CHINESE GEOGRAPHICAL SCIENCE
Volume 14, Number 4, pp. 289–295, 2004
Science Press, Beijing, China

A PATH-DEPENDENT MODEL OF INVESTMENT AND EMPLOYMENT FLOW IN A LARGE ECONOMY IN A PROCESS OF INTEGRATION

LIU An-guo[1], YANG Kai-zhong[2]
(*1. School of Economics and Management Science, Beijing University of Chemical Technology, Beijing 100029, P. R. China; 2. School of Government Administration, Peking University, Beijing 100871, P. R. China*)

ABSTRACT: This paper meant to analyze the spatial evolution of a large country in its process of integration with the world economy in general, and, to look into the possible effect of China′s accession into WTO on the future development of its spatial economy in particular. Through an approach of increasing returns, external economy, product differentiation and path-dependence, with foreign trade costs incurred by different regions within the large country discriminated, a model of investment and employment flow is developed as a simulation of a large country′s process of integration with the world economy. The modeling indicates that in the process of integration, as there exist differences in foreign trade costs among different regions within the large country, either the spatial economy of the country deviates from its symmetric structure in autarky and falls into a core-periphery relationship, or the effect of industrial agglomeration is reinforced, amplified and locked in, if the agglomeration had been started. The economic gap on either the aggregate or structural basis between different regions within the large country will increase rapidly as the integration proceeds.

KEY WORDS: increasing returns; pecuniary externality; trade cost; investment; employment

CLC number: F119.9 Document code: A Article ID: 1002-0063(2004)04-0289-07

From the 1980s onwards, KRUGMAN (1991, 1995), FUJITA (1988), VENABLES (1996) and other economists introduced the concepts of increasing returns, product differentiation and pecuniary externality into economic geography, and put forward a series of new models that shed innovative light on the explanation of trade, growth and economic agglomeration under the background of globalization. In modeling the evolution of industry agglomeration and spreading, the transaction costs incurred by different regions within a country in their trade with other countries were usually taken as equal and even. For small countries with no noticeable difference in their internal conditions such as transportation, infrastructure and institution, this treatment will not cause much distortion. However, for a country with a vast territory and with its internal regions showing substantial difference in their internal conditions (e.g. transportation, infrastructure and institution etc.), those costs cannot be simply taken as equal and even. In order to study the evolutionary pattern of the spatial economy of a large country, it seems more realistic to treat as unequal the transaction costs incurred by different regions within a large country in their trade with other countries. Taking China′s accession into WTO as the background, through an approach of increasing returns, external economy, product differentiation and path-dependence, with foreign trade costs incurred by different regions within the large country being discriminated, this article makes an attempt to model the evolutionary pattern of the spatial economy of a large country in its process of integration with the world economy in the wake of KRUGMAN and VENABLES (1995), PUGA and VENABLES (1996), VENABLES (1996), and FUJITA *et al*.(1999). On the basis of the modeling, certain implications are drawn to help us look into the possible effect of China′s accession into WTO

Received date: 2004-01-09
Foundation item: Under the auspices of the National Natural Science Foundation of China (No. 49971027) and Fund for Research in Natural Science by Young Teachers of Beijing University of Chemical Technology (No. QN0317)
Biography: LIU An-guo (1962–), male, a native of Changde of Hunan Province, associate professor, specialized in trade theory and regional economics. E-mail: anguoliu@163.com
Correspondent: YANG Kai-zhong (1962–), male, a native of Changde of Hunan Province, professor, specialized in regional economics, regional policy and tourism development. E-mail: ykz@pku.edu.cn

on the future development of its spatial economy.

1 ASSUMPTIONS IN MODELING

This model is based on the framework of Dixit-Stiglitz model of monopolistic competition (DIXIT and STIGLITZ, 1977). In the model there is a large economy geographically divided into two regions: the coastal region and the inland region. The whole economy is currently experiencing a transition from autarky to opening to the outside world as well as from command economy to market economy. Owing to differences in geography and institution, the degree of opening and the speed of transition are different between the coastal region and the inland region.

