Why Almost Similar Regions Have Different Unemployment Rates*
Preliminary version

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Abstract

I present a two-region labor matching model of unemployment where firms and workers are heterogenous. In the economy, workers look for jobs in their residential region as well as in the neighboring region but to a lesser extent. Alongside labor market frictions, I introduce a region-specific utility in the worker's individual preference that prevents total migration from the less productive region to the more productive one. Wages are determined in an individual Nash bargain. I investigate the impact of a region-specific productivity shock at the steady state of the model. I find that this shock has opposite effects on both regions: on one hand, It shifts labor demand and wages upwards and reduces unemployment in the region where the shock takes place. On the other hand, it only raises wages in the neighboring region, triggering unemployment.

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1 Introduction

Despite substantial effort and rigorous theoretical effort, European high unemployment puzzle is yet to be completely elucidated. Many macroeconomic studies have attempted to study patterns of unemployment between European regions or countries. General results indicated that unemployment disparities are mainly stressed by differences in macroeconomic shocks and institutions as recently done by Blanchard and Wolfers (2000) and Nickell *et al* (2005). However, these studies failed, in a way, to explain unemployment disparities between regions that have "not-so-different" institutions. Therefore, in the line of work done by Overman *et al* (2002), accounting for unemployment's geographical aspects also matters.

In the light of this new literature on regional labor economics, I construct a two-region version of the otherwise standard labor matching model of unemployment à la Pissarides (2000) to probe the incidence of a regional productivity shock on unemployment differentials between two almost identical neighboring regions. With the notable exception of Epifani and Gancia (2005), I am not aware of other papers combining the economic geography literature with job search theory to study the impact productivity shocks regional unemployment disparities. While neglecting transport costs as the key geographical element of the model, I use an approach similar to the one used by Ortega (2000) who studied the impact of immigration on the host country's unemployment rate in the long run.

I add two main distinctive ingredients to the general framework: the first ingredient is assuming imperfect labor mobility between regions. While allowing for distant search within a search and move strategy, I consider that the search process for a non-resident worker is less effective. The second ingredient is introducing a region-specific preference. It is represented by an exogenous utility in the worker's individual preference. As a result and following a job layoff, a worker living in the less preferred region will automatically migrate back to his home region triggering a move then search strategy. Thus, in my model, an unemployed worker's search strategy depends on his location and regional preference. Combination of both ingredients then restricts jobless workers' mobility and prevents total migration from the less productive region to the more productive one. These two main features provide the key geographical element of the model.

The analysis is conducted at the steady state of the model. The main results are the following : I find that wages are positively determined by labor productivity levels of both regions. In fact, following a positive productivity shock, the economically thriving region attracts workers of both regions. Furthermore, the threat point of employers in the economically "depressed" region increases and wages are shifted up as a result. Moreover, Studying the effect on unemployment in both regions, the analysis concurs with the partial equilibrium result. In other terms, the positive productivity rise in the shock-receiving region shifts labor demand up which drives a decrease in unemployment. Conversely, labor demand not being affected in the neighboring region, future opportunities of its workers rise, wages and unemployment increase. Hence, following a shock in productivity, two neighboring regions may experience opposite changes in their unemployment rates while similar changes in their wage levels.

The paper is organized as follows. I present the general framework of the model in the next section. In section 3, I describe the expected intertemporal profits of firms and the expected intertemporal utilities of workers in their different states. In section 4, I determine the negotiated wage curves and I draw up an analysis of partial equilibrium steady-state properties. In section 5, I study equilibrium at the steady state. I conclude in section 6.

2 The model

2.1 Environment

I develop a two-region matching model of the labor market. The economy consists of two geographically-separated regions indexed by subscripts $i, j = A, B$ with $j = -i$. Firms are free to open vacancies in both regions. However, once they hire a worker in a region, they cannot move the job to the other region. I assume that workers cannot commute. Furthermore, they are not indifferent to the region they live in. More specifically, I consider two types of workers : ones who prefer to live in region A referred to as type-A workers and others who prefer to live in region B referred to as type-B workers. Formally, a type-i worker enjoys an exogenous utility ε_i according to which, while unemployed, he chooses his residential location. In other terms, type-i unemployed workers always choose to live in region i. The size of type-i labor force is equal to $L_i(\varepsilon_i) + L_j(\varepsilon_i) + u_i(\varepsilon_i)$ where $L_k(\varepsilon_i)$ is the number of type-i employed workers in region $k = i, j$ and $u_i(\varepsilon_i)$ is the number of type-i unemployed workers. I normalize the population of same-type workers to one and thus I have $u_i(\varepsilon_i) = 1 - L_i(\varepsilon_i) - L_j(\varepsilon_i)$. The structure of the model is depicted in Fig. 1.

