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Wage Subsidy and Sector-Specific Unemployment: A New Economic Geography Approach

Yenhuang Chen
Chinese Culture University

Lihong Zhao
China HuanQiu Contracting & Engineering Corporation

Abstract

This paper uses a new economic geography approach to examine the effects of wage subsidy, which is undertake to bolster up the industrial development. This paper also highlights the effects of trade liberalization and international capital mobility. In particular, sector-specific unemployment is introduced in the monopolistically competitive sector of the home country.

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1. Introduction

Many empirical surveys reveal that a large share of international trade has taken place between similar countries.[1] Actually, there is evidence that intra-industry trade occurs not only in industrial countries but also in developing countries.[2] There has been a proliferation of studies in the field of international trade under the context of inter-industry trade, but intra-industry trade has received less attention until recent decades. Comparative advantage, based on which the inter-industry trade emerges, is not powerful enough to explain the trade between similar countries. It is the concept of economies of scale that is used to explain this sort of trade.

Monopolistic competition à la Dixit and Stiglitz (1977) incorporates important features, such as product variety, consumer preference and market entry. Economists extensively employ the monopolistically competitive approach to establish an intra-industry trade model. Krugman's (1980) model of intra-industry trade integrates production differentiation, economies of scale and imperfect competition. Now, this model has developed into the theory of "New Economic Geography" (hereafter NEG) to analyze industrial location. NEG mainly investigates the endogenous emergence of industrial agglomeration by incorporating monopolistic competition, economies of scale and iceberg transport costs.

Krugman (1991) proves that firms and workers tend to agglomerate together, primarily because of the impact of increasing returns and transport costs upon labor migration. Involving two vertically linked industries, both of which are imperfectly competitive, Venables (1996) shows that linkages between upstream and downstream can be equally effective with labor migration in endogenously determining equilibrium locations. On the basis of a similar method, Krugman and Venables (1995) address the relationship among globalization, agglomeration and international inequalities, while Forslid and Midelfart (2005) explore industrial policy implications. These papers rely on the sharp assumption that labor is the single primary factor for production. Aiming to explore the crucial role of capital on trade liberalization, this paper develops a more general framework, where both capital and labor serve as primary factors for production.[3]

Ever since the influential papers by Krugman (1980 and 1991), NEG has attracted a great deal of attention in the literature, which is evidenced by the launch of the *Journal of Economic Geography* in 2001. Currently, applications of the theory of NEG have been popularized to the fields of international trade, regional economics, economic growth, and/or economic integration.

In the real world, because of the uneven development between the urban and the rural, the phenomenon of unemployment is inevitable. On the other hand, due to some politically related reasons or the bargaining power of unions, the minimum wage is widely witnessed in the urban areas of many countries. Harris and Todaro (1970) analyze the formation of urban unemployment which is caused by institutionally fixed

[1] See, for example, Greenaway and Milner (1986), Helpman (1987) and Krugman and Obstfeld (2003).

[2] See, for example, Tharakan (1984).

[3] The large bulk of one-country general-equilibrium models utilize both capital and labor as primary factors for production. However, the introduction of capital into NEG model is still relatively scarce.

urban minimum wage, paving the way for a series of subsequent discussion. To our limited knowledge, there have been no attempts to analyze the unemployment issue in the NEG framework, which motivates us to fill this gap.

Besides this novel contribution, the present paper also introduces wage subsidy into the economy and investigates its effects. Wage subsidy is usually described as a prescribing policy sufficing to mitigate the negative effects of labor market distortion. As noted in Husby (1993), "an alternative policy that combines a minimum wage and a wage subsidy is superior to either by itself. Such a combination can assist the low wage worker, avoid disemployment effects, and maximize market efficiency (p. 30)". According to the conclusion by Husby (1993), this paper implements wage subsidy in the urban area rather than rural area, since the minimum wage only prevails in the urban area.

The remainder of this paper is organized as follows. Section 2 formulates a NEG model. In particular, sector-specific unemployment and wage subsidy are simultaneously introduced in the monopolistically competitive sector of the home country. Section 3 conducts numerical simulation for analysis. Conclusions are drawn in Section 4.

