KIER DISCUSSION PAPER SERIES

KYOTO INSTITUTE
OF
ECONOMIC RESEARCH

Discussion Paper No. 675

"Agglomeration and wage bargaining"

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June 2009

KYOTO UNIVERSITY

KYOTO, JAPAN

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June, 2009

Abstract

This paper examines the role of trade union and the type of wage bargainings in economic geography model. It is shown that stronger trade unions in both regions would put a stronger pressure toward agglomeration of firms. Under core-periphery distribution of firms, this effect can act the role as anchorage of firms. Moreover, we extend to several employment environments, which are the outside options of workers, and examine the effects on location equilibria. A key message of the paper is that generous unemployment benefit and stronger trade union make the distribution of firms more uneven and sustainable.

JEL Classification : F15, F16, J50, R12, R38

Keywords : Labour market rigidity, Regional Unemployment, Location of firms, Anchorage effect of trade union

*The author is very grateful for Carl Gaigne, Tomoya Mori, Dominique Peeters, Yasuhiro Sato, Stephane Riou, Jacque Thisse and Hylke Vandenbussche. The participants at the workshop of "Economie et Espace" are greatly appreciated for their comments. He also thanks le Commissariat général aux Relations internationales de la Communauté française Wallonie-Bruxelles de la Région Wallonne for their financial support and CORE, Université Catholique de Louvain, Belgium in 2008 for their research support, where most parts of this paper were conducted. The usual disclaimer applies.

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1 Introduction

Previous empirical studies confirm that inward FDI is sensitive to the labour market flexibility. Higher employment protection reduces FDI. Dewit, Gorg and Montagna (2009) is an exceptional empirical analysis in the literature on FDI and labour market flexibility which shows the anchorage effect of employment protection legislation on location decisions of firms. Using FDI stocks, labour market flexibility, GDP of home and host country, and union density of OECD countries data, Dewit et al. (2009) show that *domestic levels of employment protection discourage outward FDI, anchorage effect*. They conclude that *"Given that employment protection can help to anchor domestic industry by discouraging relocation, industrialized countries with a large industrial base will be able to sustain high levels of firing costs"* and "*Developing countries with a small industrial base may instead have an incentive to pursue flexible labour market policies*". Moreover, Their results also indicate that union density is negatively significant and affects the location decision of FDI as the employment protections legislation does. Thus these effects coming from labour market rigidities could retain the domestic capitals soaking from the home country. In this paper, we construct a model which would explain these phenomena with trade union wage bargaining and show the several effects analytically with location choice by firms.

On the one hand, not only high employment protection and strong trade unions but also dispersion of regional unemployment rate is widely observed in European countries. These employment environments are discussed as regional characteristics and the determinants of location decision of firms. However, these environments, themselves, are results and are determined by location decision of firms. This causality might be important to consider regional labour market rigidity.

Most of the analyses on diverse unemployment are taken in a national perspective. Blanchard and Wolfers (2000) explain the dispersed unemployment rates across nations from the role of institution, and of shock and both of them. They show while the role of institutions in labour market itself partially explains the heterogeneity in unemployment rate, when both are included, they and their interactions explains much better. Although their analysis is nation level in Europe, they show that the response to the shock and the magnitude of the shock is different with countries and not only the institution but also country-specific characteristics play an important role. However, as Elhorst (2003) points out, there is a lack of studies on unemployment in regional level. Overman and Puga (2002) is one of the exception. After controlling several regional characteristics which may explain similarities among neighbouring regions, they show that there are still significant tendencies of clustering regions which have high (low) unemployment rate and high (low) per capita and the uneven distribution of regional unemployment rate and income disparities. They stress

that the polarization has been demand rather than supply driven, that the polarized regions are not constrained with national borders, and that the disparities has hysteresis with transition matrix. European countries have promoted its integration to an unified market and, at the same time, and have experienced integration of world economy. These phenomena are explained by tremendous reduction of trade costs. Along with these phenomena, the rapid developments in transport technology accelerate regional disparities in income and unemployment environment within and between countries, which leads to the economic integration among regions. These economic integrations induce more competition in the product market and relocation of firms and plants. In the previous literature, European low mobility is stressed and modeled based on this. Decressin and Fatas (1995) show regional unemployment variation in Europe with comparing that in United States by Blanchard and Katz (1992)[1]. They show that large portion of employment shocks are region and not country-specific in Europe and that interregional migration even within countries in response to shocks is not substantial. Following their analysis, several empirical studies confirm European low mobility. Furthermore, most of the theories follow their result and note that European workers are immobile across countries and even regions. For example, referring to Decressin and Fatas (1995), and the others, Picard and Toulemonde (2006) construct a two-region model with capital mobility and immobile workers with trade unions. They show that the premium wage set by trade union can act as an agglomeration force of firms and this induces polarization of firms and disparities of regional incomes. While Decressin and Fatas (1995) use European data from 1970's to 1980's, Tani (2003) deal with that from 1988 to 1997 and show that the mobility of Europeans is improved. Since the higher mobility in goods and workers is one of the original purpose of European Union, higher mobility in workers need to be investigated. There might be sufficient institutional differences between new members and former members, which can be mentioned as transition. Overman and Puga (2002) uses neighbouring regional data of NUTS 2 in former member states from 1986 to 1996. Thus their analysis avoids the effect of new members in transition. Focusing on transitional economies, in particular on Central and Eastern Europe, Ferragina and Pastore (2008) surveyed the literature and analyzed the source of regional unemployment differentials based on optimal speed of transition model. As long as we consider symmetric two regions, it might be reasonable to focus on the scope of our analysis within 15 member states with similar population. However, still we could introduce institutional asymmetries in this setup. When we include new member states in our analysis, it should be asymmetric productivities with different institutions[2]. Overman and Puga

[1]They conducted regional unemployment rate in U.S. and show the high mobility of workers across states.

[2]The concept of disequilibrium in transition of regional economies provoked by Marston (1985) is surveyed and examined in Ferragina and Pastore (2008).

(2002) set a simple model to describe their results. However, it is not sufficient to understand the dispersion of regional unemployment and polarization in EU. There is one regional unemployment study reasoning the unemployment polarization. Puga (2002) argue this process based on some results of economic geography models. However, it models neither the aspect of institution nor unemployment, explicitly. Our model could provide some explanations for the discussions in Puga (2002).

To delve further on the interactions among agglomeration economies, trade union and unemployment, we construct a simple model of economic geography to shows the polarization process of unemployment and regional income among regions. We explicitly model imperfection in product and labour market. The model employ two region and two goods with entrepreneurs and immobile workers, where increasing returns to scale sector is unionized. We show that presence of trade unions may increase the wage of workers and this wage premium could act as an agglomeration force. Furthermore, we explicitly introduce several environments of unemployment and bargaining and show the effects from these differences. We are also interested in the effect of reduction in transport cost, which describes the economic integration of regions. This paper differs from the existing literature in several ways. First, we do not relay on a partial equilibrium framework but allow for general equilibrium. This is important for the consequences of the outside options in the union bargaining, which are determined in equilibrium. Second, we explicitly integrate the policy variables and allow our analysis to examine the effect of trade liberalization. As pointed out by Munch (2003), the threat point depends on the distribution of economic activities such that the employment opportunities for displaced workers depend on the number of firms locates in their region. Although Picard and Toulemonde (2006) exhibit a model explaining the evidence of agglomeration with unionized economy in EU, the model lacks the explanation of stylized aspects in EU, such as high unemployment rate and generous social security. Third, contrary to the previous studies[3], we assume mobility of entrepreneurs based on the model as in Forslid and Ottaviano (2003) and Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003). This allows us to analyze the bargaining process between mobile entrepreneurs and immobile workers with location choice of firms. This view is consistent with the study by Tani (2003) that European mobility is increasing.

[3]For example, Munch (2003) and Picard and Toulemonde (2006) assume not labour mobility but capital mobility. Thus their analysis explain national perspective rather than regional one.

2 The Model

2.1 Consumers

We consider an economy composed of two regions and two sectors of production, competitive sector (C) and manufacturing sectors (M).

There are two types of factors which are different in their mobility. One is entrepreneurs and the other is workers. While entrepreneurs are mobile across regions, workers are immobile. For simpler notation and calculation, total population of workers and entrepreneurs in this economy are set as 1 by each. We express the equally distributed immobile workers as 1/2.We put λ, $(1-\lambda)$,as the share of entrepreneurs in region r, (s) in this economy.

We assume each region is identical as for the initial endowments, the preference of workers and trade openness. While in $M-$sector, firms are under Dixit-Stiglitz type monopolistic competition and unionized in each firm, homogeneous good is produced under constant-returns technology in C sector. Utility function of worker residing in region r is given by

$$U = \frac{C^{1-\mu} M^{\mu}}{(1-\mu)^{1-\mu}\,\mu^{\mu}} \tag{1}$$

$$M = \left(\int_0^{n_r} m_r(i)^{\frac{\sigma-1}{\sigma}}\, d_i + \int_0^{n_s} m_s(i)^{\frac{\sigma-1}{\sigma}}\, d_i \right)^{\frac{\sigma}{\sigma-1}} \tag{2}$$

where C is the consumption of homogeneous good, and $m_r(i)$ is the consumption of differentiated manufactured good i produced in region r. The total number of firms in manufacturing sector in region r is expressed by n_r and σ express the elasticity of substitution between any two of differentiated varieties. While homogeneous good is shipped with no transport cost, manufactured goods are assumed to incur "iceberg" type transport costs. Thus one unit of each variety of manufactured goods shipped from one region to the other be arrived with the proportion $0 < \varphi < 1$ respectively. From the consumer's utility maximization, we obtain the total sales of each variety produced by a firm, $q(i)$, is as follows:

$$m_r(i) = \mu p_r(i)^{-\sigma} \left(P_r^{\sigma-1} E_r + P_s^{\sigma-1} E_s \phi \right) \tag{3}$$

where $\phi \equiv \varphi^{1-\sigma}$ and $P_r \equiv \left[\int_0^{n_r} p_r(i)^{1-\sigma}\, d_i + \int_0^{n_s} p_s(i)^{1-\sigma}\, d_i \right]^{\frac{1}{1-\sigma}}$ are defined as trade openness and a price index for each differentiated goods, respectively. When we set p_C as the price of competitive good, individual's indirect utility function may be written as,

$$V_r = p_C^{-(1-\mu)} P_r^{-\mu} w_r \tag{4}$$

The share of entrepreneurs in a region equals to the share of firms in the region.