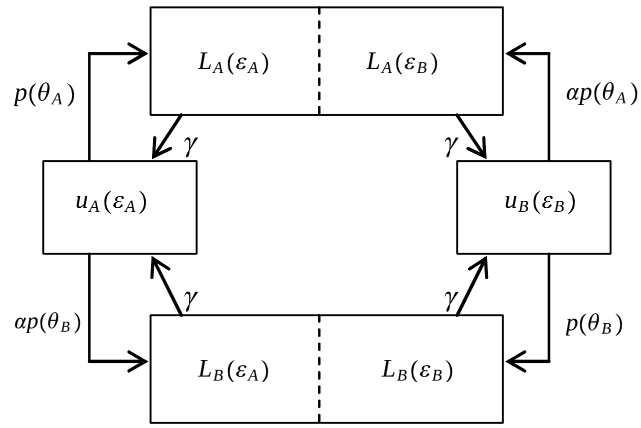

Figure 1: Dynamic structure of the model

2.2 Imperfect labor mobility and the matching function

Unemployed workers would usually search for the most productive job on the market. In this case, every job seeker would normally migrate to the region with the highest productivity generating the highest wage. However, economic barriers such as the housing market imperfections (European literature) and different social security programs (North American literature) stand in the way of workers' willingness to migrate[1]. Employment prospects of a representative unemployment worker do not only cover finding a job in the region where he lives, but they also cover finding a job in the other region, but to a lesser extent. Therefore, I model imperfect labor mobility between regions by introducing an exogenous parameter α in the otherwise standard CRS matching function à la Pissarides (2000). The flow of job creation is thus represented by:

$$m_i = m\left(u_i + \alpha u_j; v_i\right). \tag{1}$$

This matching function is assumed to be continuously differentiable, increasing and concave in both its arguments. I define $\theta_i = \dfrac{v_i}{u_i + \alpha u_j}$ as the labor market tightness in region $i = A, B$. The transition from a vacant job to a filled job is time consuming and follows a Poisson process. Under constant returns to scale, the job filling rate in region i fills a job

[1] For a review, see Elhorst (2003)

is defined by:

$$\frac{m\left(u_i+\alpha u_j;v_i\right)}{v_i}=m\left(\frac{1}{\theta_i};1\right)=q\left(\theta_i\right). \tag{2}$$

Similarly, the rate at which a type-i worker finds a job in region i is given by:

$$\frac{m\left(u_i+\alpha u_j;v_i\right)}{u_i+\alpha u_j}=m\left(1;\theta_i\right)=\theta_i q(\theta_i)=p\left(\theta_i\right). \tag{3}$$

Using the properties of the matching function, it is easy to verify that $q\left(\theta_i\right)$ and $p\left(\theta_i\right)$ are respectively decreasing and increasing in θ_i. The rate at which a type-j worker finds a job in region i is equal to $\alpha p\left(\theta_i\right)$[2].

In each period, a job can be destroyed at the exogenous rate γ. Thus, the law of motion of regional unemployment in region i is written as follows:

$$\dot{u}_i\left(\varepsilon_i\right)=-\left[p\left(\theta_i\right)+\alpha p\left(\theta_j\right)\right]u_i\left(\varepsilon_i\right)+\gamma\left[1-u_i\left(\varepsilon_i\right)\right].$$

Therefore, I get the stationary value of region i unemployment rate:

$$\overline{u}_i(\varepsilon_i)=\frac{\gamma}{p\left(\theta_i\right)+\alpha p\left(\theta_j\right)+\gamma}. \tag{4}$$

Equation (4) describes the interaction between the steady-state regional unemployment rate and regional labor market tightness (or vacancies) in both regions. It forms what is commonly known as the Beveridge curve. It is straightforward that $\overline{u}_i(\varepsilon_i)$ is decreasing in both θ_i and θ_j. The previous *ceteris paribus* result is too loose in this regional framework. Since θ_i and θ_j are endogenous, regional shocks may affect both variables in opposite ways, resulting in an uncertain impact on region-i unemployment rate. Moreover and ceteris paribus, $\overline{u}_i(\varepsilon_i)$ is found to be negatively related to labor mobility represented by parameter α, a result in harmony with the notable work provided by Decressin and Fatas (1995) on European unemployment.

