Scale Economies, Unemployment, and Industry Agglomeration

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Abstract

This paper tries to resolve the paradox raised by Corden and Findlay (1975). In this paper, it is assumed that Manufacture sector has scale economies. Both factor prices and product prices can adjust in a general equilibrium system. In a closed economy, this paper concludes that, with the expansion of capital stock both the unemployment rate and the absolute amount of unemployment will decrease. In an open economy, this paper sets up an asymmetric model, of which only one region has fixed wage rate. It will help us to investigate how the trading cost would affect the unemployment and output of the region, which may give some helpful policy implications.

Key Words: fixed wage rate, unemployment, agglomeration

1. Introduction

Since Harris and Todaro's pioneering article (1970), the phenomenon of unemployment has been a widely discussed topic of the international trade theorists. In this model, rural-urban migration is assumed to take place until there is equality between the actual rural wage and the expected urban wage, which is the actual wage times the probability of being employed. Unemployment is thus consistent with equilibrium in this model. Bhagwati and Srinivasan (1974,1975) and Corden(1974) have re-examined the welfare implication of the H-T model in the light of the theory of distortions and welfare, and Corden and Findlay(1975) have extended the model to allow for intersectoral capital mobility, thus bringing it more closely into the line with the Heckscher-Ohlin-Samuelson model of international trade theory. In this paper, Findlay proposed a paradox: with the increase of exogenous capital stock, the absolute amount of unemployment will increase. This conclusion is quite different from the reality in the developing countries. These countries attract capital to flow in so that it will bring in new firms and thus alleviate the unemployment pressure.

On the other hand, Krugman's seminal paper (1991) sets up a standard new trade model with Dixit and Stiglitz's monopolistic competition (1977) to analyze industrial location. The outcome is the so called core-periphery (CP) model, which shows how economic integration may lead to a dramatic increase in the geographical concentration of industrial production via a self-reinforcing agglomeration process. A recent paper by Forslid and Ottaviano (2003) proposes "Footloose Entrepreneur Model". It is different from Krugman's CP model in that there are two factors in the production of manufactures, and only one of the two is shared with the agriculture sector. This simple modification gives a solvable model while the spirit of new

geography theory is not changed.

The purpose of this working paper is to solve the paradox raised by Corden and Findlay (1975). In this paper, it is assumed that both agriculture and manufacture use factors of capital and labor to produce, which makes it closer to the framework of Heckscher-Ohlin-Samuelson model. Following H-T model, workers in the rural area can only obtain expected wage in the urban area. Capital can move freely between two sectors and also two regions in an open economy. This is the long-run situation in Neary (1981). Capital enters the production function of manufacture in the fixed cost, while labor in the marginal cost. So capital and labor just play the role of skilled labor and unskilled labor respectively in F-E model. Agriculture production is constant to scale, and the price of agriculture good is taken as constant. With these assumptions, this paper joints the unemployment model with the New Geography Model, and gets a general equilibrium. Using numerical method, it is easy to get the result of this general equilibrium. It shows that with the expansion of exogenous capital stock, both the unemployment rate and the absolute amount of unemployment will decline.

The remainder of the paper is organized as follows. Section 2 sets up a H-O framework where the manufacture sector follows the scale economies. Section 3 focuses on a closed economy, and studies the effect of capital expansion on unemployment. Section 4 turns to the open economy, and investigates how the trade liberalization effects unemployment and outcome of manufacture. A final section summarizes the main conclusion.

2. The Basic Model

The economy consists of two regions, 1 and 2. Each region has two sectors, agriculture and manufacture. Both the two sectors produce with the input of two factors, capital and labor, which could be moved, although not freely, between the two sectors. Total endowments are K and L for capital and labor respectively, so that $K_1 + K_2 = K$ and $L_1 + L_2 = L$, where K_i and L_i are the endowments of the two factors in region i. In each region, the allocations of capital are K_i^A and K_i^M for agriculture and manufacture sector respectively. The symbol is the same for labor allocation, L_i^A and L_i^M.