2.2 Producer Behavior

Our model is a standard monopolistic competition with two-country and two sector. As mentioned in the introduction, the main focus of our analysis is the labour market imperfection and wage bargaining. Two sectors are refereed to as unionized (M) manufacturing and competitive (C) sector. There are two production factors, workers and entrepreneurs. The production of C sector is under a constant return technology with only labour input and is traded at no cost. Since there is no transportation cost on this good, regional prices are equal between regions. Thus we normalize the price of competitive good as $p_C = w^T = 1$.

In M sector, we assume each monopolistic competitive firm is unionized. M sector's production requires one unit of workers as marginal cost and one unit of entrepreneurs as fixed cost. This would be the case that an entrepreneur establish one firm which produce $m_r(i)$ unit of a differentiated variety. The profit function can be written as,

$$\pi_r(i) = (p_r(i) - cw_r(i))\, m_r(i) - W_r \tag{5}$$

where w_r, and W_r are worker wage and entrepreneur wage in region r. Profit maximization of a firm in unionized sector is constrained with the bargaining structure. In brief, there are two types of bargaining structures which are well known *"Efficient bargaining "* and *"Right to manage"*. Besides these differences, we specify the environments that express different possibility of outside options in the following section, which is an expected opportunity for a worker who cannot take the job in the firm negotiated. Time sequence of events is that in the first stage firms choose their location and in the second stage firm and union conclude their negotiation. Firms are assumed to know the regional environments on the workers' outside option including possibility of obtaining a job in competitive sector or in manufacturing sector, unemployment benefit, and unemployment rate.

From the assumption of Dixit-Stiglitz type monopolistic competition, each firms are atomistically small to the macroeconomic variables, average wages, distribution of firms, and regional environments. Applying the zero profit condition on (5), the reward to entrepreneur is obtained as,

$$W_r = \left(1 - \frac{w_r(i)}{p_r(i)}\right) \frac{p_r(i)\, m_r(i)}{f} \tag{6}$$

We could see that the entrepreneurs' reward is proportional to their profit. However, depending on the institution, the entrepreneurs' reward can be varied as we will see.

2.3 Bargaining structures

It is our focus how institutional structures including several unemployment environments affect the distribution of firms. Thus we specify bargaining process in two styles: one is *" Efficient bargain-*

ing (E)*"*[4], where bargaining takes place over wage and employment cooperatively, and the other is *" Right to manage* (R)*"*, where bargaining takes place only over wage. Each firm bargain with $l(i)$ workers, which is assumed to be proportional to its output from (5). We assume the bargaining process using the Nash bargaining solution. There are one union in each monopolistic firm. Since firms are assumed to be atomistic, each firm and union set wages, taking the unemployment rate and wages in other firms as given. As in Blanchard and Giavazzi (2003), we posit the bargaining problem for union and a firm in M sector in logarithm as,

$$\mathcal{L} = \beta\Big[\log\left(w_r(i) - z_r\right) l_r(i)\Big] + (1-\beta)\Big[\log\left(p_r(i) - cw_r(i)\right) q_r(i)\Big] \tag{7}$$

where β is the trade union's bargaining power of manufacturing sector and z is the outside option of workers. While trade liberalization and decreasing transport cost may affect this bargaining power negatively, we assume it is unchanged. In both equations, the first term implies the surplus of workers who are members of the trade union and is composed of the premium wage and their fall-back point, outside option. The second term implies a firm's net profit. As for the firm's net profit, second term of the equations in (7) is derived from the difference of profit $\pi_i - \underline{\pi_i}$, where $\underline{\pi_i}$ is a firm's fall-back point and is idle. Fixed cost of manufacturing is assumed to be incurred before the bargaining stage[5]. For the detailed calculation, see in Appendix I.

In *efficient bargaining* allows the union and the firm bargain over wage and employment. So as to maximize Nash solution in (7), the wage and price are determined simultaneously.

$$w_r(i)^E = \left(1 + \frac{\beta}{\sigma - 1}\right) z_r, \quad p_r(i)^E = \left(1 + \frac{1}{\sigma - 1}\right) z_r \tag{8}$$

Since the price is not affected by the presence of trade union as in (8), employment level is also not affected by the bargaining. Thus price and employment level is the same as the competitive case.

Contrary to *efficient bargaining, right to manage* process, at first, the union and the firm bargain only over wage. Then the firm determines its production level with the bargained wages. Following the Nash bargaining procedure with the equation , (7), we obtain the wages and prices.

$$w_r(i)^R = \left(1 + \frac{\beta}{\sigma - 1}\right) z_r, \quad p_r(i)^R = \left(1 + \frac{1}{\sigma - 1}\right)\left(1 + \frac{\beta}{\sigma - 1}\right) z_r \tag{9}$$

[4]This assumption allows us to model the cases where include the stronger trade union and the less their employment erosion.

[5]Further assumption on the expectation of entrepreneur can be posed. One of the example might be that, assuming the risk neutrality of entrepreneur, the introduction of expectation on profit between regions. However, we do not further investigate in this respect.

The wage premium respect to outside option is expressed in the first parenthesis of (9) and (8) in each case. Comparing to both outcomes, it is obvious that employment levels are different. Since the price under right to mange is reflected the bargaining power of trade union and is set higher than efficient bargaining and competitive labour market case, employment level under right to mange is lower than the others. This is due to the fact that right to manage bargaining structure allows entrepreneurs to determine the price in the form of *double marginalization*. Without loss of generality, we assume firms in unionized sector are symmetric. Thus the firm-specific subscript (i) can be suppressed. Substituting the obtained prices into the price indices, the price indices may be written as

$$P_r^E = \frac{\sigma c}{\sigma - 1} H^{\frac{1}{1-\sigma}} \left[z_r \lambda + z_s \left(1 - \lambda\right) \phi \right]^{\frac{1}{1-\sigma}} \tag{10}$$

$$P_r^R = \left(\frac{\sigma \left(\sigma - 1 + \beta\right)}{\left(\sigma - 1\right)^2} \right) H^{\frac{1}{1-\sigma}} \left[z_r \lambda + z_s \left(1 - \lambda\right) \phi \right]^{\frac{1}{1-\sigma}} \tag{11}$$

Since the production of manufacturing good requires one unit of entrepreneur for one firm, the share of firms is equal to the share of entrepreneurs in the region, λ. From the above equations, it is clear that while under *right to manage* case, stronger bargaining power make the price index higher, *efficient bargaining* case does not affect price index. This difference in price index directly affects the real wages under each bargaining structure different.

For simplicity, we posit the outside option such that those who cannot take their position in unionized sector are all reemployed in competitive sector. Since workers' wage in competitive sector is normalized into one, the outside option is also one, $z = 1$. We set this specification as a benchmark case. Later, in section 6, we extends into several cases. This benchmark case is quite simple because the bracket in the price index only contains λ and ϕ and wage equations are boiled down into $w\left(i\right)^E = w\left(i\right)^R = \left(1 + \frac{\beta}{\sigma - 1}\right)$. While workers' wage in competitive sector is normalized into one, those who work in unionized monopolistic sector earn negotiated wage. This wage premium is expressed by $w_r - 1$. Then using (6), (9) and (8), we could rewrite the entrepreneurs' wage as,

$$W_r{}^E = \left(1 - \frac{w_r^E}{p_r^E}\right) p_r^E m_r = \frac{\left(1 - \beta\right)}{\sigma} p_r^E m_r \tag{12}$$

$$W_r{}^R = \left(1 - \frac{w_r^R}{p_r^R}\right) p_r^R m_r = \frac{1}{\sigma} p_r^R m_r \tag{13}$$

There is a clear difference between two bargaining structure in the marginal reward to entrepreneurs. It is easily shown that the marginal reward to entrepreneurs is the first parentheses in the above equations and is different under each bargaining structure. Since in both cases wages set in unionized firms are the same, the difference comes from the price setting behavior. Substituting

demand function, (5), into the equations above, we could rewrite the above equations as,

$$W_r^{\ E} = \frac{(1-\beta)\,\mu}{H\sigma}\left[\frac{E_r}{\lambda+(1-\lambda)\,\phi}+\frac{E_s}{\lambda\phi+(1-\lambda)}\phi\right] \tag{14}$$

$$W_r^{\ R} = \frac{\mu}{H\sigma}\left[\frac{E_r}{\lambda+(1-\lambda)\,\phi}+\frac{E_s}{\lambda\phi+(1-\lambda)}\phi\right] \tag{15}$$

Since μ expresses the expenditure share of manufacturing goods, the brackets with μ can be interpreted as the deflated expenditure on manufacturing goods in this economy. Comparing to the two expressions, there is a clear difference between two bargaining structures in the marginal reward to entrepreneurs, in another words, the source of wage premium to workers. The difference lies in the previous term in front of the brackets. When there is no trade union, this term is expressed as μ/σ and means the reward to entrepreneurs for their investment on fixed costs[6]. Under efficient bargaining structure, the reward to entrepreneurs reflects the bargaining power as $(1-\beta)/\sigma$ in (14). This means that a fraction of reward to entrepreneurs is transferred to workers and is the source of wage premium. This form can be interpreted as a kind of profit sharing. On the other hand, under right to manage structure, the reward to entrepreneurs is unaffected by the bargaining as in (15). This latter result is due to the *double marginalization* by entrepreneurs since employment level is determined so as to maximize the firm's profit with the bargained wage taken as given. Thus the source of wage premium comes from the higher price set on their product. This difference in price setting between both bargaining structures makes the effect of trade union on location equilibria varied, as shown in the next section.