Trade cost (or transaction cost) in the model is defined as the total cost incurred in the process of transaction between dealers at a certain distance that falls into two categories: one is the cost determined by technology and infrastructure (or technical cost for short), including transport cost and informational cost, and the other is the cost determined by institution, legal system and management practice, etc.(or institutional cost for short).

We consider a world with 4 regions starting their growth from the same level, and each region with 2 sectors (agriculture and manufacturing) and with a total labor supply equalling to 1. The agricultural sectors are perfectly competitive and produce a single, homogeneous good, whereas the manufacturing sector provides a large variety of differentiated goods that are both demanded by consumers as final products and by manufacturers as intermediate inputs. We further combine the four regions into two groups, with regions 1 and 2 as a group belonging to the same country, labeled as Group P (Periphery) (or Country P). In terms of their geographical locations, Region 1 is labeled as the Coast and Region 2 as the Inland. Regions 3 and 4 are a group of developed countries that get rich first in the course of history, labeled as Group C (Core) (Fig. 1). Assume that there exists an "iceberg" form of cost, labeled as T, in the domestic trade between Region 1 and Region 2 in Group P . We use T_{1C} to represent the trade cost between Region 1 and Group C, T_{2C} the trade cost between Region 2 and Group C, T_C the trade cost between Core Countries, and τ the "iceberg" form of tariff in trade between Country P and Group C. As Country P is a country of vast expanse of land, Region 2 faces higher cost than Region 1 in their trade with Group C, and the cost difference is about the same value as T, the domestic trade cost between Region 1 and Region 2.

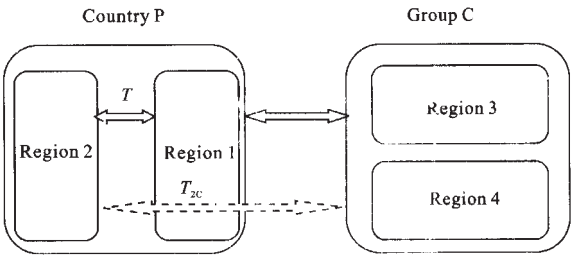

Fig. 1 A path-dependent model of investment and employment flow in a large economy in a process of integration

We assume that labor is intra-regionally mobile between sectors but inter-regionally immobile. Assume that agriculture uses constant-returns technology with labor as the only input. The wage rate in region r is w_r. The production in manufacturing exhibits scale economies arising at the level of the variety. Technology is the same for all varieties and all locations. Manufacturing uses an input composite of labor and intermediates, which enter into a production function implicitly defined in a Cobb-Douglas relation between the price of the composite input and the price of labor and the intermediates, as proposed in FUJITA *et al*. (1999). Let the price of intermediate goods in region r be G_r, then the price of the input composite is $w_r^{1-\alpha} G_r^{\alpha}$, with intermediate share α. This input is used in both the fixed cost and the marginal cost. We choose units so that the marginal input requirement equals the price-cost markup [$c = \rho = (\sigma - 1)/\sigma$] to ensure that firms set price p_r according to equation (1) (FUJITA *et al*., 1999).

$$p_r = w_r^{1-\alpha} G_r^{\alpha} \tag{1}$$

The intermediate is assumed to be a CES function of the varieties available. Then the price index for that intermediate, G_r, at location r, takes the form

$$G_r = [\sum_{s=1} n_s (p_s T_{sr} \tau_{sr})^{1-\sigma}]^{1/(1-\sigma)}$$

$$= [\sum_{s=1} n_s (w_s^{1-\alpha} G_s^{\alpha} T_{sr} \tau_{sr})^{1-\sigma}]^{1/(1-\sigma)} \tag{2}$$

where n_s is the numbers of varieties produced in location s, p_s the FOB (Free on Board) price, T_{sr} the trade cost, and τ_{sr} the tariff.

Turning to the demand side, expenditure E_r on manufactures in location r is composed of two parts: one part as final consumption by consumers and the other part for intermediate input by firms:

$$E_r = \mu Yr + \alpha n_r p_r q^* \tag{3}$$

where μ is the share of manufactures in consumption and Y is income. q^* is the sales of firms at zero-profit equilibrium.