2. The Model

Suppose that the world is composed of two countries: the home (indexed by 1) and the foreign (indexed by 2). The consumers in each country consume a group of differentiated manufactured goods and a homogeneous agricultural good. The manufactured goods are produced by a monopolistically competitive sector (indexed by *X*) with increasing-returns-to-scale technology, and the agricultural good is produced by a perfectly competitive sector (indexed by *Y*) with constant-returns-to-scale technology. Sectors *X* and *Y* are assumed to be urban manufacturing and rural agriculture, respectively. Following Krugman (1980 and 1991), the agricultural good can be traded costlessly between countries in order to simplify the model. However, the trade of manufactured goods is subject to transport costs, which take the "iceberg" form. More precisely, if one unit of manufactured goods is traded from one country to another, only $1/t$ $(t>1)$ unit will arrive.

The utility functions of all consumers are assumed to be identical. We adopt simple Cobb-Douglas preferences:

$$U = D^{\delta} Y^{1-\delta}, \tag{1}$$

where D and Y are the consumption of the composite manufactured good and of the agricultural good, and $\delta \in [0,1]$ is the income share on the composite manufactured good. As in Dixit and Stigltiz (1977), the consumption of the composite manufactured good is defined as:

$$D = \left[\sum\nolimits_h x_h^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}, \tag{2}$$

where x_h is the consumption of variety h and $\sigma>1$ is the elasticity of substitution between each pair of differentiated manufactured goods.

The price index of the composite manufactured good in country i is denoted by q_i:

$$q_i = \left[n_i p_i^{1-\sigma} + n_j (tp_j)^{1-\sigma} \right]^{1/(1-\sigma)}, \quad i, j = 1,2, \ \ i \neq j, \tag{3}$$

where p_i is the price of manufactured goods produced in country i,[4] and n_i is the number of varieties of in country i. It is noteworthy that, in equilibrium, each monopolistically competitive firm in the urban area produces a single variety of n_i differentiated manufactured goods

Let w_{Xi}, w_{Yi} and r_i be the urban wage, the rural wage and the capital rental in country i, respectively. In the home country, sector-specific unemployment is introduced into the manufacturing sector by assuming that the urban wage is rigidly set above the market-clearing level. Therefore, labor will migrate from the rural area into the urban area until the rural wage rate equals the expected urban wage rate:

$$ew_{X1} = w_{Y1}, \tag{4}$$

where

$$e = L_{X1} / (L_{X1} + U) \tag{5}$$

is the urban employment rate, and U and L_{X1} are the unemployed and employed labor in the urban area, respectively. The rural wage rate is flexible, so no unemployment occurs in the agricultural sector. In the foreign country, we assume that both urban and rural wage rates are flexible, ruling out the possibility of unemployment and leading to the same level of urban and rural wage rates, i.e., $w_{X2} = w_{Y2} \equiv w_2$.

In the production side, the production of both sectors utilizes labor and capital. Perfect competition and costless trade are assumed in the agricultural sector, so that in both countries marginal cost functions equal the world price of the agriculture good:

$$g^1(w_{Y1}, r_1) = 1, \ \ g^2(w_2, r_2) = 1, \tag{6}$$

where the agricultural good is chosen as the *numéraire* and g^i is the marginal cost function of the agricultural sector in country i.

The domestic government undertakes a specific wage subsidy in the manufacturing sector, and thus the domestic manufacturing firm will act as if the labor cost is $w_{X1}(1-s)$, where s is the subsidy rate, instead of w_{X1}. Then we can define the marginal cost of each manufacturing firm in the home country as $m^1(w_{X1}(1-s), r_1)$. Write it as $m^1(w_{X1}, r_1, s)$ in order to simplify the exposition. No subsidy is offered in the foreign country, therefore the marginal cost of each manufacturing firm in the foreign country appears as $m^2(w_2, r_2)$.

Each manufacturing firm seeks profit maximization by choosing its price. We focus on symmetric equilibria, i.e., each firm adopts the same technology to produce. The cost function for a representative firm can be expressed as $(F + x_i)m^i$, where Fm^i is the fixed cost. Considering the preference à la Dixit and Stiglitz (1977), the representative firm seeks profit maximization according to the equality between marginal revenue and marginal cost:

[4] Under symmetric assumption, all manufacturing firms (in the same country) will charge the same price in equilibrium.

$$p_i(1-1/\sigma) = m^i, \tag{7}$$

where σ is the elasticity of demand. This equation implies that in equilibrium, the price of manufactured goods is a mark-up over the marginal cost. Under monopolistic competition, free entry eliminates the profit of each firm:

$$p_i x_i = (F + x_i)m^i, \tag{8}$$

where x_i is the output level of each manufacturing firm in country i.[5] Viewing equations (7) and (8) and choosing F=1/(σ−1), these give that x_i=1.