Furthermore, suppose the brackets in each equation are constant in a partial equilibrium view, we find that reward to entrepreneurs is lower under efficient bargaining and that the effects of stronger bargaining power on reward to entrepreneurs are also different. While under efficient bargaining structure stronger bargaining power induces the reward to entrepreneurs decrease, under right to manage bargaining structure it doesn't change.

Since both equations are analogous expressions, we posit the parameter which express the ratio of an entrepreneurs' rewards over total expenditure as δ^b, and the subscript b expresses the bargaining type. Under the benchmark case, this reward ratios are $\delta^E \equiv \mu\,(1-\beta)/\sigma$, and $\delta^R \equiv \mu/\sigma$. Then we could rewrite the reward equations as,

$$W_r^{\ b} = \frac{\delta^b}{\mu}p_r^b m_r = \frac{\delta^b}{H}\left[\frac{E_r}{\lambda+(1-\lambda)\,\phi}+\frac{E_s}{\lambda\phi+(1-\lambda)}\phi\right] \tag{16}$$

Different from a one-country model of general equilibrium[7], our two-country model still keeps the interregional distribution of firms in the price index. The bracket expresses the weighted expenditure

[6] See Baldwin et al. (2003) in detail.

[7] See for example Blanchard and Giavazzi (2003).

of this economy. The expenditure on manufacturing goods is expressed as μ multiplied to the bracket. Then we could see that the reward to entrepreneurs from their investment on fixed cost is expressed by δ^b.

Regional income in r, E_r, is expressed as

$$\begin{aligned} {E_r}^b &= \frac{L}{2} + \left(w_r^b - 1\right) m_r \lambda_r H + W_r^b \lambda_r H = \frac{L}{2} + \frac{\left(w_r^b - 1\right)}{p_r^b} p_r^b m_r \lambda_r H + W_r^b \lambda_r H \\ &= \frac{L}{2} + \left(\frac{\left(w_r^b - 1\right)\mu}{p_r^b\ \delta^b} + 1 \right) W_r^b \lambda_r H = \frac{L}{2} + \left(\eta_r^b + 1\right) W_r^b \lambda_r H \end{aligned} \tag{17}$$

where $\eta_r^b = \left(w_r^{b*} - 1\right)\mu / p_r^{b*}\delta^b$ and we put w_r^{b*} and p_r^{b*} as the optimal price under certain bargaining structure, $b = E, R$. Third equality in (17) uses the first equality in (16).Now we have four unknowns, $E_1^b, E_2^b, W_1^b, W_2^b$, and four equations. Substituting (16) into (17), we have following regional income equations.

$${E_r}^b = \frac{L}{2} + \left(\eta_r^b + 1\right) \delta^b \left[\frac{E_r^b}{\lambda + (1-\lambda)\,\phi} + \frac{E_s^b}{\lambda\phi + (1-\lambda)} \phi \right] \lambda_r \tag{18}$$

This shows that the presence of trade union and bargaining structure comes on a composite in front of the bracket This expression is composed of the rewards to entrepreneurs in sales of a differentiated firm, δ^b, and an effect from the bargaining structure, $\delta^b \eta^b$. These parameters are a composite of elasticity of substitution, the share of expenditure on manufactured goods and the bargaining power. Under the benchmark case, $z = 1$ with symmetric regions, this composite is expressed as

$$\left(\eta^b + 1\right)\delta^b = \begin{cases} \frac{\mu}{\sigma} & \text{where } b = E \\ \frac{(\sigma-1)\mu}{(\sigma-1)\sigma+\sigma\beta} + \frac{(\sigma+\mu-1)\beta}{(\sigma+\beta-1)\sigma} & \text{where } b = R \end{cases} \tag{19}$$

These expressions show the effect of bargaining power on regional incomes and allocative effect on entrepreneurs' rewards. Although, thanks to the wage bargainings, immobile workers can enjoy higher wages, when $\left(\eta^b + 1\right)\delta^b > (<)\, \frac{\mu}{\sigma}$, entrepreneurs can also enjoy higher (lower) reward compared to competitive labour market. From the expressions in (19), we have $\left(\eta^E + 1\right)\delta^E = \frac{\mu}{\sigma}$. Thus we could observe that *under efficient bargaining structure, there is no allocative effect.* On the other hand, we have $\left(\eta^R + 1\right)\delta^R > \frac{\mu}{\sigma}$. Thus *under right to manage bargaining structure, there is positive allocative effect.* In sum, while under efficient bargaining structure regional income is not affected by bargaining power, under right to manage bargaining the bargaining power plays an allocative effect from workers to entrepreneurs. This allocative effect makes regional income more dependent on the firms' (and entrepreneurs') distribution of manufacturing sector than that under competitive labour market case and that under efficient bargaining structure.

Solving the regional income equations, (18), simultaneously, we obtain unknown variables.

$$W_1{}^b = \frac{L\delta^b}{2H\left(\delta^b+\delta^b\eta^b-1\right)}\frac{2\phi\lambda+(1-\lambda)\left(\phi^2-\delta^b\eta^b-\delta^b+\delta^b\phi^2+\delta^b\phi^2\eta^b+1\right)}{\delta^b\lambda(1-\lambda)(1-\phi)(1+\phi)(\eta^b+1)-(\lambda+\phi(1-\lambda))((1-\lambda)+\phi\lambda)} \tag{20}$$

$$W_2{}^b = \frac{L\delta^b}{2H\left(\delta^b+\delta^b\eta^b-1\right)}\frac{2\phi(1-\lambda)+\lambda\left(\phi^2-\delta^b\eta^b-\delta^b+\delta^b\phi^2+\delta^b\phi^2\eta^b+1\right)}{\delta^b\lambda(1-\lambda)(1-\phi)(1+\phi)(1+\eta^b)-((1-\lambda)+\phi\lambda)(\lambda+\phi(1-\lambda))} \tag{21}$$

$$E_1{}^b = \frac{L(\lambda+\phi(1-\lambda))}{2\left(\delta^b+\delta^b\eta^b-1\right)}\frac{(1-\lambda)+\phi\lambda-\delta^b(1-\lambda)+\delta^b\phi\lambda-\delta^b\eta^b(1-\lambda)+\delta^b\phi\eta^b\lambda}{\delta^b\lambda(1-\lambda)(1-\phi)(1+\phi)(1+\eta^b)-(\lambda+\phi(1-\lambda))((1-\lambda)+\phi\lambda)} \tag{22}$$

$$E_2{}^b = \frac{L((1-\lambda)+\phi\lambda)}{2\left(\delta^b+\delta^b\eta^b-1\right)}\frac{\left(\lambda-\delta^b\lambda+\phi(1-\lambda)+\delta^b\phi(1-\lambda)-\delta^b\eta^b\lambda+\delta^b\phi\eta^b(1-\lambda)\right)}{\delta^b\lambda(1-\lambda)(1-\phi)(1+\phi)(1+\eta^b)-(\lambda+\phi(1-\lambda))((1-\lambda)+\phi\lambda)} \tag{23}$$

The nominal wage difference is expressed as

$$\frac{W_1{}^b}{W_2{}^b} = \frac{2\phi\lambda+(1-\lambda)\left(\phi^2-\delta^b\eta^b-\delta^b+\delta^b\phi^2+\delta^b\phi^2\eta^b+1\right)}{2\phi(1-\lambda)+\lambda\left(\phi^2-\delta^b\eta^b-\delta^b+\delta^b\phi^2+\delta^b\phi^2\eta^b+1\right)} \tag{24}$$

Without loss of generality, we normalize the total population of entrepreneurs and immobile workers as one, $H = L = 1$.

3 Location equilibrium

We examine the stability of location equilibrium under symmetric and core-periphery distribution. While symmetric distribution is the equilibrium such that the number of firms is equal in both regions, core-periphery distribution is the equilibrium such that all firms locate in one region. In this section, we assume that both regions are symmetric in the sense that the bargaining structures and outside options are the same. Since entrepreneurs are mobile across regions, they could choose their residential place. Evaluating their indirect utility differential, they choose the region where give them higher indirect utility. When no worker could get a higher utility level by changing their resident, the distribution $\lambda \in [0,1]$ is the location equilibrium.

$$\triangle V(\lambda) \equiv \frac{W_1(\lambda)}{P_1^{\mu}(\lambda)} - \frac{W_2(\lambda)}{P_2^{\mu}(\lambda)} = 0 \tag{25}$$

or at $\triangle V(\lambda) \leq 0$ or at $\triangle V(\lambda) \geq 1$. Such an equilibrium always exists since $V_r(\lambda)$ is a continuous function of λ. A spatial equilibrium is (locally) stable, if, for any marginal deviation of the population distribution from the equilibrium, the equation of motion.

$$\dot{\lambda} = \lambda(1-\lambda)\triangle V(\lambda) \tag{26}$$

While as long as $\triangle V(\lambda)$ is negative, symmetric distribution is stable, core-periphery distribution is stable if it is an equilibrium[8].

[8]Taking logarithem of both sides, (25) can be written as $\ln \triangle V(\lambda) = \ln W_1(\lambda)/W_2(\lambda) - \ln P_1^{\mu}(\lambda)/P_2^{\mu}(\lambda)$. As is seen in this equation, the effect from a change in λ comes from the nominal wage differential and the price index differencial.

Firstly we observe symmetric distribution, where half of firms locate in each region. After differentiating real wage differential respect to λ and evaluating at symmetric distribution, $\lambda = 1/2$, we solve for the critical point of transport costs, ϕ. It would be written as,

$$\phi_C^b = \frac{(\sigma - \mu - 1)}{(\sigma + \mu - 1)} \frac{\left(1 - \delta^b - \delta^b \eta^b\right)}{\left(1 + \delta^b + \delta^b \eta^b\right)} \quad , \forall b \in \{E, R\} \tag{27}$$

When transport costs becomes lower than this critical point (higher $\phi_C^b < \phi$), symmetric distribution is unstable. The lower subscript, C, expresses the specification of outside option. At this benchmark case we assume the outside option is that all workers who cannot retain their job in unionized sector can find their job in competitive sector, namely $z = 1$. Comparative statics with bargaining parameters, δ and η, are both negative, $\frac{d}{d\delta}\phi_C^b < 0$, $\frac{d}{d\eta}\phi_C^b < 0$. This shows that an increase in the bargaining power of trade union decreases the break point.

