \tau$ and $F^{''}(\theta) > 0$, the sign of $F^{'}(\theta)$ is given by

$$F'(\theta) > F'(\tau) = 2\tau^2(1-\tau^2)L_N > 0 \tag{C.3}$$

Therefore, $F'(\theta) > 0$ for $\theta \geq \tau$. Then, the value of $F(1)$, $F(\theta_N)$, and $F(\theta_S)$ can be obtained as follows:

$$F(1) = (1-\tau)^2(L_S-\tau L_N), \tag{C.4}$$

$$F(\theta_N) = \frac{(1-\tau^2)^2\tau L_NL_S}{(\tau^2L_N+L_S)^2}(\tau L_N - L_S), \tag{C.5}$$

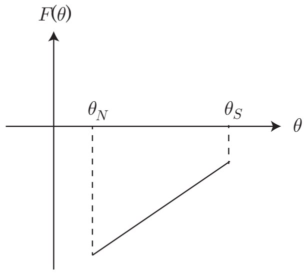

Figure C.1: $L_N < \tau^3 L_S$

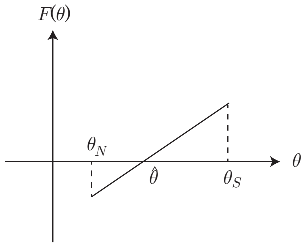

Figure C.2: $\tau^3 L_S < L_N < \tau L_S$

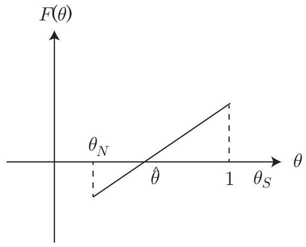

Figure C.3: $\tau L_S < L_N < L_S/\tau$

$$F(\theta_S) = \frac{(1-\tau^2)^2 L_N L_S}{\tau^2 (L_N + L_S)^2}(L_N - \tau^3 L_S). \tag{C.6}$$

Then, we have $F(\theta_N) < 0$ from Assumption 1, while $F(\theta_S) \gtreqless 0$ holds when $L_N \gtreqless \tau^3 L_S$.

When $L_N < \tau^3 L_S$, we have $0 < \theta_S < 1$, $F(\theta_N) < 0$, and $F(\theta_S) < 0$. Then, we can depict $F(\theta)$ in Figure C.1. Because $F'(\theta) > 0$ for $\theta > \tau$, $F(\theta_N) < 0$, and $F(\theta_S) < 0$, we know that $F(\theta)$ is negative for $\theta_N < \theta < \theta_S$. Therefore, $\partial g/\partial \theta < 0$ holds.

When $\tau^3 L_S < L_N < \tau L_S$, we have $0 < \theta_S < 1$, $F(\theta_N) < 0$, and $F(\theta_S) > 0$. Then, we can depict $F(\theta)$ in Figure C.2. Because $F(\theta_N) < 0$ and $F(\theta_S) > 0$, there exists the unique solution of $F(\hat{\theta}) = 0$. Then, $F(\theta)$ is negative for $\theta_N < \theta < \hat{\theta}$ and $F(\theta)$ is positive for $\hat{\theta} < \theta < \theta_S$. Therefore, $\partial g/\partial \theta < 0$ holds for $\theta_N < \theta < \hat{\theta}$ and $\partial g/\partial \theta > 0$ holds for $\hat{\theta} < \theta < \theta_S$.

When $\tau L_S < L_N < L_S/\tau$, we have $\theta_S > 1$, $F(\theta_N) < 0$, and $F(1) > 0$. Then, we can depict $F(\theta)$ in Figure C.3. Because $F(\theta_N) < 0$ and $F(1) > 0$, there exists the unique solution of $F(\hat{\theta}) = 0$. Then, $F(\theta)$ is negative for $\theta_N < \theta < \hat{\theta}$ and $F(\theta)$ is positive for $\hat{\theta} < \theta < 1$. Therefore, $\partial g/\partial \theta < 0$ holds for $\theta_N < \theta < \hat{\theta}$ and $\partial g/\partial \theta > 0$ holds for $\hat{\theta} < \theta < 1$.