We use λ_r to denote the share of labor force in manufacturing of region r. The total value of manufacturing output in region r is $n_r p_r q^*$, so the manufacturing wage bill in region r is a share $(1-\alpha)$ of this:

$$w_r \lambda_r = (1-\alpha) n_r p_r q^* \tag{4}$$

We choose units such that $q^*=1/(1-\alpha)$, so that

$$n_r = (w_r/p_r)\lambda_r \tag{5}$$

Inserting (1) and (5) into (2), we have

$$G_r=[\sum_{s=1}^{4} \lambda_s w_s^{1-\sigma(1-\alpha)} G_s^{-\alpha\sigma} (T_{sr}\tau_{sr})^{1-\sigma}]^{1/(1-\sigma)} \tag{6}$$

where, (2) and (6) are identical. We will use them interchangeably without any discrimination.

2 MODELING OF INVESTMENT AND EMPLOYMENT FLOW

From (6) and (2) we derive equations (7), (8) and (7′), (8′), two equivalent forms of price index equation:

$$G_1^{1-\sigma} = \lambda_1 w_1^{1-\sigma(1-\alpha)} G_1^{-\alpha\sigma} + \lambda_2 w_2^{1-\sigma(1-\alpha)} G_2^{-\alpha\sigma} T^{1-\sigma} + 2\lambda_C w_C^{1-\sigma(1-\alpha)} G_C^{-\alpha\sigma} (T_{1C}\tau)^{1-\sigma} \tag{7}$$

$$G_2^{1-\sigma} = \lambda_1 w_1^{1-\sigma(1-\alpha)} G_1^{-\alpha\sigma} T^{1-\sigma} + \lambda_2 w_2^{1-\sigma(1-\alpha)} G_2^{-\alpha\sigma} + 2\lambda_C w_C^{1-\sigma(1-\alpha)} G_C^{-\alpha\sigma} (T_{2C}\tau)^{1-\sigma} \tag{8}$$

$$G_1^{1-\sigma} = n_1 (w_1^{1-\alpha} G_1^{\alpha})^{1-\sigma} + n_2 (w_2^{1-\alpha} G_2^{\alpha} T)^{1-\sigma} + 2n_C (w_C^{1-\alpha} G_C^{\alpha} T_{1C}\tau)^{1-\sigma} \tag{7′}$$

$$G_2^{1-\sigma} = n_1 (w_1^{1-\alpha} G_1^{\alpha} T)^{1-\sigma} + n_2 (w_2^{1-\alpha} G_2^{\alpha})^{1-\sigma} + 2n_C (w_C^{1-\alpha} G_C^{\alpha} T_{2C}\tau)^{1-\sigma} \tag{8′}$$

Manufacturing wages are determined by the following equations:

$$(w_1^{1-\alpha} G_1^{\alpha})^{\sigma}/(1-\alpha) = E_1 G_1^{\sigma-1} + E_2 G_2^{\sigma-1} T^{1-\sigma} + 2E_C G^{\sigma-1} (T_{1C}\tau)^{1-\sigma} \tag{9}$$

$$(w_2^{1-\alpha} G_2^{\alpha})^{\sigma}/(1-\alpha) = E_1 G_1^{\sigma-1} T^{1-\sigma} + E_2 G_2^{\sigma-1} + 2E_C G_C^{\sigma-1} (T_{2C}\tau)^{1-\sigma} \tag{10}$$

We will use equations(7), (8), (9) and (10) to analyze the pattern of employment (labor) flow between agriculture and manufacturing within Region 1 and Region 2 in Country P, and equations (7′), (8′), (9) and (10) to analyze the pattern of flow of investment and firms as tariff and trade cost change in the process of Country P′s integration with the global economy.