The agriculture sector faces a completely competitive market, and the production follows constant return to scale, with the production function as bellow:

$$Q_A = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)} L_A^{\alpha} K_A^{1-\alpha} \qquad (1)$$

In this system, the price of agriculture product is chose to be numeraire 1. Under the maximization choice, the bundle cost of agriculture would become:

$$w_A^{\alpha} \cdot r^{1-\alpha} = 1 \qquad (2)$$

Firms in sector manufacture are monopolistically competitive and employ both capital and labor under increasing returns to scale. Product differentiation ensures a one-to-one relation between firms and varieties. But different from Krugman's CP model, the fixed cost only employs α units of capital, and a marginal input requires βx units of labor. The total cost of production of a firm, in region I, is thus given by:

$$TC_i = r \cdot f + w_i^M \cdot f \cdot x_i \qquad (3)$$

On the demand side, preferences are defined over two final goods, a horizonally differentiated good C_M (manufactures) and a homogenous good C_A (agriculture):

$$U = C_M^{\mu} \cdot C_A^{1-\mu} \qquad (4)$$

Given equation (4), manufactures and agricultures will receive a share of μ and $1-\mu$ of the expenditure respectively. The manufactures aggregate C_M is defined by

$$C_M = \left[\sum_{s=1}^{N} c_s^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)} \qquad (5)$$

where N is the total number of varieties, which consists of products from the two regions 1 and 2 so that $N = n_1 + n_2$. $\sigma > 1$ is the elasticity of substitution among the products.. Maximization of (4)yields CES demand by residents in region I for a variety produced in location j:

$$C_{ji}(s) = \frac{p_{ji}(s)}{P_i^{1-\sigma}} \cdot \mu Y_i, i, j = \{1, 2\} \qquad (6)$$

where p_{ji} is the price faced by a consumer in region i for the product in region j. P_i is the local CES price index:

$$P_i = \left[\sum_{s=1}^{n_1} p_{ii}(s)^{1-\sigma} + \sum_{s=1}^{n_2} p_{ji}(s)^{1-\sigma} \right]^{1/(1-\sigma)} \qquad (7)$$

The trading of manufactures bears an iceberg cost, $p_{ji} = \tau \cdot p_{ii}$, where $\tau > 1$ is assumed to be the transportation cost. The trading of agricultures bears no lost in the transportation, so the price must be the same in both the regions.

3. Closed Economy

First, let's focus on a closed economy, which means that the transportation cost is infinite high. So, the equation of (7) would become

$$P_i = \left[\sum_{s=1}^{n_1} p_{ii}(s)^{1-\sigma} \right]^{1/(1-\sigma)} \tag{7'}$$

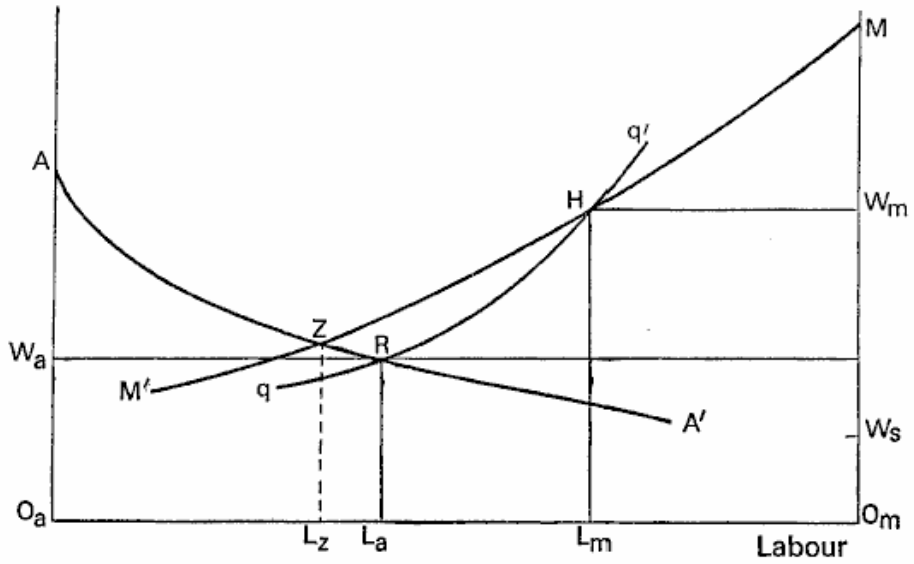

FIGURE 1 Allocation of labour between manufacturing (L_mO_m), agriculture (O_aL_a) and urban unemployment (L_aL_m), with minimum wage W_m and capital stocks specific. qq' is the Harris–Todaro curve.