Result 1 *In general, an increase in the bargaining power of trade union may decrease the break point* ϕ_C^b.

Symmetric equilibrium is never stable when (27) is negative. In order to rule out the case that core-periphery distribution is always dominant, we assume two conditions. One is the non-black hole condition, which is standard assumption on the location analysis, and the other is the non-black hole condition of allocative effect. The former one is obtained from the first parenthesis, $\mu < \sigma - 1$. The latter one is expressed by $\delta^b \left(\eta^b + 1\right) < 1$. Without specifying the bargaining structure, this composite is complicated to explain. Later, we may refer to this latter condition in detail. Note that either of these two conditions can dominate the other.

Next, we observe core-periphery distribution, where all firms locate in one region. Evaluating the real wage differential, (25), at core-periphery distribution as $\lambda = 1$, where all firms locate in one region, as long as this real wage differential is positive, core-periphery distribution is sustainable, otherwise, not. Examining this sustainability of core-periphery distribution, we could find the condition is not analytically solvable. However, the solution for the following equation is the critical value of transportation costs satisfying the following equation.

$$1 = \left(\varphi_S^b\right)^{\frac{\mu}{\sigma - 1}} \left(\frac{\left(1 - \delta^b - \delta^b \eta^b\right)}{2\phi_S} + \frac{\left(1 + \delta^b + \delta^b \eta^b\right)}{2} \varphi_S^b \right) \tag{28}$$

We may refer to this transportation costs, $\varphi \in (0, 1)$, as sustain point. Note that the property of this sustainability point also rely on the same composite, $\delta^b \left(\eta^b + 1\right)$ as in the symmetry break points.

So far, we examine the location equilibrium in general form regardless of the labour market institutions. Next, we specify the labour market institutions. Since the sustainability point of core-periphery distribution is not analytically obtained, we focus on the analytical results of break point for symmetric distribution.

3.1 Competitive labour market

Under $b = C$, there is no bargaining power in trade union. Using (8) and $\beta = 0$, we have $\delta^C = \mu/\sigma$ and $\eta^C = 0$. Substituting these two bargaining structure-specific variables into the nominal wage difference in (24), differentiating λ and evaluating it at $1/2$, we could find the symmetry break point under competitive labour market. This can be expressed as,

$$\phi^C = \frac{(\sigma - \mu)}{(\sigma + \mu)} \frac{(\sigma - \mu - 1)}{(\sigma + \mu - 1)}$$

This is one of the results in the models of footloose entrepreneurs by Forslid and Ottaviano (2003) and is originally shown in Fujita, Krugman and Venables (1999).

3.2 Efficient bargaining

Under $b = E$, we have (8) and $\delta^E = \mu(1 - \beta)/\sigma$. Then $\eta^E = \mu\beta/\delta^E\sigma = \beta/(1 - \beta)$ .Substituting these bargaining structure-specific variables into the nominal wage difference in (24), we have,

$$\frac{W_1}{W_2} = \frac{2\sigma\lambda\phi + (1 - \lambda)\left(\sigma - \mu + \sigma\phi^2 + \mu\phi^2\right)}{2\sigma(1 - \lambda)\phi + \lambda\left(\sigma - \mu + \sigma\phi^2 + \mu\phi^2\right)} \tag{29}$$

This equation doesn't include bargaining power. Thus it shows that the difference of nominal rewards to entrepreneurs is unaffected by efficient bargaining. The symmetry break point can be expressed as,

$$\phi_C^C = \phi_C^E = \frac{(\sigma - \mu)}{(\sigma + \mu)} \frac{(\sigma - \mu - 1)}{(\sigma + \mu - 1)} \tag{30}$$

As we could see in the above equation, the symmetry break point is unaffected and is identical to the case under competitive labour market.

Although there are trade unions and higher wage than competitive sector is set in manufacturing sector, as long as the bargaining structure is efficient bargaining, labour market imperfection doesn't affect the bifurcation of location equilibrium. This is due to the fact that wage bargaining doesn't play the allocative role under efficient bargaining.

As is observed in the previous section, workers receive higher wages than competitive sector and this wage premium comes from a portion of entrepreneurs' rewards as a consequence of negotiation. However, this efficient bargaining sets the same price with the one under competitive labour market.

Thus output level of each differentiated firms is also the same with the one under competitive labour market.

Proposition 1 *Under efficient bargaining structure, symmetry braking point is exactly the same with the one without trade union and is unaffected by bargaining power.*

This is due to the fact that efficient bargaining affect neither the price nor employment level, compared to competitive labour market case.

3.3 Right to manage

On the other hand, under $b = R$, we have (9) and $\delta^R = \mu/\sigma$. Then $\eta^R = (\sigma - 1)\,\mu\beta/\,(\sigma + \beta - 1)\,\delta^R$ $= (\sigma - 1)\,\beta/\,(\sigma + \beta - 1)$. Since the equation of nominal wage difference under right to manage is quite tedious, we only show the symmetry breaking point as,

$$\phi_C^R = \left(\frac{(\sigma-1)(\sigma-\mu)+\beta\sigma(1-\mu)}{(\sigma-1)(\sigma+\mu)+\beta\sigma(1+\mu)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{31}$$

The stable dispersed equilibrium under competitive labour market, $\beta = 0$, is no longer stable under imperfect labour market with trade union. If trade freeness ϕ increases further away from ϕ_A^R, namely transport costs decreases, dispersed equilibrium is unstable. In order to examine the effect of trade union, starting from the case where the bargaining power of trade union is zero, there is a clear effect on the critical value ϕ_C^b.

$$\frac{d}{d\beta}\phi_C^R = -2\frac{(\sigma-1)^2\sigma\mu}{(\sigma\beta-\mu-\sigma+\sigma\mu+\sigma\beta\mu+\sigma^2)^2}\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} < 0$$

Comparing to each of the bargaining structures, sharp difference comes from the allocative role of bargaining power. These results are summarized in the next proposition and drawn in Figure 2.

Proposition 2 *Under right to manage bargaining structure, an increase in the bargaining power of trade union decreases the symmetry break point ϕ_C^b.*

The intuition behind this proposition is as follows. In brief, *the amount of regional income sensitive to the location of firms matters.* Positive bargaining power of trade union incurs wage premium in manufacturing sector. This wage premium is accompanied with location choice of manufacturing firms. Under efficient bargaining, this wage premium is a kind of profit sharing without any changes in price and employment. A part of reward to entrepreneurs are now transferred to workers in unionized sector. From the regional point of view, the amount of regional income dependent on the location of firms is the same with competitive case. On the other hand, under right

to manage, while bargaining power makes employment level lower, expenditure on manufacturing goods remains unchanged. Then the allocative effect stemmed from wage bargaining makes the amount of income dependent on the location of firms larger than competitive labour market case and the benefit from the relocation of firms under lower transport costs becomes larger. This allocative effect comes not only from the region where the firm locates but also from the other region. In the other words, comparing to the competitive labour market case, presence of wage premium and double marginalization enable firms to steal some portion of manufactured goods expenditure from the other region and this makes the amount of regional income dependent on the location of firms larger. This attracts entrepreneurs to agglomerate in one region at even higher transport costs (lower ϕ) comparing to competitive labour market. This means that *bargaining power can play a role that makes the home market effect stronger*. Thus the stable dispersed equilibrium under competitive labour market, $\beta = 0$, is no longer stable under imperfect labour market with trade union.

4 Different bargaining structures

We have examined different labour market institutions. However, we pose an assumption that each region has the same labour market institution. In this section, we relax this point. More precisely, we could allow different wage bargaining structures. Since we could not obtain analytical solution for different bargaining structures, we provide some simulation results. We set that while in region 1, there is wage bargaining in the form of *right to manage*, in region 2, there is competitive labour market. The stable location equilibrium is obtained from (24) with specifying the bargaining specific parameters and the equation by

$$\frac{{W_1}^R}{{W_2}^C} = \frac{2\phi\lambda + (1-\lambda)\left(\phi^2 - \frac{\mu\beta(\sigma-1)}{\sigma(\sigma+\beta-1)} - \frac{\mu}{\sigma} + \frac{\mu}{\sigma}\phi^2 + \frac{\mu\beta(\sigma-1)}{\sigma(\sigma+\beta-1)}\phi^2 + 1\right)}{2(1-\lambda)\phi + \lambda\left(1 - \frac{\mu}{\sigma} + \phi^2 + \frac{\mu}{\sigma}\phi^2\right)} \tag{32}$$

We choose the parameter values such that there are a interesting multi-equilibria case: $\sigma = 6, \mu = 0.4$, and bargaining power in region one is $\beta_1 = 0.01, \beta_2 = 0$. With these values, the diagram of stable location equilibria can be drawn as in Figure 3. Similar to the previous section, stronger bargaining power can induce stronger home market effect. In our simulations, the presence of trade union in region 1 attracts entrepreneurs in region 1, where there is stronger trade union. Thus the core-periphery distribution under different wage bargaining structure has wider range of sustainability in its distribution. As is shown in Figure 3, there is a small range that region 2 (periphery) can steal the core from region 1, multiple-equilibria. This range can emerge only when the relative strength of bargaining power between two regions is very small, $\beta_1 - \beta_2 < 0.03$ when

$\sigma = 6, \mu = 0.4$. When the relative strength of bargaining power between two regions is not small, the range where periphery region can steal the core be vanished. Furthermore, even when both regions are right to manage bargaining structure, if the relative difference of bargaining power is small, we could obtain the same results and draw the diagram in Figure 3.

In sum, interesting multi-eruilibria can be obtained under the case that one region is with right to manage bargaining structure and the other region is with any bargaining structure with relatively small difference in bargaining power. When the relative difference is larger, the possible range where region 2 can steal the core is vanished and the sustainable range of core-periphery distribution becomes larger. Starting from core-periphery distribution, when the trade union in core region is stronger than that in periphery, this core-periphery distribution is sustainable in wider range than the case under symmetric bargaining power in both regions. This exhibits the *anchorage effect* by trade union in home region. This result is consistent with the findings by Dewit et al. (2009). Furthermore, our result is similar to Munch (2003) who model Cournot type monopolistic competition with unionized sector. An implicit assumption on our results and Munch (2003) should be pointed out that monopolistic producers only locate in one place and produce at the same place. This coincidence on the location of sales and production may leads to our results. However, as long as the monopolistic producers are sensitive and attracted with larger market, our results hold.