Both manufacturing and agriculture generate income. Assume that agricultural output is freely tradable, and taken as numeraire. Assume that agricultural production function $A(1-\lambda_r)$ is increasing and concave, and agricultural output depends on the amount of labor employed in the sector, $1-\lambda_r$, income in each region is respectively, therefore,

$$Y_1 = w_1 \lambda_1 + A(1-\lambda_1) \qquad Y_2 = w_2 \lambda_2 + A(1-\lambda_2) \tag{11}$$

The agricultural wage is the marginal product of labor, $A′(1-\lambda_r)$, and the wage gap between sectors is defined as v_r:

$$v_1 = w_1 - A′(1-\lambda_1) \qquad v_2 = w_2 - A′(1-\lambda_2) \tag{12}$$

Given the shares of each region′s labor force in manufacturing, λ_1 and λ_2, equations (7)–(12) characterize the short-run equilibrium and give the wage levels and the wage gap between agriculture and industry in each region. Assume a simple adjustment dynamic in which, within each region, labor moves from agriculture to industry if v_r is positive, and vice versa. The long-run equilibrium occurs either when v_r is 0 in both regions, or at a corner point, when one sector has contracted to 0 in one region. Long-run equilibrium manufacturing wages, therefore, satisfy

$$w_r \begin{cases} = A′(1-\lambda_r), & \lambda_r \in (0,1) \\ \geqslant A′(1-\lambda_r), & \lambda_r = 1 \\ \leqslant A′(1-\lambda_r), & \lambda_r = 0 \end{cases} \tag{13}$$

Assume a myopic entry and exit process, according to which firms enter and exit in response to profit opportunities. This is described by differential equations:

$$\dot{n}_r = \delta \pi_r, \quad n_r \geqslant 0 \tag{14}$$

When the short-run profit is positive, new firms will enter; when it is negative, there will be exit. A long-run equilibrium is arrived at when the numbers of firms are such that there are zero profits in each region where there is a positive number of firms and negative profits (for potential, if not actual, firms) wherever the number of firms is zero:

$$\pi_r n_r = 0, \quad \pi_r = 0, \quad n_r \geqslant 0$$

The profit of a firm is determined by the actual level of output of the firm, q_r, which responds to the demand in the market, and is compared with the equilibrium level of output for all the firms in the economy, q^*:

$$\pi_r = \frac{p_r}{\sigma}(q_r - q^*) \tag{15}$$

And the demand in the market is determined by the level of price indices, tariff and trade cost:

$$q_r = \sum_{s=1}^{4} (p_s T_{sr} \tau_{sr})^{-\sigma} G_r^{\sigma-1} E_r \tag{16}$$

3 ECONOMIC EXPERIMENT IN THREE PHASES

We carry out an economic experiment on the basis of the following assumption.

Manufacturing goods take a rather low share($\mu < 0.5$) in consumption in Country P so that there exists agricultural activity even when all the manufacturing activities

in Country P concentrate in a single region. Until the formation of a complete industrial agglomeration, agricultural production function keeps to be a linear one: $A(1-\lambda_r)=1-\lambda_r$. This ensures that equilibrium wage rate in both regions is unity and equals the marginal product of agricultural labor.

We further assume that the core group represents a club of developed countries of a huge level of economic activities, whose share of manufacturing, price index, wage rate and manufacture consumption will be little affected by Country P′s later integration with the world economy and thus can be taken as exogenously given.

Now, the central question is: with an industrialized core having already existed in the world, how will the two regions within the peripheral Country P develop? We would introduce an economic experiment of three phases and focus the analysis on the evolution of the spatial structure of Country P′s economy.

3.1 Phase Ⅰ: Autarky

In Phase Ⅰ, Country P is in autarky. As it has no trading connection with Group C, the industrialized core, the trade cost between Region 1/Region 2 and Group C in equations (7)–(10) can be taken as infinite. Regions 1 and 2 develop in isolation from the outside world. Equations (7)–(10) can be rewritten as follows:

$$G_1^{1-\sigma}=\lambda_1 w_1^{1-\sigma(1-\alpha)}G_1^{-\alpha\sigma}+\lambda_2 w_2^{1-\sigma(1-\alpha)}G_2^{-\alpha\sigma}T^{1-\sigma} \quad (17)$$

$$G_2^{1-\sigma}=\lambda_1 w_1^{1-\sigma(1-\alpha)}G_1^{-\alpha\sigma}T^{1-\sigma}+\lambda_2 w_2^{1-\sigma(1-\alpha)}G_2^{-\alpha\sigma} \quad (18)$$

$$(w_1^{1-\alpha}G_1^{\alpha})^{\sigma}/(1-\alpha)=E_1G_1^{\sigma-1}+E_2G_2^{\sigma-1}T^{1-\sigma} \quad (19)$$

$$(w_2^{1-\alpha}G_2^{\alpha})^{\sigma}/(1-\alpha)=E_1G_1^{\sigma-1}T^{1-\sigma}+E_2G_2^{\sigma-1} \quad (20)$$