3 Agents

Every region is composed of firms and workers. In the following two subsections, I solve the model via a series of Bellman equations describing the discounted values of a vacant job, filled job, employed worker and unemployed worker. I denote the proportion of type-i unemployed workers among all workers searching in region i by $\phi_i=u_i/\left(u_i+\alpha u_j\right)$.

[2] The flow of job creation in region i is equal to: $p\left(\theta_i\right)\left(u_i+\alpha u_j\right)=p\left(\theta_i\right)u_i+\alpha p\left(\theta_i\right)u_j$

3.1 Firms

Each firm has one job that can be in one of the two states, filled and producing or vacant and searching. When a job is occupied in region i, the firm, pays a wage $w_i(\varepsilon_k)$ to a type-k worker and it produces an exogenous region-specific output y_k with $k = i, j$. When the job is vacant, the firm bears an exogenous job vacancy cost c. In region i, a job can either be filled by a proportion ϕ_i of type-i unemployed workers at the rate $\phi_i q(\theta_i)$ or by a proportion $(1-\phi_i)$ of type-j unemployed workers at the rate $(1-\phi_i) q(\theta_i)$. Let $J_i(\varepsilon_k)$ be the expected profit from a job filled by a type-k unemployed worker. The free-entry condition of firms is written as follows[3]:

$$\begin{aligned}\frac{c}{q(\theta_i)} &= \phi_i J_i(\varepsilon_i) + (1-\phi_i) J_i(\varepsilon_j) \\ &= \frac{y_i - [\phi_i w_i(\varepsilon_i) + (1-\phi_i) w_i(\varepsilon_j)]}{r+\gamma}. \end{aligned} \quad (5)$$

For a firm, $\frac{1}{q(\theta_i)}$ is the expected duration of a vacant job. The free-entry condition (5) then states that, at equilibrium, the expected profit from an occupied job is exactly equal to the expected cost of a vacant job. It is straightforward that setting parameter α to zero gives us the standard free-entry condition of the basic model found in Pissarides (2000).

3.2 Workers

Workers can be either employed and productive or unemployed and searching. I do not consider on-the-job search.

3.2.1 Search and move or move and search?

Standard search models implicitly assume that a worker has to live in a region in order to access job offers there. In my model, I assume that unemployed workers combine two different search strategies depending on their location at the time of the job loss. While staying in region i, a type-i unemployed worker may find a job locally or he may look for one over distance : he only moves to the other region once the job matching occurs and the job is accepted. Molhio (2001) calls it a 'search then move' migration. On the other hand, if a type-i individual working in region j loses his job, he automatically migrates to his preferred region triggering a 'move then search' migration.

[3] See appendix A for details

3.2.2 Employment and unemployment income

In region $k = i, j$, let $V_k^E(\varepsilon_i)$ be the expected intertemporal utility of a type-i employed worker and $V_i^S(\varepsilon_i)$ the expected intertemporal utility of a type-i unemployed worker. I define $V^S(\varepsilon_i) = \max\left[V_i^S(\varepsilon_i); V_j^S(\varepsilon_i)\right]$ and I assume that, for type-i workers, the expected utility of being unemployed in region i is superior to the expected utility of being unemployed in the other region and thus $V^S(\varepsilon_i) \equiv V_i^S(\varepsilon_i)$. In a stationary environment, the expected lifetime utilities for a type-i worker are given by:

$$rV_k^E(\varepsilon_i) = w_k(\varepsilon_i) + \varepsilon_k + \gamma\left[V_i^S(\varepsilon_i) - V_k^E(\varepsilon_i)\right]. \quad (6a)$$

$$rV_i^S(\varepsilon_i) = b + \varepsilon_i + p(\theta_i)\left[V_i^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right] + \alpha p(\theta_j)\left[V_j^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right]. \quad (6b)$$