5 Welfare analysis

When agglomeration occurs, there are two advantages for living at core region from price index effect and market size effect. Firstly, more firms come to the region, the price index in this region becomes lower due to the fact that all products are domestic and do not incur transport costs. Secondly, the move by entrepreneurs makes the regional income higher. This makes the home market effect larger. Hence each individual prefers residing in the core to the periphery. As entrepreneurs can move to the core, they could enjoy higher welfare level, when there is agglomeration. On the other hand, workers are immobile between regions. While there is a positive externality from the move of entrepreneurs to the workers in the core, the workers in the periphery suffers negative externality. In the core, workers enjoy higher welfare than under dispersed equilibrium just as entrepreneurs. In the periphery, as the price index becomes higher for importing all products from the core, immobile workers in the periphery are worse off. Welfare analysis on economic geography model accompanies opposite interest groups against the change of firms' distribution. Thus the detailed analysis based on the geographically different interest groups would be ambiguous results

and is very complicated[9]. Since one of our focuses is the comparison among the different bargaining structures and competitive labour market, for this purpose, we employ the total social welfare function (hereafter SWF) of this economy. Depending on the distribution of firms and bargaining structure, SWF is specified as follows:

$$\mathcal{W}(\lambda)_{j}^{b}=\sum_{r=1}^{2}\frac{\lambda_r w_r^b(\lambda_r)}{(P_r^b(\lambda_r))^{\mu}}+\sum_{r=1}^{2}\frac{\frac{1}{2}}{(P_r^b(\lambda_r))^{\mu}} \quad ,\forall b\in C,E,R \text{ and } \forall\ j\in A,D \tag{33}$$

The lower subscript (j) of SWF indicates the distribution of firms. While $j=A$ is the agglomerated core-periphery structure $(\lambda=1)$, $j=D$, is the symmetrically dispersed case $(\lambda=1/2)$. This functional form of SWF is a special case of CES class, where there is no inequality aversion and it can be recognized as *utilitarian* welfare function. In the following analysis, the rank of SWF is simply ordered by the value of total SWF[10].For comparison of SWF, we set the difference of SWF between agglomeration and dispersion, $\mathcal{D}_{j_m j_n}^{b_1 b_2}$ as;

$$\mathcal{D}_{j_m j_n}^{b_1 b_2}=\mathcal{W}(\lambda)_{j_m}^{b_1}-\mathcal{W}(\lambda)_{j_n}^{b_2} \quad ,\forall b_1,b_2\in C,E,R \text{ and } \forall\ j_m,j_n\in A,D \tag{34}$$

For example, if we use regional expenditure, a comparison between agglomeration and dispersion under the same institution can be written as,

$$\mathcal{D}_{AD}^{bb}=\sum_{r=1}^{2}\frac{E_r^b}{(P_r^b)^{\mu}}\bigg|_{\lambda=1}-\sum_{r=1}^{2}\frac{E_r^b}{(P_r^b)^{\mu}}\bigg|_{\lambda=\frac{1}{2}} \quad ,\forall b\in C,E,R$$

Between all the range of transport costs $[0,1]$, this function cross at least once with x-axis: there is a critical value which expresses the change on the socially preferable location equilibrium. We refer to this critical value by using hat as, $\widehat{\phi_c^b}$, where $D_{AD}^{bb}=0$.When there is no transport costs, $\phi=1$, the welfare in each location equilibrium is identical, $D_{AD}^{bb}=0$.When $\phi>\widehat{\phi_c^b}$, we have $D_{AD}^{bb}<0$.Then dispersed distribution equilibrium is socially preferred. On the other hand, when $\phi<\widehat{\phi_c^b}$, we have $D_{AD}^{bb}>0$.Then agglomerated core-periphery structure is preferred. For the following analysis, the necessary comparisons are performed in Appendix II. When the comparisons are performed under the same institution, $\mathcal{D}_{AD}^{CC}, \mathcal{D}_{AD}^{EE}, \mathcal{D}_{AD}^{RR}$, the results are nonlinear and difficult to be shown analytically. Although the critical value, $\widehat{\phi_c^b}$, cannot be obtained analytically, its existences are confirmed in Appendix II. On the other hand, comparisons across different institutions in the same location equilibrium, $D_{AA}^{CR}, D_{AA}^{ER}, D_{DD}^{CR}, D_{DD}^{ER}, D_{AA}^{CE}, D_{DD}^{CE}$, are solved analytically. In Table 1, for

[9]Using Krugman's core-periphery model, Charlot, Gaigne, Robert-Nicoud and Thisse (2006) show that both location equilibrium, dispersion and agglomeration, are not Pareto dominant. They also show that under sufficiently low transport costs, agglomeration is socially preferable including compensation scheme. Otherwise, it is impossible to disentangle the different geographical groups.

[10]We set the same normalization as in the previous section, $H=L=1$.

the plausible parameters, we compute the break point and sustain point of market outcome and that of social break point where socially preferred location equilibrium changes.

(i) Competitive labour market $(b = C)$

When transportation costs are very high, SWF of dispersion is higher, $\mathcal{D}_{AD}^{CC} < 0$. On the other hand, when transportation costs decrease, there is a critical value that agglomeration is socially preferred to dispersion, $\mathcal{D}_{AD}^{CC} = 0$. Further decrease in transport costs makes the gradient of the agglomeration superiority decrease. In the end, when transportation costs vanish, $\phi = 0$, total social welfare functions under agglomeration and dispersion are identical, $\mathcal{D}_{AD}^{CC} = 0$. Socially optimal change of location equilibria is induced at the point that $\widehat{\phi_c^C} = 0.747$ when $\sigma = 6, \mu = 0.4$. Note that $\widehat{\phi_c^C}$ is larger than the symmetry break point, $\phi_c^C = 0.745$ from (30), resulted from the market outcome. With these values and under certain transport costs $\phi_c^C < \phi < \widehat{\phi_c^C}$, while market outcome leads to core-periphery distribution, symmetrically dispersed distribution is socially preferred. This implies *there might be excessive agglomeration.* For example in the first and second columns of Table 1 , excess agglomeration may occur only when expenditure share is relatively low. On the other hand, when expenditure share is relatively high, the symmetry break from market outcome is larger than socially preferred one, $\widehat{\phi_c^C} < \phi_c^C$ and implies *there might be less agglomeration.*

(ii) Efficient bargaining $(b = E)$

In this case, regional income is boiled down into the same with competitive labour market case. So there is no change with competitive labour market. However, this is due to our simplified SWF adopted here, it cannot reflect inequality of wealth among individuals. As in Charlot et al. (2006) if we adopt CES form of SWF, we could make distinct difference between $\mathcal{D}_{AD}^{CE}, \mathcal{D}_{DD}^{CE}, \mathcal{D}_{AA}^{CE}$.

(iii) Right to manage $(b = R)$

Socially optimal change of location equilibria is induced at the point that $\widehat{\phi_c^R} = 0.726$ when $\sigma = 6, \mu = 0.4, \beta = 0.1$. Note that $\widehat{\phi_c^R}$ is smaller than $\phi_c^R = 0.736$ from (31). From Table 1, under right to manage and positive bargaining power, most of the symmetry break point from market outcome are larger than socially preferred one. This implies that there is little excess agglomeration case, $\phi_c^R < \widehat{\phi_c^R}$. Thus under right to manage bargaining, *there might be less agglomeration.*

Summing up the results from these comparisons on location equilibria between market outcome and social optimal, when there is no trade union, the parameter range for socially excessive agglomeration, $\phi_c^C < \phi < \widehat{\phi_c^C}$, is the largest. On the other hand, when there are trade unions and the bargaining power becomes stronger, this parameter range becomes smaller and socially agglomeration is preferred.

Proposition 3 *When the bargaining power of trade union becomes stronger, agglomeration is so-*

cially preferable.

6 Extensions

So far, avoiding the complicated expressions, we assume that all of the workers in unionized sector would be reemployed in competitive sector when they cannot work in the same sector. However, this benchmark case couldn't explain the various possibilities of obtaining the other jobs. Some might be able to obtain their job in unionized sector, again. Some may not be able to obtain their job in competitive sector. In order to make more realistic implications, we extend the specification of outside option into several environments. The following extensions can be interpreted as frictional reemployment in unionized sector or frictional unemployment. Different specification of outside option can be interpreted as the different regional characteristics. In the line with Lejour and Verbon (1996), the outside options are taken the form of expected probability of obtaining a status. For simple analysis, we set them as a binary choice as follows.

$$\begin{array}{lll} \text{Benchmark}: & \text{All reemployed in C sector:} & z_r = 1 \\ (1)\ \text{Case MC}: & \text{Reemployed in M sector, } \gamma, \text{ or in C sector, } 1-\gamma & z_r = \gamma w_r + (1-\gamma) \\ (2)\ \text{Case MU}: & \text{Reemployed in M sector, } 1-\psi, \text{ or in unemployed, } \psi & z_r = (1-\psi)\, w_r + \psi b \\ (3)\ \text{Case CU}: & \text{Reemployed in C sector, } 1-\psi, \text{ or unemployed, } \psi & z_r = (1-\psi) + \psi b \end{array} \tag{35}$$

where γ is the probability of reemployed in M sector and ψ is the probability of unemployed for a worker who cannot get a job in the same firm after the bargaining and b expresses unemployment benefit which is levied in lump sum manner. This outside option acts as an expected wage when the worker cannot get his job in the unionized sector. Suppose under case MU and there are λ_r of M sector-firms in region r, regional unemployment rate, u_r, is simply expressed as $u_r = \lambda_r \psi$. Since $0 \leq \lambda_r \leq 1$ and $b < 1$, z_r is a decreasing function of ψ. Note that as we set the total number of firms one, unemployment rate is equivalent to regional unemployment.