D Proof of Lemma 2

We investigate the value of $f_0(\tau)$. We have $s^* > 0$ if $f_0(\tau) > 0$; otherwise $s^* = 0$. From (38), we know that if $L_N > [\tau(\theta - \tau)/(1 - \theta\tau)] L_S$, then $f_0(\tau) > 0$. In the following, we investigate the condition which holds $L_N >$

$[\tau(\theta-\tau)/(1-\theta\tau)]\, L_S$. Since

$$\frac{\partial}{\partial\tau}\left[\frac{\tau(\theta-\tau)}{1-\theta\tau}\right]=\frac{\theta\tau^2-2\tau+\theta}{(1-\theta\tau)^2},$$
$$\theta\tau^2-2\tau+\theta|_{\tau=0}=\theta>0,$$
$$\theta\tau^2-2\tau+\theta|_{\tau=\theta}=\theta^3-\theta<0,$$
$$\theta\tau^2-2\tau+\theta|_{\tau=1}=2(\theta-1)<0,$$

we know that $[\tau(\theta-\tau)/(1-\theta\tau)]\, L_S$ is maximized (and positive) at $\overline{\tau}\in(0,\theta)$, which is the smaller root of $\theta\tau^2-2\tau+\theta=0$. Let $\overline{\lambda}\equiv[\overline{\tau}(\theta-\overline{\tau})/(1-\theta\overline{\tau})]$. Thus, if $L_N>\overline{\lambda}L_S$, then $f_0(\tau)>0$, which is equivalent to $s^*>0$ for any τ because of (37). Furthermore, since

$$f_0(0)=L_N>0,$$
$$f_0(1)=(1-\theta)(L_N+L_S)>0,$$

the equation $f_0(\tau)=0$ has two roots, τ_{01}, τ_{02}, in $(0,1)$ if $L_N<\overline{\lambda}L_S$. Thus, if $L_N<\overline{\lambda}L_S$, it holds that $s^*=0$ for $\tau\in[\tau_{01},\tau_{02}]$ because of (37).

The difference of θ^2 and $\overline{\lambda}$ is

$$\begin{aligned}&\theta^2-\frac{\overline{\tau}(\theta-\overline{\tau})}{1-\theta\overline{\tau}}\\ =&\ \frac{\overline{\tau}^2-\theta(1+\theta^2)\overline{\tau}+\theta^2}{1-\theta\overline{\tau}}.\end{aligned}\tag{D.1}$$

We know that the numerator of (D.1) is positive since the discriminant is

$$\left[\theta(1+\theta^2)\right]^2-4\theta^2=\theta^2\left[(1+\theta^2)^2-4\right]<0.$$

This implies that $\overline{\lambda}<\theta^2$. Finally, if $\tau_{02}\geq\tau_1$, it holds that $s^*=1$ in $[\tau_1,\tau_{02}]$ from Lemma 1, which contradicts the last result. Thus, $\tau_{02}<\tau_1$.

E Proof of Proposition 3

For the interior equilibrium (i.e., $s^*\in(0,1)$), from the market clearing condition of manufacutured goods, we have

$$\mu(L_N+L_S)=\frac{\sigma}{\sigma-1}\left(n_{Nt}q_{Nt}+n_{St}q_{St}\right)=\sigma\left(n_{Nt}+\frac{n_{St}}{\theta}\right)\pi_{Nt},\tag{E.1}$$

where the second equality is from (12) and (26). Thus, we have

$$\pi_{Nt}=\frac{\mu\theta(L_N+L_S)}{\sigma(\theta n_{Nt}+n_{St})}.$$

From this equation and (32), we have another expression of the growth rate:

$$g=\frac{\mu\theta(L_N+L_S)}{\eta\sigma(\theta s+1-s)}-\rho.$$

In addition, the next lemma holds concerning the function $h(\tau)$ defined by (42):

Lemma E.1 *It holds that $h(\tau_1) \geq 0$. Furthermore, if $L_N < \overline{L}_N$, it holds that $h(\tau_{01}) \leq 0$ and $h(\tau_{02}) \geq 0$.*

Proof. If $h(\tau_1) < 0$, we have $\partial s/\partial \tau < 0$ at $\tau = \tau_1$ from (43). It evidently contradicts Lemma 1. If $h(\tau_{01}) > 0$, we have $\partial s/\partial \tau > 0$ at $\tau = \tau_{01}$ from (43). It evidently contradicts Lemma 2. Finally, we can show that $h(\tau_{02}) \geq 0$ in a similar way.