For some reason, this region has a fixed wage for the manufacture sector, which is higher than the equilibrium wage of agriculture in a labor market. As shown in Figure 1, $\overline{w_M}$ is higher than w_A. Following the H-T model, it is assumed that the agriculture wage equals the expected wage in the urban area.

$$w_A = e \cdot \overline{w_M} \tag{8}$$

where e is the employment rate in the urban area. It is the existence of fixed wage rate that caused the unemployment in the urban area.

A typical firm s will maximize its profits:

$$\prod_s = p_s \cdot x_s - q \cdot \overline{w_M} \cdot x_s - r \cdot f \tag{9}$$

The first order condition for maximization gives

$$p_s = \frac{q\sigma}{\sigma - 1} \cdot \overline{w_M} \tag{10}$$

Arrange units so that $\frac{q\sigma}{\sigma - 1} = 1$. The operating profits of per unit product is $\frac{\overline{w_M}}{\sigma}$. The product market is monopolistically competitive, the free entry of new firm drives the profits of a typical firm zero, so that:

$$r \cdot f = \frac{\overline{w_M}}{\sigma} \cdot x_s \tag{11}$$

Using equation (6),(7'),(10), market clearing for a typical variety produced implies:

$$x_s = \frac{\mu Y}{\overline{w_M} \cdot n} \tag{12}$$

where n is the number of firms in this region, Y is the total income of this region.

For the agriculture sector, it receives constant share of $1 - \mu$ of the total income. With the constant price of 1, the outcome of agriculture is that

$$C_A = (1 - \mu) \cdot Y \tag{13}$$

The equilibrium in the labor market is that:

$$L = L_A + L_M + U$$

$$= C_A \cdot \alpha \cdot (\frac{w_A}{r})^{\alpha - 1} + \frac{q \cdot x_s \cdot n}{e} \tag{14}$$

where the second equations represents the labor in the rural area plus labor in the urban area.

Similarly, the equilibrium in the capital market is that:

$$K = K_A + K_M$$

$$= C_A \cdot (1 - \alpha) \cdot (\frac{w_A}{r})^{\alpha} + n \cdot f \tag{15}$$

The total income in this region is the sum of return from capital and labor force, using equation (14),(8), it is easy to get:

$$Y = r \cdot K + w_A \cdot L_A + w_M \cdot L_M$$

$$= r \cdot K + w_A \cdot L \tag{16}$$

So far, we have got a general equilibrium of this closed economy, with the equations of (2),(11),(12),(13),(14),(15),(16). The system is too complicated to get a expressive solution, rather we will rely on the numerical simulation. As we change the endowments of capital K, we could get table 1 listed below.

K	0.9	1.0	1.1	1.2
e	0.81	0.84	0.866	0.892
w_A	1.216	1.26	1.301	1.339
r	0.676	0.63	0.591	0.426
n	0.72	0.8	0.88	0.96
x	1.351	1.26	1.182	1.116
Y	1.824	1.89	1.951	2.009
L_A	0.2	0.2	0.2	0.2
L_M	0.648	0.672	0.693	0.714
U	0.152	0.128	0.107	0.086
K_A	0.18	0.2	0.22	0.24
K_M	0.72	0.8	0.88	0.96

Table 1

It is clear that as the capital expanses from 0.9 to 1.1, the employment rate increases from 0.81 to 0.892 and the amount of unemployment decreases from 0.152 to 0.086. This result provides a strong evidence that can solve the paradox raised by Corden and Findlay. With the inflow of capital, both the unemployment rate and unemployment quantity decrease.

There are two reasons for the difference from Corden's conclusion. For one thing, this paper focuses on the general equilibrium, while Corden on the partial equilibrium. In the latter's world, the home country is a small country, whose price level is determined by the world market, so the prices of products and factors keep constant. The allocation of resources is totally decided by the most efficient production way. But in this paper, we are talking about a general equilibrium in a closed economy, whose production is not only determined by the supply behalf but also by the demand. As the capital stock expands, the national income increases, this will bring a enhancement of both manufacture and agriculture.