The economy in autarky is the same as described by FUJITA *et al*. (1999). Suppose we start our experiment with all manufacturing concentrated in one region, for example, Region 1. As labor supply is infinite, the manufacturing wage rate w_1 in Region 1 is 1. With domestic trade cost staying very high, Region 2 has to pay a very high price for manufacturing goods transported from Region 1, which may support potential wage rate w_2 in Region 2 at a level to be no less than 1. A high level of potential wage rate w_2 renders incentive for investors to open new plants in Region 2. w_2, potential wage rate supportable in Region 2, and the domestic trade cost T, exhibit a nonlinear relationship as described in Fig. 2.

With domestic trade cost $T>T(S)$, potential positive profit in Region 2 induces firms to invest in it and recruits workers at a wage rate no less than 1 to produce manufactures. As investment and firms flow into Region 2, agricultural workers will flow into manufacturing, too. As the industrial concentration in Region 1 is unsustainable, some firms in Region 1 may change their production location and remove to Region 2. This process will continue until firms or manufacturing spread evenly between the two regions, with both region having the same number of firms and the same share of manufacturing. The economy of Country P is thus led to a symmetrical equilibrium.

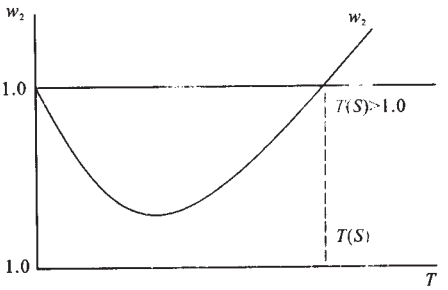

Fig. 2 Potential wage rate w_2 in Region 2

If, with the advancing of industrialization, domestic trade cost in Country P does drop below a critical point in a later stage, the symmetrical structure will be broken, which will lead to agglomeration of manufacturing in a single region.

At intermediate level of trade cost, multiple equilibriums arise.

3.2 Phase Ⅱ: Open Door Policy Implemented

In Phase Ⅱ, Country P starts its process of opening to the outside world, which will be a gradual transition from closed economy to open economy. In this process, although tariff barriers will experience a cross-the-board reduction, they are still kept at a considerable level. Institutional reform in Country P is also inaugurated at the same time. Although there is a noticeable drop in the foreign trade cost, as practices of both market economy and command economy are in operation in tandem, domestic trade cost are not much affected in spite of Country P′s proceeding toward an open economy. In this process, import tariffs go down from a prohibitively high level ($+\infty$). Despite their downward trend, import tariffs are still characterized by its protective nature.

Therefore, at the beginning of economic opening, exit of firms from manufacturing can be hardly observed. The improved availability of new intermediate goods from abroad leads to a gradual drop of the manufacture price index in Country P and generates incentives for new investment and firms to flow into manufacturing. As assumed before, Region 2 faces higher cost than Region 1 in their trade with Group C and the cost differ-

ence is about the same value as T, the domestic trade cost between Region 1 and Region 2. Manufacture price indices in regions 1 and 2 in this case are given by (7) and (8), the general form of equations.

As domestic trade cost do not change much in a short period of time after economic opening, manufacture price indices in regions 1 and 2 respond only to the change of trade volumes (or varieties traded, to put it more exactly) of intermediate goods between Country P and Group C. With the gradual change in manufacture price indices, firms begin to readjust their policy in production location in terms of changed accessibility to market and changed pecuniary externality arising therefrom. In the short run, the behavior of investment and firms can be described by λ_1, λ_2, n_1 and n_2 as in equations (7) and (8) or (7)′ and (8)′.