From (42), we know that

$$h(0) = L_N - \theta^2 L_S,$$
$$h(1) = (L_N - L_S)(1-\theta)^2,$$

and the vertex of $h(\tau)$ is

$$\tau^* \equiv \frac{L_N - L_S}{\theta^2 L_N - L_S}.$$

We consider the following four cases separately: (a) $\theta^2 L_S < L_S < \theta^2 L_N < L_N$, (b) $\theta^2 L_S < \theta^2 L_N < L_S < L_N$, (c) $\theta^2 L_N < \theta^2 L_S < L_N < L_S$, and (d) $\theta^2 L_N < L_N < \theta^2 L_S < L_S$. We know that $\tau^* > 1$, $h(0) > 0$, $h(1) > 0$, and $h(\tau)$ is convex in case (a), while $\tau^* < 0$, $h(0) > 0$, $h(1) > 0$, and $h(\tau)$ is concave in case (b). Thus, we conclude that $h(\tau) > 0$ for $\tau \in (0,1)$ in these two cases. In case (c), we know that $\tau^* \in (0,1)$, $h(0) > 0$, $h(1) < 0$, and $h(\tau)$ is concave. From Lemma E.1, we conclude that $h(\tau) > 0$ for $\tau \in (0, \tau_1)$. Summarizing the results of (a)-(c), we have i) in Proposition 3 by (43).

In case (d), we know that $\tau^* \in (0,1)$, $h(0) < 0$, $h(1) < 0$, and $h(\tau)$ is concave. From Lemma E.1 and the definition of τ_2 (i.e., the smaller root of $h(\tau) = 0$), we conclude that $\tau_2 < \tau_1$, $h(\tau) < 0$ for $\tau \in (0, \tau_2)$ and $h(\tau) > 0$ for $\tau \in (\tau_2, \tau_1)$. Therefore, from Lemmas 2, E.1, and Equation (43), we obtain ii) and iii) in Proposition 3.

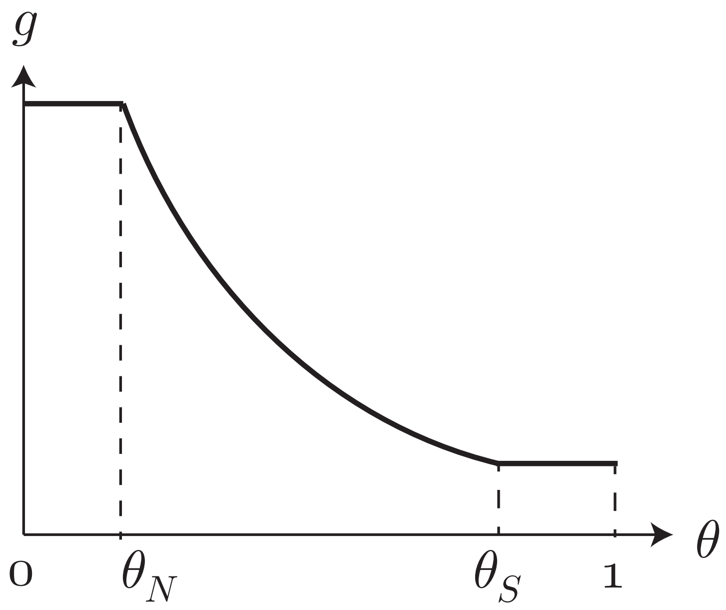

Figure 1: The relationship between transaction costs and growth rate when $L_N/L_S < \tau^3$

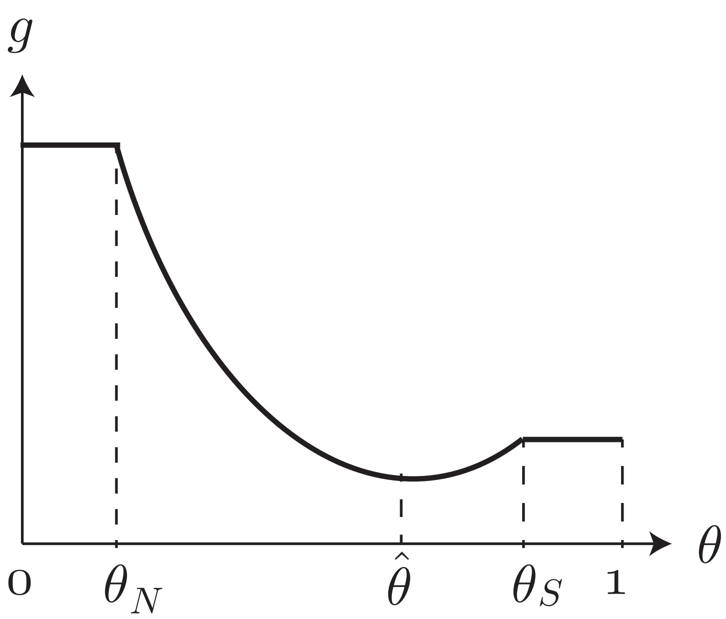

Figure 2: The relationship between transaction costs and growth rate when $L_N/L_S \in (\tau^3, \tau)$