Due to zero-profit condition, the equilibrium output level of each manufacturing firm must satisfy:

$$x_i = 1 = p_i^{-\sigma} q_i^{\sigma-1} \delta I_i + p_i^{-\sigma} t^{1-\sigma} q_j^{\sigma-1} \delta I_j, \tag{9}$$

where I_i is the national income in country i. Note that the first term on the right side is country i's demand for a variety of manufactured good produced in country i, while the second term is country j's demand for the variety of manufactured good produced in country i.[6]

The national income in country i is defined as:[7]

$$I_i = w_{Xi} L_{Xi} + w_{Yi} L_{Yi} + r_i K_i = w_{Yi} L_i + r_i K_i, \tag{10}$$

where L_i and K_i are the labor and capital endowments in country i, respectively.

Factor markets' clearing requires that, in equilibrium, the supply of both factors is equal to the demand. Using Shephard's Lemma, we can obtain the following factor market equilibrium conditions:

$$Y_i g_w^i + n_i(x_i + F)m_w^i + U = L_i, \tag{11}$$

$$Y_i g_r^i + n_i(x_i + F)m_r^i = K_i, \tag{12}$$

where the subscripts of marginal cost functions denote partial derivative.

In sum, the general equilibrium is specified by equations (3), (4), (5), (6), (7), (9), (10), (11) and (12), which can be solved for Y_i, I_i, n_i, w_{Y1}, w_2, r_i, e, U, p_i and q_i. The parameters of the model are L_i, K_i, w_{X1}, σ and δ, which are exogenously given.

3. Numerical Simulation

Since this model is too complicated to solve analytically, we in this section assign key values to parameters and specify specific technologies to conduct numerical simulation as usual in such models.[8] Suppose that the marginal cost functions of the agricultural sector and of the manufacturing sector in both countries are:

[5] Under symmetric assumption, all manufacturing firms (in the same country) will have the same output level in equilibrium.

[6] Detailed derivations of the demand functions see Fujita et al. (1999).

[7] In the home country, $L_1=L_{X1}+L_{Y1}+U$. Taking into account the definition of e yields $I_1=w_{Y1}L_1+r_1K_1$.

[8] See, for example, Krugman and Venables (1995) and Fujita et al. (1999).

$$g^1(w_{Y1}, r_1) = w_{Y1}^{\alpha} r_1^{1-\alpha}, \quad g^2(w_2, r_2) = w_2^{\alpha} r_2^{1-\alpha};$$

$$m^1(w_{X1}, r_1, s) = [w_{X1}(1-s)]^{\beta} r_1^{1-\beta}, \quad m^2(w_2, r_2) = w_2^{\beta} r_2^{1-\beta}.$$

Meanwhile, we assign these values to the exogenous parameters:[9]

$$\delta = 0.5, \ w_{X1} = 1.5, \ \sigma = 5, \ \alpha = 2/3, \ \beta = 1/3, \ L_1 = L_2 = K_1 = K_2 = 100.$$

The objective of this section is not to calculate the estimate of the effects of wage subsidy, since it goes beyond the scope of this paper. Rather, the objective is to explore the direction of the change in each variable and to see the likely size of these effects.

In what follows, we assume that labor is always specific to each country but mobile between sectors within each country. Our analysis begins with the scenario in which capital is also specific to each country, but it is mobile between sectors within each country. Later, we will relax the constraint on international capital mobility. Suppose that the domestic wage subsidy is set at s=0.2. Table 1 summarizes the simulation result of the effects of trade liberalization.[10]

Table 1. Effects of trade liberalization when capital is specific to each country and s=0.2

	t=2.5	t=2.0	t=1.5
e	0.680	0.682	0.686
U	12.809	12.567	11.994
n_1	76.203	75.235	73.561
n_2	80.314	81.389	83.219
p_1	1.294	1.289	1.280
p_2	1.251	1.255	1.263
Y_1	91.297	92.813	95.415
Y_2	99.608	98.260	95.956
w_{Y1}	1.020	1.023	1.028
w_2	0.998	0.996	0.990

We can see from each column in Table 1 that the price of manufactured goods in the home country is higher than that in the foreign country ($p_1 > p_2$). The reason is that the minimum wage in the urban area of home country makes the production cost of manufactured goods in the home country higher. Table 1 also shows that the varieties of manufactured goods in the home country are less than those in the foreign country ($n_1 < n_2$), as a result, intra-industry occurs and the home (foreign) country is a net importer (exporter). Moreover, the foreign labor receives a lower wage than the domestic labor ($w_2 < w_{Y1} < w_{X1}$), and the foreign country tends to produce more agricultural good ($Y_2 > Y_1$). As long as the minimum urban wage is higher than the domestic rural wage, urban unemployment prevails in the home country.