In region $k = i, j$, a type-i employed worker earns $w_k(\varepsilon_i)$ and enjoys utility ε_k ($\varepsilon_k = 0$ for $k \neq i$). Should a job loss occur in region $k = i, j$, a type-i worker bears a capital loss of $V_i^S(\varepsilon_i) - V_k^E(\varepsilon_i)$. A type-$i$ unemployed worker enjoys unemployment benefit b. He finds a job in region i at rate $p(\theta_i)$ and he finds a job in the other region at rate $\alpha p(\theta_j)$. His net gain from obtaining a job in region i is $V_i^E(\varepsilon_i) - V_i^S(\varepsilon_i)$ and his net gain from obtaining a job in the other region is $V_j^E(\varepsilon_i) - V_i^S(\varepsilon_i)$.

4 Wage setting

4.1 Nash bargaining

Wages are assumed to be the outcome of Nash bargaining. For a type-i worker in region $k = i, j$, the firm's and the worker's net returns from the job (surplus) are respectively $J_k(\varepsilon_i)$ and $V_k^E(\varepsilon_i) - V_i^S(\varepsilon_i)$. Thus, $w_k(\varepsilon_i)$ is the solution to:

$$\max_{w_k(\varepsilon_i)} \left[V_k^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right]^\beta \left[J_k(\varepsilon_i)\right]^{1-\beta}, \quad (7)$$

where β is an exogenous parameter that relatively measures workers' share of surplus or bargaining power. It strictly lies between 0 and 1. Thus, first-order conditions derived from (7) are given by:

$$(1-\beta)\left[V_k^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right] = \beta J_k(\varepsilon_i). \quad (8)$$

4.2 Regional wages

Wage computation steps are developed in appendix B. Combining equations (6a), (6b) and (16) and plugging them into (8) yield the following wage equations for a type-i individual respectively working in region i and j:

$$\begin{aligned} w_i(\varepsilon_i) &= \frac{1}{r+\gamma+\beta p(\theta_i)+\alpha\beta p(\theta_j)}\left\{\beta\left[r+\gamma+p(\theta_i)+\beta\alpha p(\theta_j)\right]y_i\right. \\ &\quad \left.+\beta\alpha p(\theta_j)(1-\beta)y_j+(1-\beta)(r+\gamma)b-\alpha p(\theta_j)\beta(1-\beta)\varepsilon_i\right\}; \end{aligned} \quad (9)$$

$$\begin{aligned} w_j(\varepsilon_i) &= \frac{1}{r+\gamma+\beta p(\theta_i)+\alpha\beta p(\theta_j)}\left\{\beta\left[r+\gamma+\beta p(\theta_i)+\alpha p(\theta_j)\right]y_j\right. \\ &\quad \left.+p(\theta_i)\beta(1-\beta)y_i+(1-\beta)(r+\gamma)b+(1-\beta)\left[r+\gamma+\beta p(\theta_i)\right]\varepsilon_i\right\}. \end{aligned} \quad (10)$$

Wage equations (9) and (10) are obtained under assumptions of imperfect labor mobility and region-specific preference. In the particular case where $\alpha = 0$, I define the no-mobility wage equation $w_i^n(\varepsilon_i)$ as follows:

$$\begin{aligned} w_i^n(\varepsilon_i) &= \frac{\beta\left[r+\gamma+p(\theta_i)\right]y_i+(1-\beta)(r+\gamma)b}{r+\gamma+\beta p(\theta_i)} \\ &= \frac{\beta\left[r+\gamma+p(\theta_i)\right]y_i+(1-\beta)(r+\gamma)b+\left[r+\gamma+\beta p(\theta_i)\right]b-\left[r+\gamma+\beta p(\theta_i)\right]b}{r+\gamma+\beta p(\theta_i)} \\ &= b+\frac{\beta\left[r+\gamma+p(\theta_i)\right]y_i+\left\{(1-\beta)(r+\gamma)-\left[r+\gamma+\beta p(\theta_i)\right]\right\}b}{r+\gamma+\beta p(\theta_i)}, \end{aligned}$$

and defining $\Gamma(\theta_i) = \frac{\beta[r+\gamma+p(\theta_i)]}{r+\gamma+\beta p(\theta_i)}$ yields

$$w_i^n(\varepsilon_i) = b + (y-b)\,\Gamma(\theta_i),$$

which verifies the usual wage properties in the basic matching model[4].