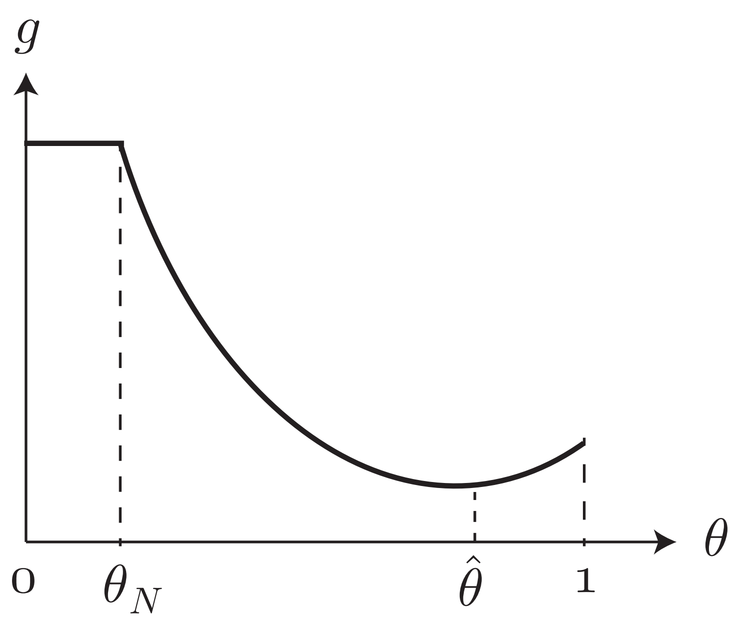

Figure 3: The relationship between transaction costs and growth rate when $L_N/L_S \in (\tau, 1/\tau)$

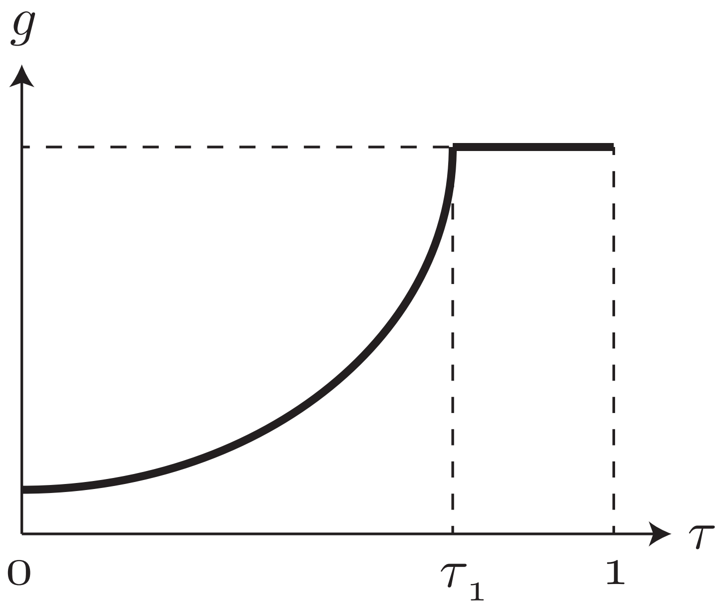

Figure 4: The relationship between trade costs and growth rate when $L_N/L_S > \theta^2$

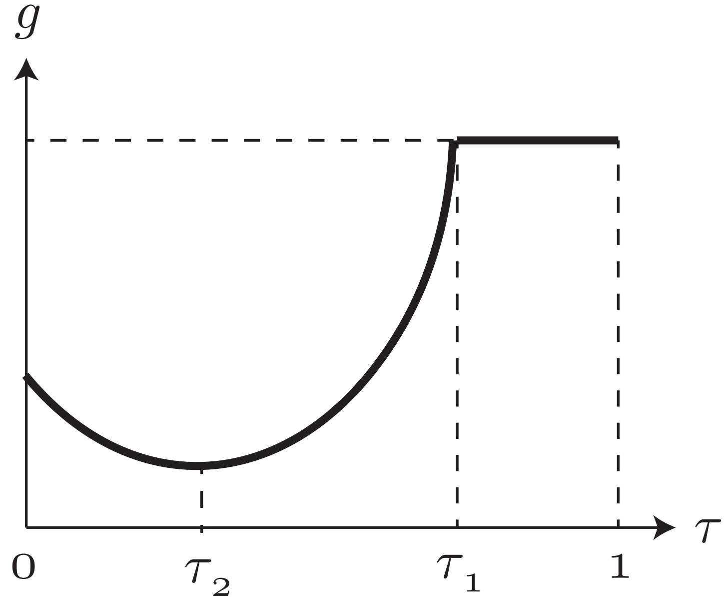

Figure 5: The relationship between trade costs and growth rate when $L_N/L_S \in (\bar{\lambda}, \theta^2)$