For the second, the scale economies contribute a great part to our conclusion. Even if the prices keep fixed, as assumed in Corden's model, the manufacture will not grab resources from agriculture so much as Corden's model. When new capital enters manufacture sector, it will create many new firms. As shown in equation (12), this will decrease the firm scale, which will decrease the capital return in the manufacture, as shown in equation (11). This decline will baffle the inflow of capital into manufacture sector, and this will explain why the manufacture does not expand so much.

By inspecting the result carefully, we could find an interesting result that is quite out

of our expectation before the simulation. The labor force in the agriculture will remain the same no matter how much capital is introduced. This is the result of the special assumption we made for the manufacture sector. In a closed economy, the scale of a typical firm is determined by the fixed wage rate and the number of the firms, as shown in equation (12). With equations(8),(12),(14), we can get the labor force in the urban area:

$$L_M + U = \frac{f \cdot \mu \cdot Y}{w_A} \tag{17}$$

The fixed wage rate totally disappears! On the other hand, with the equations (2),(14), we can get the labor force in the agriculture or the rural area

$$L_A = \frac{(1-\mu) \cdot \alpha \cdot Y}{w_A} \tag{18}$$

It is easy to see that the equations above share the same term. Because the labor endowment remains unchanged, labor forces in the rural and urban area hold a constant share of the labor endowment and so does the quantity .

Following the same rule, we can find another interesting result of this model. With the equations (11),(12)and (15), the capital used in agriculture is

$$K_A = \frac{(1-\mu) \cdot (1-\alpha) \cdot \sigma}{\mu} \cdot n \cdot f \tag{19}$$

The fixed wage rate also disappears from this equation, and the capital used in manufacture is

$$K_M = n \cdot f \tag{20}$$

The capital used in the manufacture and agriculture is proportional to each other, so that they grab a constant share of the newly introduced capital.

From the equations (17),(18),(19),(20), we get a conclusion that both the shares of labor and capital between the two areas remain constant, it is not influenced by the level of fixed wage rate. But bear in mind, this is the story in a closed economy, where the price index is not affected by the other region. When we turn to an open economy, this result will not hold.

4. Open economy

In this section, the world consists of two regions. One is the country we investigated in the last section, and it is called region 1 where exists fixed wage rate for the manufacture sector. The other region is called foreign region, and it uses the same technology to produce as that of region 1. The only difference between the two regions is that the region 2 does not have fixed wage rate for the manufacture sector, but has completely competitive labor market. The labor can move freely between the two sectors for the same wage rate, ensuring no unemployment. The asymmetric organization will cause some interesting result that is different from the CP model.

It is assumed that capital can move freely between the two regions, but the labor force can not move out of the region. The transportation of manufactures will bear an "iceberg" form cost, ie, after transported to the other region, the goods will melt and only a fraction $\frac{1}{\tau}(\tau > 1)$ of the goods will be left. Transportation of agricultural output will be assumed to be costless, which ensures that the price of agriculture good will be the same in either region. With these assumptions and equation (7),(10), the price indexes of the two regions will become:

$$P_1 = [n_1 \cdot w_M^{1-\sigma} + n_2 \cdot \phi \cdot w_2^{1-\sigma}]^{\frac{1}{1-\sigma}}$$

$$P_2 = [n_1 \cdot \phi \cdot w_M^{1-\sigma} + n_2 \cdot w_2^{1-\sigma}]^{\frac{1}{1-\sigma}} \qquad (21)$$

where $\phi = \tau^{1-\sigma}$,

The total production by a typical firm in location i consists of two parts, the part consumed in home region and the part transported to the foreign region. Similar as equation (12), the output of a typical firm is:

$$x_1 = \frac{w_M^{-\sigma} \cdot \mu \cdot Y_1}{P_1^{1-\sigma}} + \frac{w_M^{-\sigma} \cdot \phi \cdot \mu \cdot Y_2}{P_2^{1-\sigma}}$$

$$x_2 = \frac{w_2^{-\sigma} \cdot \phi \cdot \mu \cdot Y_1}{P_1^{1-\sigma}} + \frac{w_2^{-\sigma} \cdot \mu \cdot Y_2}{P_2^{1-\sigma}} \qquad (22)$$

Similarly, using equations (2),(11),(14),(15),(16), we can get a expression of r, L, K, Y in region 2.