The trend of trade liberalization has totally different results across countries. Initially (the case of $t = 2.5$), the foreign country produces more varieties of

[9] The condition that $\alpha > \beta$ implies that manufactured goods are relatively capital intensive.

[10] Throughout this paper, we use the term "trade liberalization" sorely in the sense of a decrease in transport costs.

manufactured goods than does the home country ($n_1 < n_2$). Owning to increasing-returns-to-scale technology adopted in the production of manufactured goods, trade liberalization attracts the domestic manufacturing to the foreign country and widens the difference in the variety. This phenomenon is so-called "deindustrialization". Let the difference between n_1 and n_2 represent the volume of intra-industry trade. The simulation result shows that the volume of intra-industry trade increases with the trend of trade liberalization. For the foreign country, the variety expansion constitutes an element of gains from intra-industry trade.

On the other hand, trade liberalization will generate resource re-allocation. In this model, the demand for capital in the manufacturing sector decreases (increases) in the home (foreign) country, leading to an expansion (a constriction) in the supply of capital in the agricultural sector in the home (foreign) country since capital is immobile between countries. These results increase the domestic rural wage, which will attract some of the unemployed labor to the rural area, and thus the level of employed labor and employment rate change in the same direction as the domestic rural wage. In the meanwhile, these results decrease the foreign wage, and thus increase (decrease) the output level of agricultural good in the home (foreign) country. In sum, we can obtain the following lemma.

Lemma 1. *When capital is specific to each country, the trend of trade liberalization has totally different results across countries. It leads to a decrease* (*an increase*) *in the price of manufactured goods in the home* (*foreign*) *country, a decrease* (*an increase*) *in the varieties of manufactured goods produced in the home* (*foreign*) *country, and an increase* (*a decrease*) *in the output level of agricultural good in the home* (*foreign*) *country. These results positively impact upon the rural wage, the level of employed labor and employment rate in the home country but negatively impact upon the wage in the foreign country.*

Another issue we concern about is the effects of wage subsidy. Suppose that the transport costs are fixed at t=1.5. Table 2 summarizes the simulation result.

Table 2. Effects of wage subsidy when capital is specific to each country and t=1.5

	s=0.2	s=0.4	s=0.5
e	0.686	0.685	0.690
U	11.994	19.040	24.974
n_1	73.561	95.892	115.169
n_2	83.219	70.610	60.248
p_1	1.280	1.165	1.085
p_2	1.263	1.214	1.176
Y_1	95.415	61.050	30.239
Y_2	95.956	111.568	123.951
w_{Y1}	1.028	1.027	1.035
w_2	0.990	1.030	1.063

Initially (the case of s=0.2), the foreign country produces more varieties of manufactured goods than does the home country ($n_1 < n_2$), and the home (foreign) country is a net importer (exporter). However in the cases of s=0.4 and s=0.5, that

will be reversed ($n_1 > n_2$) and the home (foreign) country becomes the net exporter (importer). The volume of intra-industry trade is always increasing.

Wage subsidy exerts a cost-reducing effect from the point view of manufacturing firms, therefore the price of manufactured goods in the home country decreases with the increase in wage subsidy and thus the production of domestic manufacturing is promoted at the expense of foreign manufacturing. The home country demands more manufactured goods but less agricultural good, so the production of foreign agriculture is promoted at the expense of domestic agriculture. Therefore, balance of trade can be maintained. These results increase the foreign wage. In the home country, theses results make the urban area more attractive and induce some of the agricultural labor to migrate to the urban area where they may be employed. It will negatively impact upon the level of employed labor in the home country. The change in domestic rural wage depends on the degree of wage subsidy, so does the urban employment rate. In sum, we can obtain the following lemma.