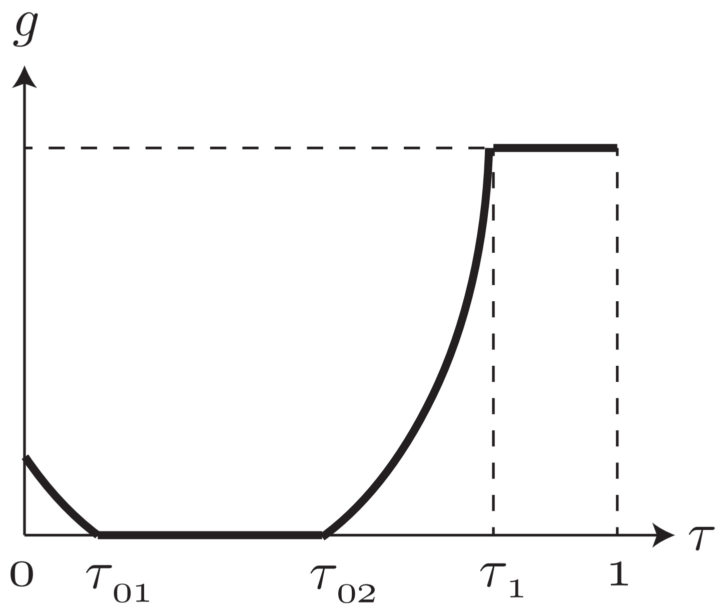

Figure 6: The relationship between trade costs and growth rate when $L_N/L_S < \bar{\lambda}$