Since we set the outside options in each region endogenous, we need to solve them. In each cases above, firstly we solve the regional unionized wage and fall-back point with using (9) or (8), and (35) simultaneously. From (9) or (8), we know that under both bargaining structures, unionized wage is the same. Thus unionized wage and fall-back point is the same regardless of the bargaining structure. Using the specified unionized wage and fall-back point according to the above cases, we plug them into (27) to observe the symmetry break point. Detailed derivations for each cases can be found in appendix III.

(i) Case MC

Outside option in this case is composed of the reemployment in M-sector and in C-sector. Each probability is expressed by γ and $1-\gamma$. We are interested in the relation between the transportation costs and the distribution of firms. This is captured by the symmetry breaking point. After some manipulation, we obtain the following critical value in each bargaining structure.

$$\phi_{MC}^{E} = \left(\frac{(\sigma-\mu)-\gamma(\sigma-\mu+\beta\mu)}{(\sigma+\mu)-\gamma(\sigma+\mu-\beta\mu)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)}, \tag{36}$$

$$\phi_{MC}^{R} = \left(\frac{(1-\gamma)(\sigma-\mu)(\sigma+\beta-1)-\mu\beta(\sigma-1)}{(1-\gamma)(\sigma+\mu)(\sigma+\beta-1)+\mu\beta(\sigma-1)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{37}$$

This case explicitly examine not unemployment but reemployment probability in unionized sector. Since $z_{MC}=\gamma w_r+(1-\gamma)=\gamma(w_r-1)+1>1$, this is a case such that the outside option is clearly above the benchmark case where all can be employed in competitive sector.

(ii) Case MU

The outside option is depicted by reemployed in M-sector and unemployed to receive benefit. When individuals are unemployed, they receive unemployment benefit from government. This compensation is assumed to be financed by payroll taxes.

$$\phi_{MU}^{E} = \left(\frac{\sigma\psi b(1-\mu)+\mu(\sigma-1)-\mu(1-\psi)(\sigma+\beta-1)}{\sigma\psi b(1+\mu)-\mu(\sigma-1)+\mu(1-\psi)(\sigma+\beta-1)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{38}$$

$$\phi_{MU}^{R} = \left(\frac{\sigma\psi b(\sigma+\beta-1)(1-(1-\beta)\mu)+\mu(\sigma-1)^2(1-\beta)+\mu(1-\psi)(\sigma-1)(\beta-1)(\sigma+\beta-1)}{\sigma\psi b(\sigma+\beta-1)(1+(1-\beta)\mu)-\mu(\sigma-1)^2(1-\beta)-\mu(1-\psi)(\sigma-1)(\beta-1)(\sigma+\beta-1)}\right) \times\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{39}$$

Unemployment benefit should be lower than the wage in competitive sector. In this case, depending on the unemployment rate, the outside option can be varied around benchmark case, $z_{MU}=\psi b+(1-\psi)w>(<)1$.

(iii) Case CU

The outside option is described by being reemployed in C-sector and being unemployed to receive benefit. When individuals are unemployed, they receive unemployment benefit from government. The assumption on the public finance is the same with MU case.

$$\phi_{CU}^{E} = \left(\frac{(\sigma-\mu)-\psi\sigma(1-b)(1-\mu)}{(\sigma+\mu)-\psi\sigma(1-b)(1+\mu)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{40}$$

$$\phi_{CU}^{R} = \left(\frac{(\sigma-1)(\sigma-\mu)+\beta\sigma(1-\mu)-\psi\sigma(1-b)(\sigma+\beta-1)(1-\mu)}{(\sigma-1)(\sigma+\mu)+\beta\sigma(1+\mu)-\psi\sigma(1-b)(\sigma+\beta-1)(1+\mu)}\right)\frac{(\sigma-\mu-1)}{(\sigma+\mu-1)} \tag{41}$$

The outside option is lower than the benchmark case, $z_{CU}=\psi b+(1-\psi)=1-\psi(1-b)<1$.

Comparison among cases

Benchmark case and the extensions are consistently related with each other. Starting from the case studied in the previous sections, the benchmark case where all can obtain job in competitive

sector is identical to the *case MC* when $\gamma = 0$, no possibility of obtaining job in M sector. When $u = 0$ under *Case CU*, no unemployment, this is identical to the benchmark case. From the above results, in each cases, symmetry break point under efficient bargaining is larger than that under right to manage. From our analytical results in Appendix III, we could confirm that *increase in unemployment rate induces the break point larger*, which means that the stable range of symmetric distribution becomes larger. On the other hand, *more generous unemployment benefit could induces the break point smaller*, which means that the stable range of symmetric distribution becomes smaller.

Proposition 4 *Regional differences of employment environments have unambiguous effect on stability of location equilibria. In particular, lower unemployment rate and generous unemployment benefit induces symmetric distribution of firms more unstable.*

7 Discussion and conclusion

In this paper, wage bargaining structure and location of firms are examined in the model of economic geography. It is shown that the presence of trade union and stronger bargaining power makes home market effect stronger. This is induced by allocative effect from immobile workers of both regions to entrepreneurs and is from the increase in the amount of regional income dependent on location of firms. While under efficient bargaining this effect is absent, under right to manage bargaining we could observe this positive effect. Moreover, we analyze the effects of asymmetric regions, that is different bargaining structures on location equilibrium. When the location equilibrium is core-periphery structure, relatively stronger trade union in core region makes the agglomeration force stronger and this core-periphery structure more stable. This can be applied not only to the benchmark case but also the cases including several employment environments.

We explicitly introduce several unemployment circumstances, which is the outside option of workers. In particular, we allow the unemployment circumstances and the bargaining process to vary across several cases. It is analytically shown that the different unemployment circumstances affect the stability of symmetrically distributed firms. When there are unemployed, unemployment insurance is introduced in a lump sum manner. We show that not only the degree of bargaining power of trade union but also the unemployment benefit can play a role as a centrifugal force. A key message of the paper is that generous unemployment benefit and higher trade union make the distribution of firms more dispersed and stable. This is consistent with the empirical findings by Dewit et al. (2009). Note that there is an implicit assumption on location of sales and production

which should be the same place. In the process of enlargement of EU, residents in the original EU member countries do not have to worry about the relocation of firms from their countries to newly member countries.

Furthermore our welfare analysis reveals that there is an effect from stronger trade union on the socially optimal location structure. When the labour market is competitive, there is a certain possible parameter range which allows excessive agglomeration. If the bargaining power of trade union becomes stronger, this possible range of excessive agglomeration shrinks and that of less agglomeration expands.

Appendix I

Derivations of (9) and (8) are straight forward in the two steps. Under *Right to manage* (R), after the bargaining over wage between the trade union and the firm, the firm sets their price. Namely, maximizing (7) respect to w_i yields the next equation.

$$\frac{\vartheta \mathcal{L}}{\vartheta w_i} = \frac{\beta}{w_i - z} - \frac{(1-\beta)}{p_i - c w_i} = 0 \tag{A1}$$

After solving for w_i and plugging it into profit function in (5), maximization of profit function respect to price yields the equations in (9).

Under *Efficient bargaining* (E), wages and prices (employment) are jointly determined by using Nash-solution. Maximization of (7) respect to $w(i)$ and $l(i)$ yields the same equation in the above and the one following.

$$\frac{\vartheta \mathcal{L}}{\vartheta p_i} = -\frac{\beta\sigma}{p_i} - (1-\beta)\left(\frac{\sigma}{p_i} + \frac{1}{w_i - p_i}\right) = 0 \tag{A2}$$

Solving these two equation simultaneously, we obtain the equations in (8).

Appendix II

We could readily obtain the SWF for agglomeration and dispersion by using (33). Note that the rewards for entrepreneurs in each bargaining structure are the same regardless of the location equilibrium, $W_A^{\,b} = W_D^{\,b}$ and that under competitive labour market, there is no bargaining power on the optimal price and the wage. It is straight forward to obtain the SWF in (33) for agglomeration and dispersion as;

$$\begin{aligned}
\mathcal{W}_A^{\,b} &= \frac{(\sigma-1)}{2\sigma}\left(\frac{\left(1+\delta^b+\delta^b\eta^b\right)}{\left(1-\delta^b\eta^b-\delta^b\right)} + \phi^{\frac{\mu}{\sigma-1}}\right) \\
\mathcal{W}_D^{\,b} &= \left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}} \frac{(\sigma-1)}{\sigma\left(1-\delta^b\eta^b-\delta^b\right)}\left(1+\phi\right)^{\frac{\mu}{\sigma-1}}
\end{aligned}$$

The lower subscript indicates the location structure of the global welfare. A is under agglomeration and D is under dispersion. For more in detail, we obtain for all cases.

$$\left.\begin{array}{c} \mathcal{W}_{A}^{C}=\mathcal{W}_{A}^{E}=\frac{(\sigma-1)}{2\sigma}\left(\frac{\sigma+\mu}{\sigma-\mu}+\phi^{\frac{\mu}{\sigma-1}}\right) \\ \mathcal{W}_{D}^{C}=\mathcal{W}_{D}^{E}=\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}}\frac{(\sigma-1)}{\sigma-\mu}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}} \\ \mathcal{W}_{A}^{R}=\frac{1}{2\sigma}\left(\sigma-1\right)\left(\phi^{\frac{\mu}{\sigma-1}}+\frac{(\sigma-1)(\sigma+\mu)+\sigma\beta(1+\mu)}{(\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu)}\right) \\ \mathcal{W}_{D}^{R}=\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}}\frac{(\sigma+\beta-1)(\sigma-1)}{(\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu)} \end{array}\right\} \tag{A3}$$

Using (34) and above equations, we could perform the comparisons among different location equilibria as follows.

$$\mathcal{W}_{A}^{b}-\mathcal{W}_{D}^{b}\equiv\mathcal{D}_{AD}^{bb}=\frac{(\sigma-1)}{2\sigma}\left(\phi^{\frac{\mu}{\sigma-1}}-\frac{\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}-1}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}}-\left(1+\delta^{b}+\delta^{b}\eta^{b}\right)}{\left(1-\delta^{b}\eta^{b}-\delta^{b}\right)}\right)$$