$$w_A^{\alpha} \cdot r^{1-\alpha} = 1$$

$$w_2^{\alpha} \cdot r^{1-\alpha} = 1 \qquad (2')$$

$$r \cdot f = \frac{\overline{w_M}}{\sigma} \cdot x_1$$

$$r \cdot f = \frac{w_2}{\sigma} \cdot x_2 \qquad (11')$$

$$L_1 = L_A + L_M + U$$

$$= Q_A^1 \cdot \alpha \cdot (\frac{w_A}{r})^{\alpha-1} + \frac{q \cdot x_1 \cdot n}{e}$$

$$L_2 = L_A^2 + L_M^2$$

$$= Q_A^2 \cdot \alpha \cdot (\frac{w_2}{r})^{\alpha-1} + q \cdot x_2 \cdot n_2 \qquad (14')$$

$$K_1 = K_A^1 + K_M^1$$

$$= Q_A^1 \cdot (1-\alpha) \cdot (\frac{w_A}{r})^{\alpha} + n_1 \cdot f$$

$$K_2 = K_A^2 + K_M^2$$

$$= Q_A^2 \cdot (1-\alpha) \cdot (\frac{w_2}{r})^{\alpha} + n_2 \cdot f \qquad (15')$$

$$Y_1 = r \cdot K_1 + w_A \cdot L_1$$

$$Y_2 = r \cdot K_2 + w_2 \cdot L_2 \qquad (16')$$

As the agriculture output can be transported without cost, the consumer will be indifferent with the agriculture good produced in either region. The total outcome of agriculture will take a constant share of the two regions national income:

$$Q_A^1 + Q_A^2 = (1-\mu) \cdot (Y_1 + Y_2) \qquad (23)$$

Capital can move freely between the two regions, so that:

$$K_1 + K_2 = K \qquad (24)$$

With equations (21),(22),(2'),(11'),(14'),(15'),(16'),(23),(24), we can get an general equilibrium system. At trading cost $\tau = 2$, the ratio of capital return rate of the two regions is shown in Figure 2.

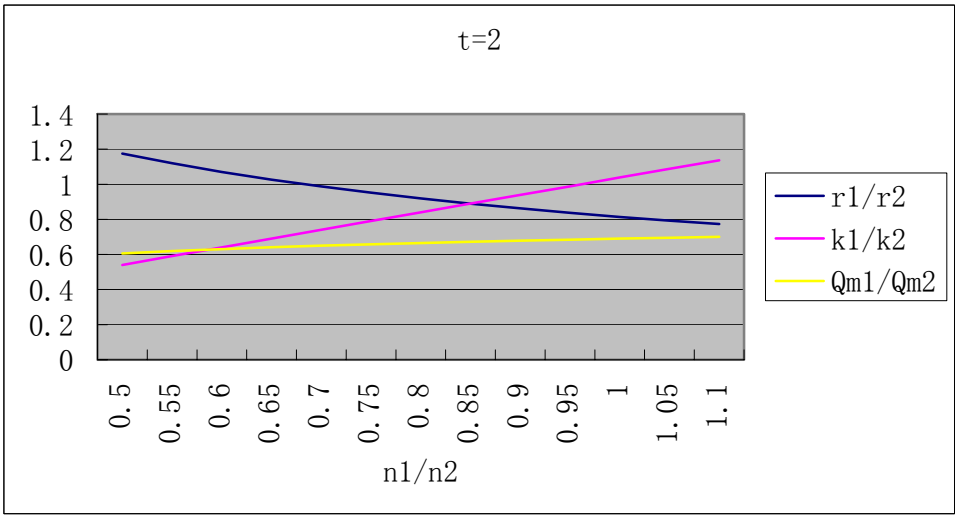

Figure 2

Figure 2 shows that when r1=r2, the equilibrium state, the number of firms in region 1 is much less than that of region 2. Because the only difference of the two regions is that region 1 has fixed wage rate for manufacture, it is obvious such wage institution put one region in a quite inferior position when competed with some other regions.

The main reason for this disadvantage lies in the price of manufactures. As shown in Figure 1, the fixed wage is higher than the equilibrium wage without such institution, so the price is higher than that of the rival's (equation (10)). The high price makes region 1 lose its market to its rivals, and has a smaller outcome for a typical firm. (equation (22)). The more subtle implication can be caught from Figure 2. At the

equilibrium state, region 1's share of manufacture industry is even lower than that of capital. This is the result of "double low" both of its firm number and individual outcome.