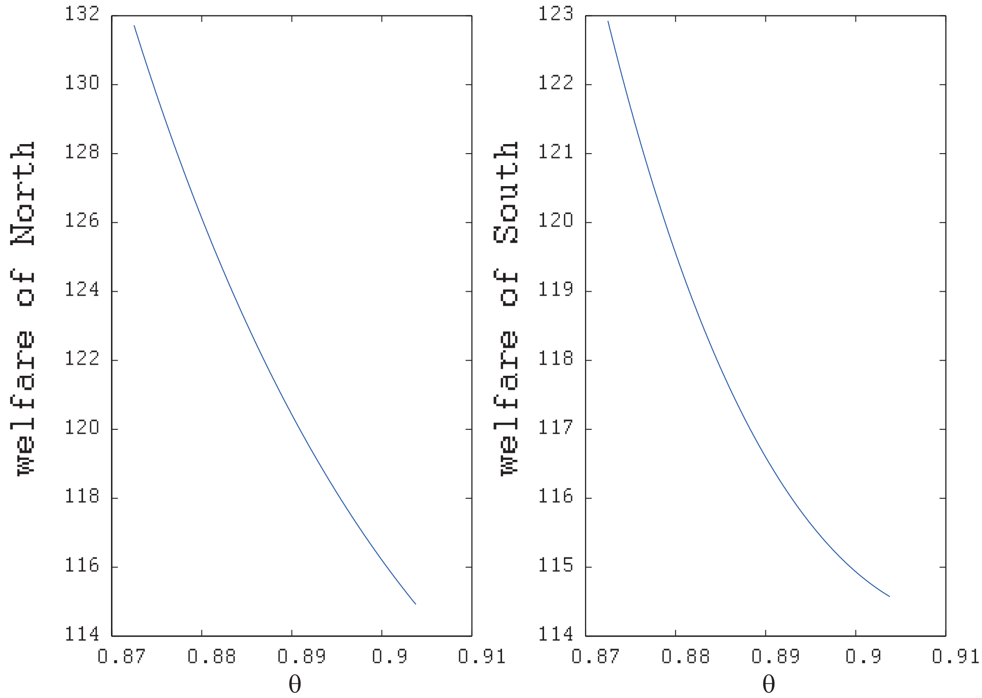

Figure 7: $\tau = 0.8$

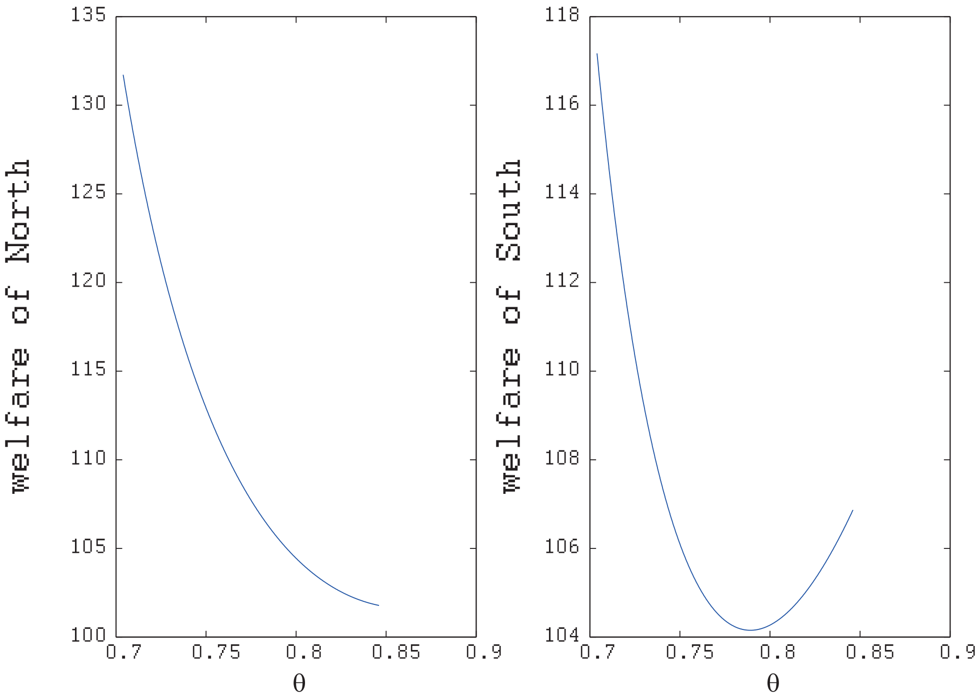

Figure 8: when $\tau = 0.6$