Assume that, during the transition from autarky to open economy, manufacturing goods of Country P/Group C penetrates Group C′s/ Country P′s market at such a cumulative rate as though Country P′s import tariff rate decreases from τ_0 to τ_1 at a time-dependent rate of $e^{-\delta/t}$ and therefore, Country P, the large economy, also passes its transition from autarky to open economy at a rate of $e^{-\delta/t}$①. Therefore, the behavior of investment and firms can be described by the following equations:

$$G_1(t)^{1-\sigma}=n_1(t)[w_1(t)^{1-\sigma}G_1(t)^{\alpha}]^{1-\sigma}+n_2(t)[w_2(t)^{1-\sigma}G_2(t)^{\alpha}T]^{1-\sigma}+2n_C(w_C^{1-\alpha}G_C^{\alpha}T_{1C})^{1-\sigma}[e^{-\delta/t}(\tau_1-\tau_0)+\tau_0]^{1-\sigma} \quad (21)$$

$$G_2(t)^{1-\sigma}=n_1(t)[w_1(t)^{1-\sigma}G_1(t)^{\alpha}T]^{1-\sigma}+n_2(t)[w_2(t)^{1-\sigma}G_2(t)^{\alpha}]^{1-\sigma}+2n_C(w_C^{1-\alpha}G_C^{\alpha}T_{2C})^{1-\sigma}[e^{-\delta/t}(\tau_1-\tau_0)+\tau_0]^{1-\sigma} \quad (22)$$

$$[w_1(t)^{1-\alpha}G_1(t)^{\alpha}]^{\sigma}/(1-\alpha)=E_1(t)G_1(t)^{\sigma-1}+E_2(t)G_2(t)^{\sigma-1}T^{1-\sigma}+2E_CG_C^{\sigma-1}T_{1C}^{1-\sigma}[e^{-\delta/t}(\tau_1-\tau_0)+\tau_0]^{1-\sigma} \quad (23)$$

$$[w_2(t)^{1-\alpha}G_2(t)^{\alpha}]^{\sigma}/(1-\alpha)=E_1(t)G_1(t)^{\sigma-1}T^{1-\sigma}+E_2(t)G_2(t)^{\sigma-1}+2E_CG_C^{\sigma-1}T_{2C}^{1-\sigma}[e^{-\delta/t}(\tau_1-\tau_0)+\tau_0]^{1-\sigma} \quad (24)$$

If Country P, the large economy, is still in its symmetrical equilibrium at the time point when it starts its opening process, then the action of economic opening will avail Regions 1 and 2 opportunities to obtain more varieties of intermediate products. Price indices in both regions will go down. The improved pecuniary externality attracts more investment and firms flowing into manufacturing sector in both regions, both n_1 and n_2 (and consequently λ_1 and λ_2) increase, although by different fraction. As Region 1 has a cost advantage over Region 2 in trading with Group C, price indices decrease more in Region 1 than in Region 2. Region 1 enjoys higher pecuniary externality than Region 2. There are more investment and firms flowing into Region 1 than into Region 2. Therefore, Region 1 has a higher manufacturing share than Region 2. However, as long as domestic trade cost remains high enough, full agglomeration of industry in Region 1 is hardly attainable. With domestic trade cost remaining high enough, Region 2 has to pay prices high enough for manufactures if we concentrate all industries in Region 1, and potential positive profit will induce firms to invest in Region 2. The result is a stable coexistence of manufacturing in both regions, with Region 1 having more firms (or higher manufacturing share) than Region 2.

If, with the advancing of economic opening and institutional reform, domestic trade cost in Country P drops below a critical point, and the above equilibrium will no longer be stable. A process of industrial agglomeration in Region 1 will be triggered off just because of the effect of circular causation.

If, however, industrious agglomeration in region 1 of Country P has already been under way at the instant when it opens itself to the world, the trend of agglomeration will be further reinforced because of the effect of path-dependence.