The upper subscripts indicate the bargaining structure of the comparison and lower subscript DA expresses this difference is the comparison from dispersed structure to agglomeration. When this $D_{AD}^{b_1b_2}=0$, socially preferable location equilibrium changes from symmetrically dispersed distribution to agglomerated core-periphery distribution. b_1 and b_2 correspond to the bargaining structure of D and A. Using (34) and above equations, we could perform the comparisons among different labour market institutions as follows.

$$\left.\begin{array}{l} \mathcal{D}_{AD}^{CC}=\mathcal{D}_{AD}^{EE}=\frac{(\sigma-1)}{2\sigma}\left(\phi^{\frac{\mu}{\sigma-1}}-\frac{\sigma+\mu}{\sigma-\mu}-\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}-1}\frac{\sigma}{\sigma-\mu}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}}\right) \\ \mathcal{D}_{AD}^{RR}=\frac{(\sigma-1)}{2\sigma}\left(\phi^{\frac{\mu}{\sigma-1}}+\frac{(\sigma-1)(\sigma+\mu)+\sigma\beta(1+\mu)}{(\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu)}\right)-\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}}\frac{(\sigma-1)(\sigma+\beta-1)}{(\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu)} \\ \mathcal{D}_{AA}^{CE}=0,\ \mathcal{D}_{DD}^{CE}=0 \\ \mathcal{W}_{A}^{C}-\mathcal{W}_{A}^{R}\equiv\mathcal{D}_{AA}^{CR}=\mathcal{D}_{AA}^{ER}=-\frac{\beta\mu(\sigma-1)^{2}}{(\sigma-\mu)((\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu))}<0 \\ \mathcal{D}_{DD}^{CR}=\mathcal{D}_{DD}^{ER}=-\frac{\beta\mu(\sigma-1)^{2}}{(\sigma-\mu)((\sigma-1)(\sigma-\mu)+\sigma\beta(1-\mu))}\left(\frac{1}{2}\right)^{\frac{\mu}{\sigma-1}}\left(\phi+1\right)^{\frac{\mu}{\sigma-1}}<0 \end{array}\right\} \tag{A4}$$

Appendix III

Case MC

Solving wage equation in (8) or (9) and fall-back point in (35) simultaneously, we have $w=\frac{(\sigma+\beta-1)(1-\gamma)}{(\sigma+\gamma-\sigma\gamma-\beta\gamma-1)}$, $z=\frac{(1-\gamma)(\sigma-1)}{(\sigma+\gamma-\sigma\gamma-\beta\gamma-1)}$. Substituting these results into bargaining parameter η, $\eta_{MC}^{E}=\frac{\beta}{(1-\gamma)(1-\beta)}$. Similarly to the case under right to manage, we have $\eta_{MC}^{R}=\frac{\beta(\sigma-1)}{(1-\gamma)(\sigma+\beta-1)}$. Using these parameters, we obtain the expression in the text.

Case MU

The same procedure applying to the case of MU fall-back point results in $w=\frac{(\sigma+\beta-1)(1-\gamma)}{(\sigma+\gamma-\sigma\gamma-\beta\gamma-1)}$, $z=\frac{(1-\gamma)(\sigma-1)}{(\sigma+\gamma-\sigma\gamma-\beta\gamma-1)}$. Substituting these results into bargaining parameter η, $\eta_{MU}^{E}=\frac{(\sigma+\beta-1)(b\psi-\psi+1)+1-\sigma}{(1-\beta)b\psi}$. Similarly, for the case under right to manage, we have $\eta_{MU}^{R}=\frac{(\sigma-1)((\sigma+\beta-1)(b\psi-\psi+1)+1-\sigma)}{(\sigma+\beta-1)b\psi}$. Using these parameters, we obtain the expression in the text.

Case CU

Following above cases, we obtain $w = \frac{(\sigma+\beta-1)(b\psi-\psi+1)}{(\sigma-1)}$, $z = (b\psi - \psi + 1)$. Using these results, we have bargaining parameter in each case as $\eta^E_{CU} = \frac{(\beta+\psi-b\psi-\sigma\psi-\beta\psi+b\sigma\psi+b\beta\psi)}{(1-\psi+b\psi)(1-\beta)}$, and $\eta^R_{CU} = \frac{(\beta+\psi-b\psi-\sigma\psi-\beta\psi+b\sigma\psi+b\beta\psi)(\sigma-1)}{(b\psi-\psi+1)(\sigma+\beta-1)}$. From these parameters, we obtain the expression in the text.

Comparative statics of symmetry break point w.r.t. ψ and b

As for unemployment rate, ψ, we could easily obtain following equations.

$$\frac{d}{d\psi}\phi^E_{MU} = \frac{2b\sigma\beta\mu(\sigma-\mu-1)}{(\sigma+\mu-1)(\sigma\psi b(1+\mu)-\mu(\sigma-1)+\mu(1-\psi)(\sigma+\beta-1))^2} > 0$$

$$\frac{d}{d\psi}\phi^R_{MU} = \frac{(\sigma-\mu-1)(2b\sigma\beta\mu(\sigma-1)(1-\beta)(\sigma+\beta-1))}{(\sigma+\mu-1)\left(\sigma\psi b(\sigma+\beta-1)(1+(1-\beta)\mu)-\mu(\sigma-1)^2(1-\beta)-\mu(1-\psi)(\sigma-1)(\beta-1)(\sigma+\beta-1)\right)^2} > 0$$

$$\frac{d}{d\psi}\phi^E_{CU} = \frac{(\sigma-\mu-1)(2\sigma\mu(\sigma-1)(1-b))}{(\sigma+\mu-1)(\sigma+\mu-\sigma\psi+b\sigma\psi-\sigma\mu\psi+b\sigma\mu\psi)^2} > 0$$

$$\frac{d}{d\psi}\phi^R_{CU} = \frac{(\sigma-\mu-1)\left(2\sigma\mu(\sigma-1)^2(1-b)(\sigma+\beta-1)\right)}{(\sigma+\mu-1)((\sigma-1)(\sigma+\mu)+\beta\sigma(1+\mu)-\psi\sigma(1-b)(\sigma+\beta-1)(1+\mu))^2} > 0$$

As for unemployment benefit, b, we could obtain following equations.

$$\frac{d}{db}\phi^E_{CU} = -\frac{2\sigma\mu\psi(\sigma-1)(\sigma-\mu-1)}{(\sigma+\mu-1)(\sigma+\mu-\sigma\psi+b\sigma\psi-\sigma\mu\psi+b\sigma\mu\psi)^2} < 0$$

$$\frac{d}{db}\phi^R_{CU} = -\frac{2\sigma\mu\psi(\sigma-1)^2(\sigma+\beta-1)(\sigma-\mu-1)}{((\sigma-1)(\sigma+\mu)+\beta\sigma(1+\mu)-\psi\sigma(1-b)(\sigma+\beta-1)(1+\mu))(\sigma+\mu-1)} < 0$$

$$\frac{d}{db}\phi^R_{MU} = -\frac{2\sigma\mu\psi(\sigma-\mu-1)(\sigma+\beta-1)}{(\sigma+\mu-1)(\sigma\psi b(1+\mu)-\mu(\sigma-1)+\mu(1-\psi)(\sigma+\beta-1))^2}\left(\psi - \frac{\beta}{(\sigma+\beta-1)}\right)$$

$$\frac{d}{db}\phi^R_{MU} = -\frac{2\sigma\mu\psi(\sigma-1)(1-\beta)(\sigma+\beta-1)^2}{\left(\sigma\psi b(\sigma+\beta-1)(1+(1-\beta)\mu)-\mu(\sigma-1)^2(1-\beta)-\mu(1-\psi)(\sigma-1)(\beta-1)(\sigma+\beta-1)\right)^2}\left(\psi - \frac{\beta}{(\sigma+\beta-1)}\right)$$

The last two equations can be negative as long as $\psi > \frac{\beta}{\sigma+\beta-1}$ holds.

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		Competitive labour market			Under right to manage bargaining								
		Break Point	Social Break Point	Sustain point	Break Point	Social Break Point	Sustain point	Break Point	Social Break Point	Sustain point	Break Point	Social Break Point	Sustain point
		ϕ_c^C	$\widehat{\phi_c^C}$	φ_S^C	ϕ_c^R	$\widehat{\phi_c^R}$	φ_S^R	ϕ_c^R	$\widehat{\phi_c^R}$	φ_S^R	ϕ_c^R	$\widehat{\phi_c^R}$	φ_S^R
σ	μ	$\beta = 0$			$\beta = 0.1$			$\beta = 0.2$			$\beta = 0.3$		
4	0.2	0.792	0.806	0.791	0.784	0.79	0.783	0.777	0.774	0.776	0.77	0.76	0.769
4	0.4	0.626	0.627	0.622	0.614	0.599	0.61	0.602	0.574	0.598	0.592	0.551	0.588
4	0.6	0.493	0.464	0.484	0.478	0.429	0.469	0.465	0.398	0.455	0.453	0.371	0.443
4	0.8	0.386	0.318	0.369	0.371	0.281	0.353	0.357	0.250	0.339	0.344	0.222	0.325
6	0.2	0.864	0.870	0.863	0.858	0.858	0.857	0.853	0.847	0.852	0.847	0.836	0.847
6	0.4	0.745	0.747	0.744	0.736	0.726	0.734	0.726	0.706	0.725	0.718	0.687	0.716
6	0.6	0.643	0.632	0.64	0.630	0.604	0.627	0.618	0.577	0.615	0.607	0.553	0.603
6	0.8	0.554	0.524	0.548	0.539	0.491	0.533	0.525	0.460	0.519	0.513	0.433	0.506
8	0.2	0.898	0.902	0.898	0.894	0.893	0.893	0.890	0.884	0.889	0.886	0.875	0.885
8	0.4	0.807	0.808	0.806	0.799	0.791	0.798	0.791	0.775	0.79	0.784	0.760	0.783
8	0.6	0.725	0.719	0.723	0.714	0.696	0.712	0.704	0.674	0.702	0.694	0.653	0.692
8	0.8	0.650	0.634	0.648	0.638	0.605	0.635	0.625	0.579	0.622	0.614	0.554	0.61