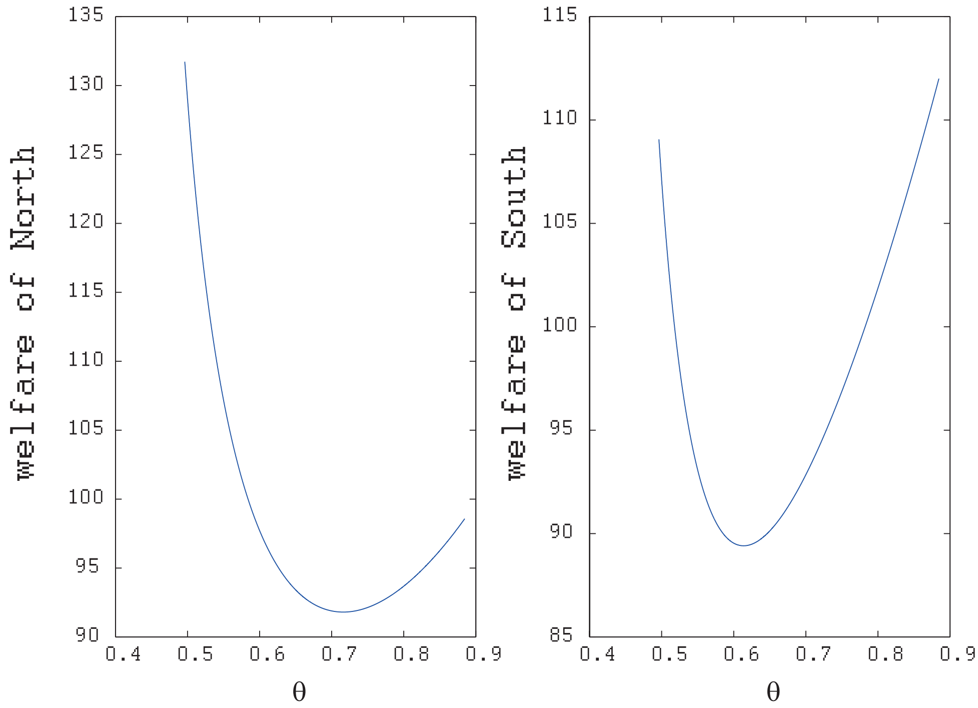

Figure 9: when $\tau = 0.4$

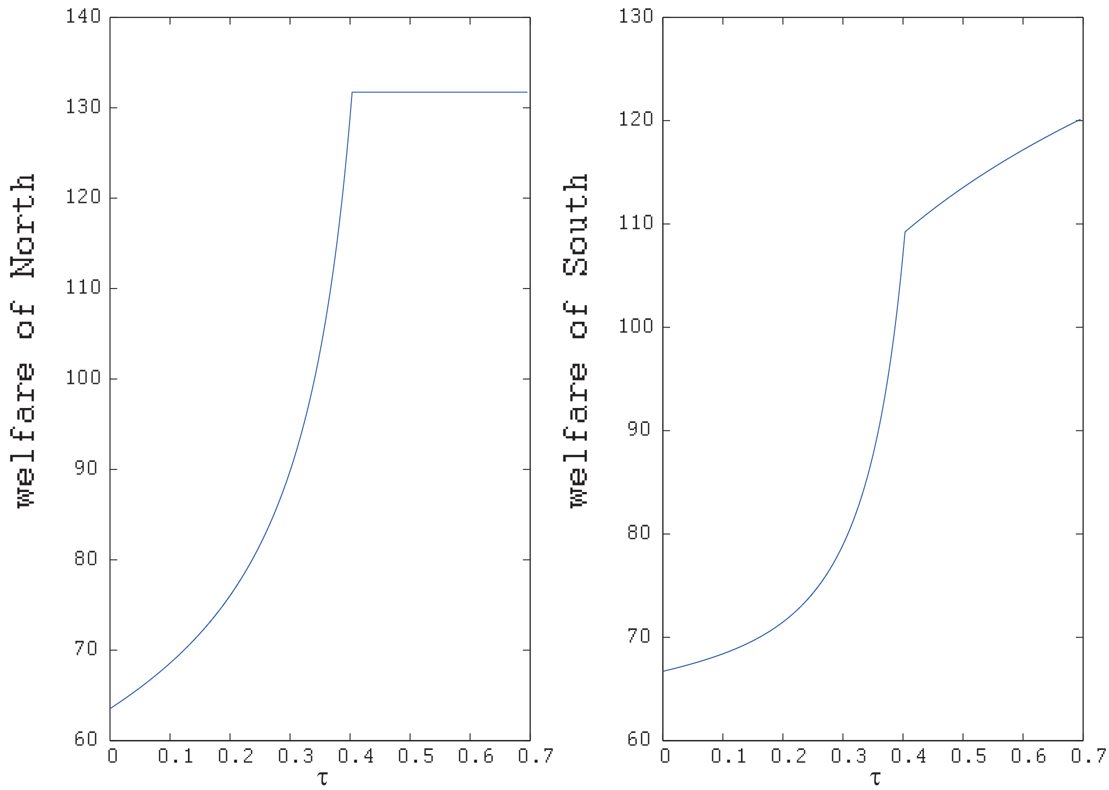

Figure 10: when $\theta = 0.5$