To recapitulate, after economic opening, Region 1 (the coastal region) advances faster than Region 2 (the inland region) in their transition from command economy to market economy. As institutional reform deepens, Region 1 will become a market economy first while Region 2 will remain a command economy. Therefore, whether there is industrial agglomeration in the pre-opening large economy or not, after opening, difference in foreign trade cost between the coastal and inland regions either sways the center of gravity of manufacturing industries toward the coastal region or has the trend of agglomeration strengthened/reinforced owing to the effect of path-dependence—if such an agglomeration has been started in the coastal region already.

3.3 Phase Ⅲ: Toward Full Integration with the World

In Phase Ⅲ, the economy initiates a process of complete integration with the world, to which China′s accession into WTO is analogous. In this phase, not only the level of tariff rate approaches zero (τ decreases from τ_1 to τ_2 and approaches 1), what is more important is that full integration requires that domestic institutional reform go further in depth. With Region 2 catching up with Region 1 by getting rid of out-dated practices in

① The assumption is made merely for facilitating the comparison between G_1, G_2, n_1, n_2, λ_1 and λ_2 at any point of time during the period of market penetration.

administering macro-economy, domestic trade cost $T(t)$ decreases sharply with the land-sliding fall in institutional cost. The dynamics of flow of investment and firms with the change of both domestic and foreign trade cost can be described by equations (25)–(28):

$$G_1(t)^{1-\sigma}=n_1(t)[w_1(t)^{1-\sigma}G_1(t)^{\alpha}]^{1-\sigma}+n_2(t)[w_2(t)^{1-\sigma}G_2(t)^{\alpha}T(t)]^{1-\sigma}+2n_C w_C^{1-\alpha}G_C^{\alpha}T_{1C}^{1-\sigma}[e^{-\delta/t}(\tau_2-\tau_1)+\tau_1]^{1-\sigma} \quad (25)$$

$$G_2(t)^{1-\sigma}=n_1(t)[w_1(t)^{1-\sigma}G_1(t)^{\alpha}T(t)]^{1-\sigma}+n_2(t)[w_2(t)^{1-\sigma}G_2(t)^{\alpha}]^{1-\sigma}+2n_C w_C^{1-\alpha}G_C^{\alpha}T_{2C}^{1-\sigma}[e^{-\delta/t}(\tau_2-\tau_1)+\tau_1]^{1-\sigma} \quad (26)$$

$$[w_1(t)^{1-\alpha}G_1^{\alpha})^{\sigma}/(1-\alpha)=E_1(t)G_1(t)^{\sigma-1}+E_2(t)G_2(t)^{\sigma-1}T(t)^{1-\sigma}+2E_C G^{\sigma-1}T_{1C}^{1-\sigma}[e^{-\delta/t}(\tau_2-\tau_1)+\tau_1]^{1-\sigma} \quad (27)$$

$$[w_2(t)^{1-\alpha}G_1^{\alpha})^{\sigma}/(1-\alpha)=E_1(t)G_1(t)^{\sigma-1}T(t)^{1-\sigma}+E_2(t)G_2(t)^{\sigma-1}+2E_C G^{\sigma-1}T_{2C}^{1-\sigma}[e^{-\delta/t}(\tau_2-\tau_1)+\tau_1]^{1-\sigma} \quad (28)$$

If the coexistence of manufacturing is still maintained in both Regions at the instant when Country P initiates its process of integration, then integration will pose Region 1 in a more advantageous position than Region 2. As foreign trade cost further falls, Region 1 receives even more varieties of foreign intermediate goods than Region 2. What is more, as there is more inter-industry linkage in region 1, FDI (Foreign Direct Investment) would more willingly choose Region 1 rather than Region 2 as destination. More varieties of intermediates and more FDIs make the price index go down in Region 1 and generate even higher pecuniary externality for Region 1 than for Region 2.