As predicted by the standard model, I find that $w_i(\varepsilon_i)$ and $w_i(\varepsilon_j)$ are positively related to the regional productivity level y_i. Furthermore, Equations (9) and (10) enable to study the effet of y_j on $w_k(\varepsilon_i)$. Following a rise in y_j, unemployed workers from both regions become more and more interested in job offers stemming from region j. Therefore, the threat point of employers in region i increases. As a result, wages $w_i(\varepsilon_i)$ are driven upwards.

The wage equation also states that following an increase in θ_i, $w_i(\varepsilon_i)$ unambiguously shifts up if $y_i \geqslant y_j$. This is in harmony with the usual findings in this type of models. Moreover,

[4]See Cahuc and Zylberberg (2004)

a shift in θ_j has an unambiguous positive impact on $w_i(\varepsilon_i)$ if $y_j \geqslant y_i + \varepsilon_i$. In fact, a rise in θ_j will make job offers arrive to workers at higher rate in region j; since y_j is already greater than y_i, the threat point of employers in the region i increases. As a result, wages $w_i(\varepsilon_i)$ are driven upwards.

An unambiguous negative relationship $w_i(\varepsilon_i)$ and ε_i and a positive one between $w_j(\varepsilon_i)$ and ε_i are found. The first impact is explained by the fact that, *ceteris paribus,* following a rise in ε_i, *a type-i* individual is keener on working in region i rather than in region j. Moreover, $V_i^E(\varepsilon_i)$ increases more sharply than $V_i^S(\varepsilon_i)$. Therefore, type-i worker's surplus shifts up. Thus, the only way for the firm's surplus to increase is that $w_i(\varepsilon_i)$ decreases. In other terms, if a worker's region-specific preference increases, he will be more and more willing to accept a lower wage in order to live in the preferred region. In a similar way, one can explain the positive relationship between $w_j(\varepsilon_i)$ and ε_i.

Finally, I compute the wage differential $w_i(\varepsilon_i) - w_j(\varepsilon_i)$ and I get:

$$w_i(\varepsilon_i) - w_j(\varepsilon_i) = \beta(y_i - y_j) - (1-\beta)\varepsilon_i. \tag{11}$$

$w_i(\varepsilon_i) - w_j(\varepsilon_i)$ increases in productivity differential $y_i - y_j$ and decreases in ε_i. This differential is equal to zero whenever $y_i - y_j = \frac{\beta}{1-\beta}\varepsilon_i$. In a symmetric Nash bargain, the latter condition is written $y_i - y_j = \varepsilon_i$. If $y_i = y_j$ then $w_i(\varepsilon_i) - w_j(\varepsilon_i) = -(1-\beta)\varepsilon_i$. This result concurs with the negative relationship between type-i wage and preference for region-i.

5 Equilibrium

Plugging wage equations in the free-entry condition (5), I get

$$\frac{c}{q(\theta_i^*)} = \frac{y_i - [\phi_i w_i^*(\varepsilon_i) + (1-\phi_i) w_i^*(\varepsilon_j)]}{r+\gamma}; \tag{12}$$

$$\frac{c}{q(\theta_j^*)} = \frac{y_i - \left[\phi_j w_j^*(\varepsilon_j) + \left(1-\phi_j\right) w_j^*(\varepsilon_i)\right]}{r+\gamma}. \tag{13}$$

As it is acknowledged in appendix **??**, the free-entry conditions cannot be solved analytically in order to determine the impact of a region-specific shock on the other region's labor market tightness and unemployment level. Therefore, I proceed in simulating the model.

5.1 Parametrization

I parameterize the matching function as a Cobb-Douglas function:

$$m_i = a \times (u_i + \alpha u_j)^{\eta} \, v_i^{1-\eta}, \tag{14}$$

where a is the standard matching parameter and η is the matching function elasticity with respect to unemployment. I report the baseline parameter values used in the simulation in Table 1. The length of the period is one quarter. Matching parameter is commonly set to 1. Values for productivity, separation rate, discount rate, vacancy cost and unemployment insurance (or value of leisure) are taken from Shimer (2005). The worker's bargaining power is set to 0.5, the choice being driven by the common assumption of symmetric Nash bargaining. Following Hosios (1990), the matching function elasticity is assumed to be equal to a worker's bargaining power. Parameter α describes labor mobility. I therefore consider two cases : strong labor mobility $\alpha = 0.8$ and weak labor mobility $\alpha = 0.2$. Values for preferences ε_k are set to match reasonable unemployment rates (French regional data).