Lemma 2. *When capital is specific to each country, an increase in the wage subsidy leads to a decrease in the price of manufactured goods in both countries, an increase* (*a decrease*) *in the varieties of manufactured goods in the home* (*foreign*) *country, and a decrease* (*an increase*) *in the output level of agricultural good in the home* (*foreign*) *country. These results negatively impact upon the level of employed labor in the urban area in the home country but positively impact upon the wage in the foreign country.*

In order to identify the features of international capital mobility, we next analyze the other scenario, in which no constraint on capital mobility is placed, i.e., capital is mobile both between sectors and countries. In equilibrium, both countries have the same capital rental. Tables 3 and 4 summarize the simulation results of the effects of trade liberalization when the wage subsidy is set at s=0.2, and the effects of wage subsidy when transport costs are set at t=1.5, respectively.

Table 3. Effects of trade liberalization when capital is mobile internationally and s=0.2

	t=2.5	t=2.0	t=1.5
e	0.673	0.672	0.671
U	12.976	12.447	9.215
n_1	73.129	70.206	51.333
n_2	83.250	86.308	106.075
p_1	1.313	1.313	1.317
p_2	1.239	1.239	1.242
Y_1	91.352	93.668	108.684
Y_2	99.776	97.809	85.063
w_{Y1}	1.009	1.009	1.006
w_2	0.673	0.672	0.671

Compared with Table 1, we find that similar effects exist between with and without international capital mobility in the employed level of the home country, the varieties of manufactured goods in both countries and the output levels of agricultural good in both countries. In addition, we can demonstrate that international capital mobility enhances the effects of trade liberalization upon these variables. However, when

transport costs are not that high, different effects exist in the urban employment rate, the price of manufactured goods and the rural wage in the home country.

When capital is allowed to be mobile internationally, the scale of domestic (foreign) manufacturing is less (larger) than that without international capital mobility. It indicates that the capital removes from the home country to the foreign country, which in turn makes the scale of domestic (foreign) manufacturing shrink (expand). When transport costs are not that high, the scale of domestic (foreign) manufacturing shrinks (expands) quickly with the trend of trade liberalization. Therefore, we can argue that international capital mobility accelerates the deindustrialization of the home country. Moreover, in view of the increasing-returns-to-scale technology in the production of manufactured goods of both countries, the price of manufactured goods in the home (foreign) country is higher (lower) than that without international capital mobility.

Table 4. Effects of wage subsidy when capital is mobile internationally and t=1.5

	s=0.2	s=0.4	s=0.5
e	0.671	0.686	0.706
U	9.215	19.213	27.662
n_1	51.333	97.452	141.685
n_2	106.075	69.227	38.889
p_1	1.317	1.162	1.053
p_2	1.242	1.215	1.181
Y_1	108.684	59.940	9.582
Y_2	85.063	112.256	135.7891
w_{Y1}	1.006	1.029	1.058
w_2	0.671	0.686	0.706

In contrast with Table 2, an increase in wage subsidy unambiguously increases the rural wage and urban employment rate in the home country. Nonetheless, similar effects exist between with and without international capital mobility upon other variables.

Compared with Table 2, international capital mobility enhances the effects of wage subsidy. When capital is allowed to be mobile internationally, the scale of domestic (foreign) manufacturing expands (shrinks) much more quickly than that without international capital mobility, suggesting that the capital removes from the foreign country to the home country. Similarly, the scale of domestic (foreign) agriculture shrinks (expands) much more quickly than that without international capital mobility. Therefore, if the rate of wage subsidy continues to increase, the home country will become a manufacturing “core” but an agricultural “periphery”, while the foreign country will become an agricultural “core” but a manufacturing “periphery”. The simulation result shows that such a rate of wage subsidy that industrial agglomeration occurs lies between 0.51 and 0.52.

Therefore, we can obtain the following proposition.

Proposition 1. *No matter whether the wage subsidy or the trend of trade liberalization works, international capital mobility accelerates the deindustrialization of the home country.*

4. Conclusions

This paper sets up a NEG model with sector-specific unemployment to examine the effects of wage subsidy and trade liberalization. There are two alternative scenarios: first, capital is specific to each country and second, capital is mobile internationally.

When capital is specific to each country, it is shown that trade liberalization attracts the domestic manufacturing to the foreign country, resulting in positive effect upon employment but deindustrialization. Furthermore, wage subsidy promotes the production of domestic manufacturing at the expense of foreign manufacturing.

When capital is mobile internationally, the direction of capital mobility is completely different with respect to which element works. However, no matter whether the wage subsidy or the trend of trade liberalization works, international capital mobility accelerates the deindustrialization of the home country.

These conclusions are of particular interest to the policy makers in developing countries.

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