The sharp decrease in domestic trade cost creates more serious consequence for Region 2. With domestic trade cost falling sharply, on one hand, firms in Region 1 can supply Region 2 with more varieties of manufactures at substantially lowered prices; on the other hand, potential manufacturing wage rate attained in Region 2 under the supposed condition of forced manufacturing concentration in Region 1 will not be as high as in the case of high domestic trade cost—it may even be less than unity with the wage rate offered to agricultural workers. As a result, firms previously operated in Region 2 lose its competitiveness to their rivals in Region 1. They face two alternatives: to close down or to remove to Region 2. The close-down of the first batch of inefficient firms makes the inter-industry linkage between firms in Region 2 further weaker so that even those efficient firms have to consider removing to Region 1 owing to a lack of support by sufficient number of local firms (or varieties of input). The close-down and removal of firms render a large number of workers in Region 2 unemployed. While the reduced number of firms means fewer varieties of manufactures produced locally and higher price index in Region 2, reduced employment means reduced purchasing power in the local market. Disheartened by both a thin local market and high price index (here local market effect and price index effect work), even more firms will leave Region 2, and more manufacturing workers will be laid off there. Unemployment in the short run turns out a serious challenge for local government.

As firms flow into Region 1, the strong pecuniary externality in it gets more reinforced. This creates a snowballing process in which more and more firms and FDI are attracted into Region 1 and more and more agricultural workers in Region 1 flow into the manufacturing sector. An irreversible industrial agglomeration thus takes place as the advantage in manufacturing of Region 1 is amplified as a result of path-dependence, and manufacturing activities will be locked in Region 1.

If, however, industrious agglomeration in region 1 of Country P has already been under way at the instant when it initiates its process of complete integration, the trend of agglomeration will be further reinforced owing to the effect of path-dependence.

The analysis above shows that the large country′s complete integration with the world economy either leads to industrial agglomeration in its coastal region, or has the trend of agglomeration in the coastal region reinforced—if such an agglomeration has been started in the coastal region already. A core-periphery relationship between the coastal and inland region is the inevitable consequence of economic integration.

4 CONCLUSION AND IMPLICATIONS

The modeling indicates that in the process of integration, as there exists a difference in foreign trade costs between different regions within a large country, either the spatial economy of the country deviates from its symmetric structure in autarky and falls into a core-periphery relationship, or the effect of industrial agglomeration is reinforced, amplified and locked in if the agglomeration had been started. The economic gap of either the aggregate or structural basis between different regions within the large country will increase rapidly as the integration proceeds. A core-periphery relationship between the coastal and inland region is the inevitable consequence of economic integration.

On the basis of the modeling, following implications can be drawn to help us look into the effect of China′s accession into WTO on the future evolution of China′s spatial economy:

(1) As domestic trade cost goes down sharply in Chi-

na with its accession into WTO, a process of large-scale relocation of domestic firms and investment from inland region to coastal region will take place along with the flow of FDI into the coastal region. The center of gravity of manufacturing industries will be further swayed toward the coastal region and a core-periphery relationship between coastal region and inland region will be formed and strengthened.

(2) Agglomeration of manufacturing in the coastal region will lead to quick industrialization of the coastal region first. Employment in the manufacturing sector in the coastal region will go up steadily.

(3) In contrast, the close-down or removal of firms in inland region owing to both price index effect and local market effect gives rise to widespread unemployment in the region. To fight unemployment and create jobs for the unemployed will remain a serious issue to the local government.

REFERENCES

DIXIT A K, STIGLITZ J E, 1977. Monopolistic competition and optimum product diversity [J]. *American Economic Review*, 67: 297–308.

FUJITA Masahisa, 1988. A monopolistic competition model of spatial agglomeration: differentiated products approach [J]. *Regional Science and Urban Economics*, 18: 87–124.

FUJITA M, KRUGMAN P, VENABLES A, 1999. *The Spatial Economy*: *Cities, Regions, and International Trade* [M]. Cambridge: MIT Press.

KRUGMAN Paul, 1991. Increasing returns and economic geography [J]. *Journal of Political Economy*, 99: 483–499.

KRUGMAN P, VENABLES A J, 1995. Globalization and the inequality of nations [J]. *Quarterly Journal of Economics*, 110: 857–880.

PUGA Diego, VENABLES A J, 1996. The spread of industry: spatial agglomeration and economic development [J]. *Journal of the Japanese and International Economies*, 10: 440–464.

VENABLES A J, 1996. Equilibrium locations of vertically linked industries [J]. *International Economic Review*, 37: 341–359.