Table 1: Symmetry break and sustain points

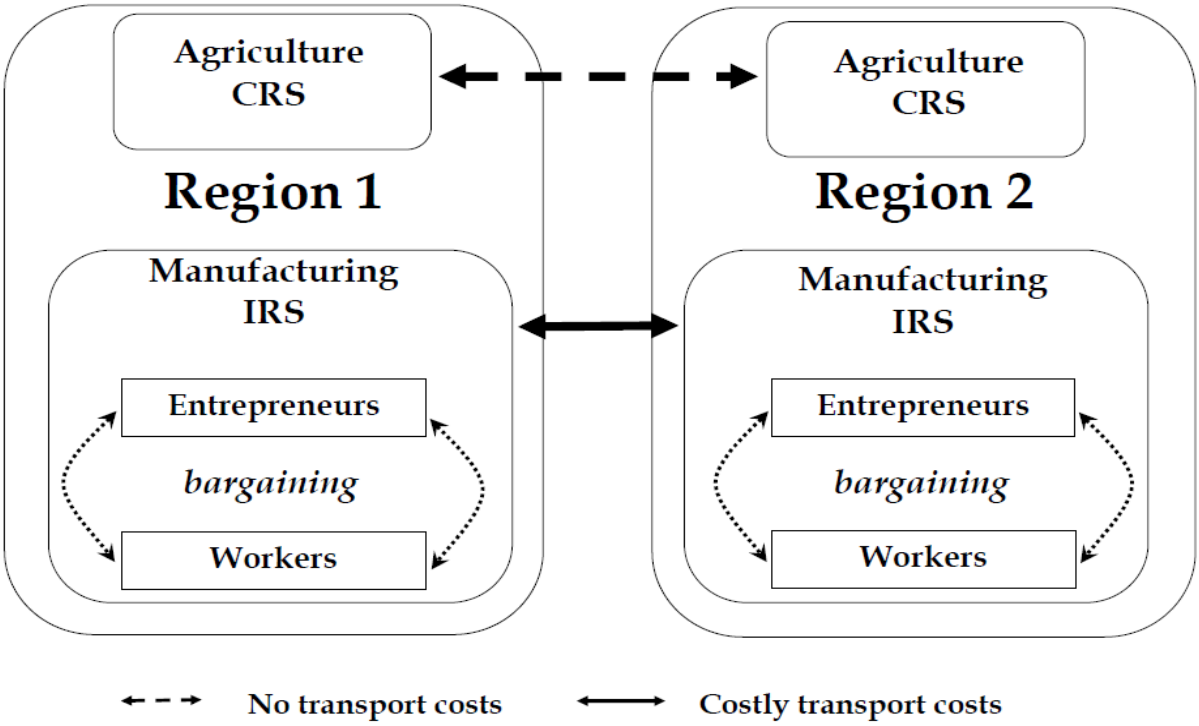

Figure 1 Schematic description of the model

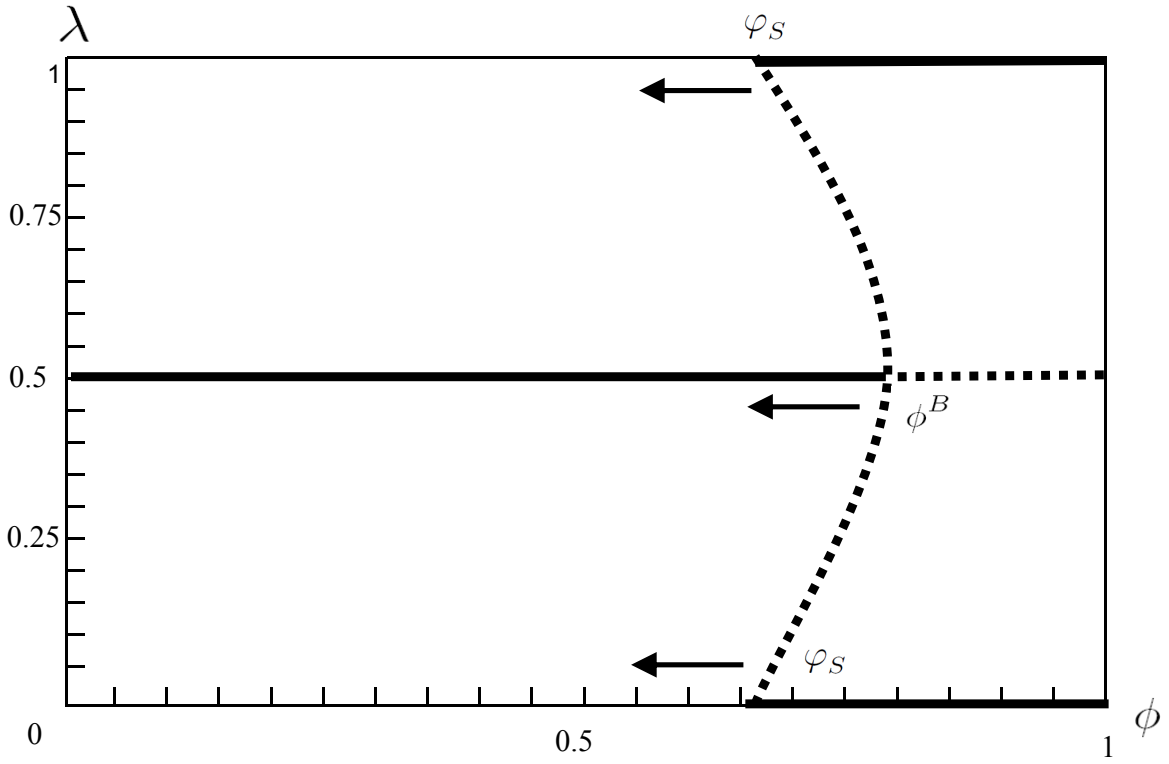

Figure 2 Stable distribution of firms and the effect of stronger bargining power under right to manage bargaining

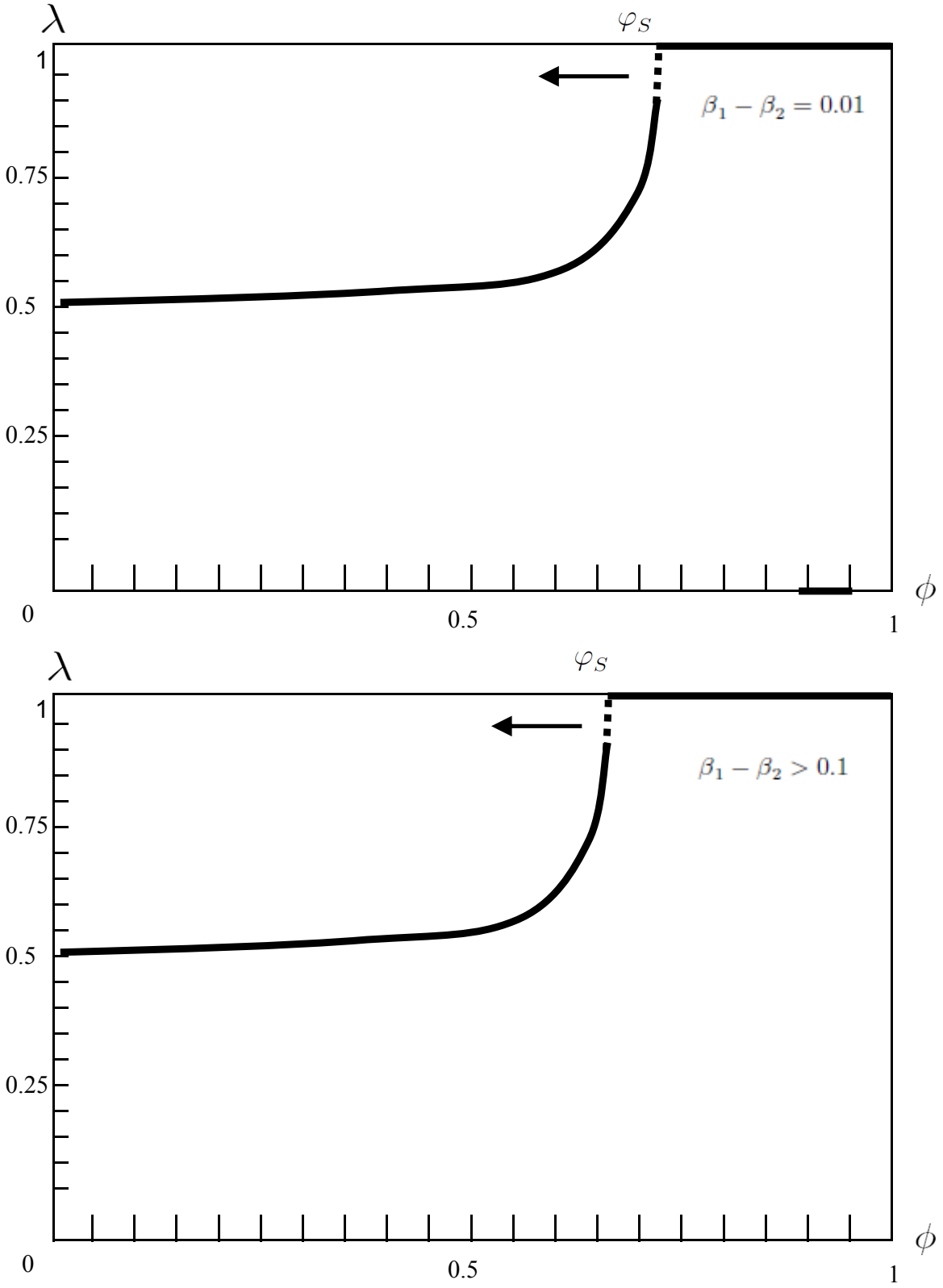

Figure 3 Stable distribution of firms under different bargaining structures and the effect of stronger bargining power under right to manage bargaining
[region 1 : right to manage, region 2 : efficient bargaining]