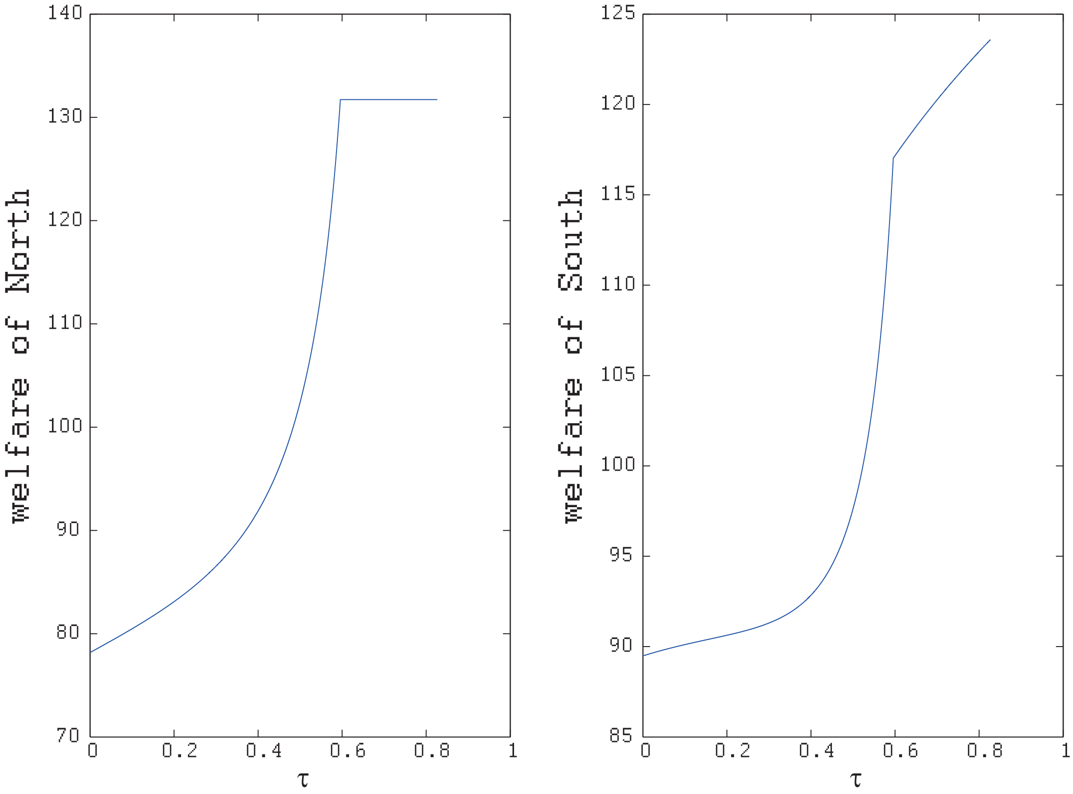

Figure 11: when $\theta = 0.7$

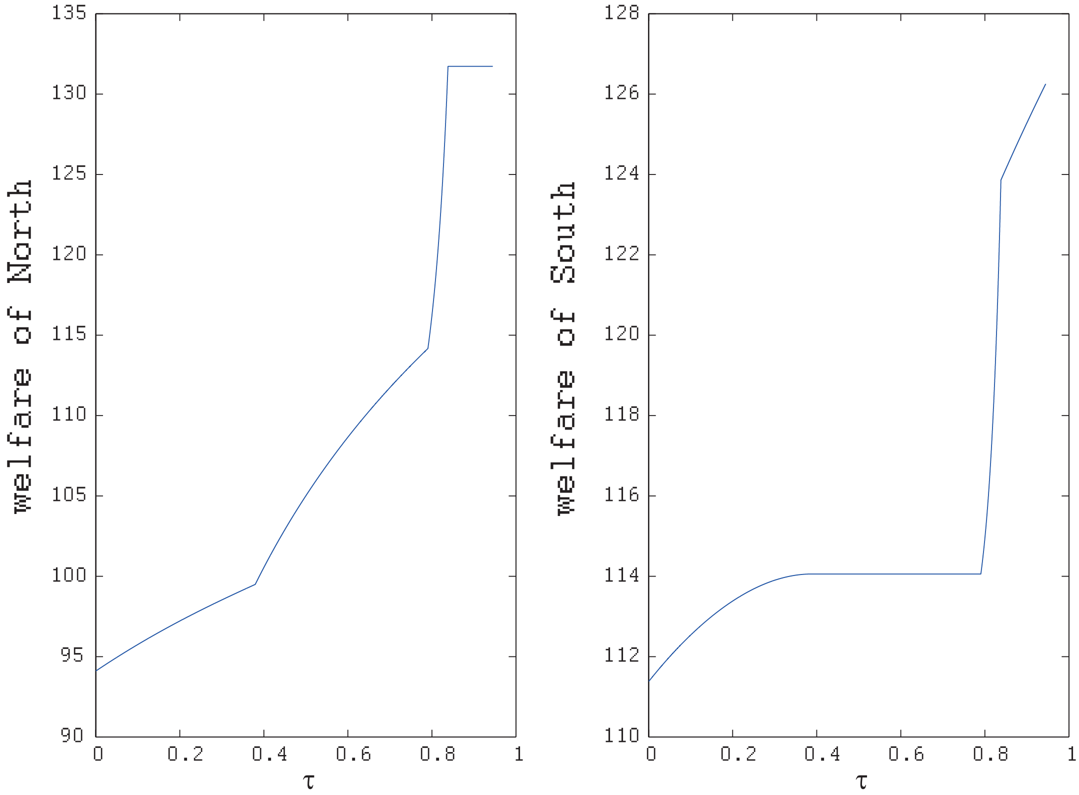

Figure 12: when $\theta = 0.9$