Next, we will investigate how the decrease of trading cost would effect the agglomeration trend. Figure 2 shows a stable equilibrium state, as the capital return decreases as new firm is born, which will baffle further inflow of capital. But different from most C-P models, this is a asymmetric model, the different wage institution put the two regions in different positions. As the trading barrier is removed from t=2 to t=1.1, the curve of capital ratio does not reverse its slope, **but shifts down**. It is shown in Figure 3 that, when trading cost is low enough, the capital ratio curve will remain below 1. In this situation, both capital and firms will move out from region 1 to region 2.

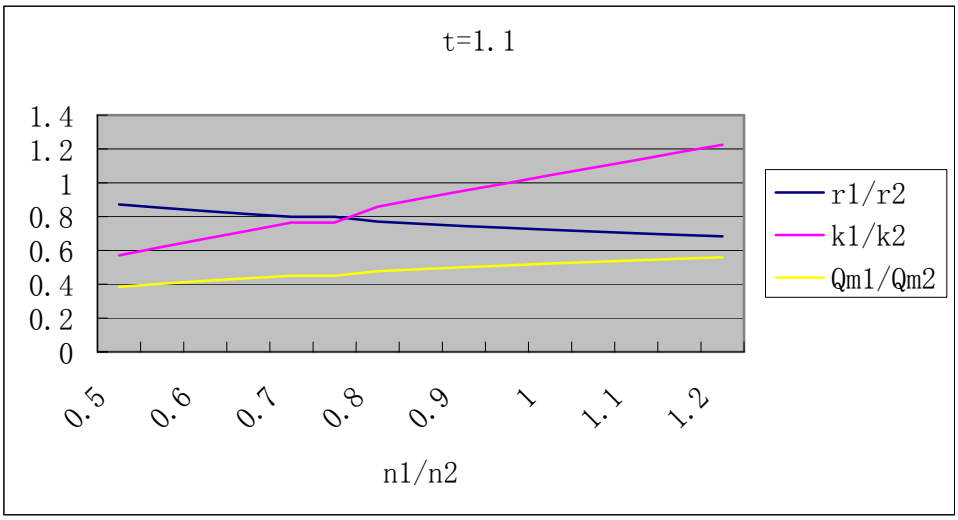

Figure 3

Now, let's turn to the problem we concerned in a closed economy, the unemployment. By numerical methods, we may find that when trading cost decreases from t=2.5 to t=1.5, the employment rate will decrease from 0.913 to 0.903 as shown in Table 2. In this process, capital and firms move out from region 1. But the outcome of agriculture will increase, which corresponds to the phenomenon of "industry ?".

t	1.5	2.0	2.5
e	0.903	0.910	0.913
K	0.809	0.840	0.865
n	0.611	0.649	0.682
Qm	0.906	0.921	0.933
Qa	0.587	0.541	0.500
Y	2.775	2.687	2.612

Table 2

This result gives some policy implications. The country with fixed wage institution will definitely be damaged from the process of trade liberalization, not only the capital will move out from the country, but also unemployment rate will increase. This provides some reason for the policy makers in such region to resist trade liberalization.

But obviously, the best method to get out of such predicament is not the passive measure, like tariff protection, but to transform the unreasonable wage institution, which deprives its equal position in trading process.

5. Conclusion

This paper tries to resolve the paradox raised by Corden and Findlay. By introducing the H-O framework into Forslid's "Footloose entrepreneur model", a kind of the New Geography theory, this paper successfully gets a conclusion: with the expansion of capital, the unemployment rate and the absolute amount of unemployment will both decrease. This result matches the reality of the developing countries very well. The main difference of this model from Corden's is the scale economies of manufacture sector, which restrict the industry from grabbing so much resource from agriculture sector. The special assumption of production function also derives interesting result. In a closed economy, manufacture and agriculture will get constant share of both labor force and capital stock.

In an open economy, this paper sets up an asymmetric model, in which only one region has fixed wage rate. This model will help us scrutinize how this wage institution would affect one region's economy when trading with neighbor region. The numerical simulation gives some hint about this effect. The fixed wage rate institution will put the region in an inferior position. With the decrease of trading cost, the region loses capital and firms to the neighbor regions, and it will also have high unemployment rate. But the best to avoid such phenomenon is not to impede trade, but reform its unreasonable wage institution.

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