Baseline parameter values	
Matching parameter	1
Productivity in region i	1
Productivity in region j	1
Matching function elasticity	0.5
Separation rate	0.15
Rate of labor mobility	0.8 and 0.2
Workers' bargaining power	0.5
Discount rate	0.012
vacancy cost	0.213
Unemployment insurance	0.4
Preference for region i	0.1
Preference for region i	0.1

Table 1: Baseline parameter values

5.2 Asymmetric productivity shock

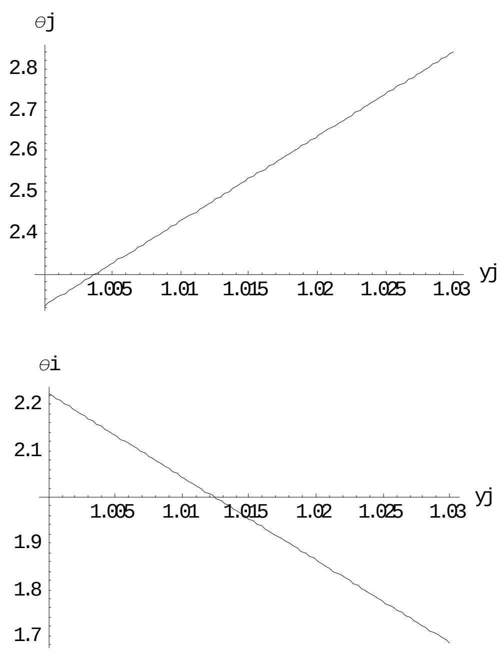

Figure 2-a: Regional productivity shock with strong labor mobility $\alpha = 0.8$: $d\theta_j/dy_j > 0$ and $d\theta_j/dy_i < 0$

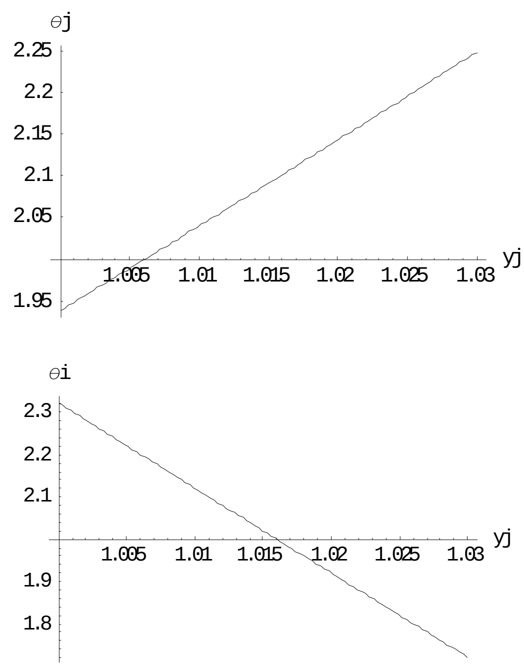

Figure 2-b: Regional productivity shock with weak labor mobility $\alpha = 0.2$: $d\theta_j/dy_j > 0$ and $d\theta_j/dy_i < 0$

Whether the two-region economy is characterized by a strong or weak labor mobility as depicted in Figures 2-a and 2-b, the impact of a region-specific shock at the steady state of the model is interpreted as follows : In an autarky economy, this shock shifts labor demand upward and induces a rise in wages $w_i(\varepsilon_i)$ and a decrease in unemployment in the region where it occurs. In contrast, when job seekers in the neighboring region have a positive probability (per unit of time) to find a job in the expanding region, the productivity shock improves their future opportunity. Therefore, workers' threat point when negotiating their wage in the neighboring region is increased, which enables them to obtain a higher level of wages $w_j(\varepsilon_i)$. In other words, a positive productivity shock in region i spills over the wage levels of both regions. In the region, this wage increase only attenuates the direct positive effect of productivity on the employment level. In contrast, labor market tightness of the neighboring region θ_j is shifted downwards since the productivity shock has no impact on the labor demand. Thus, the wage increase of $w_j(\varepsilon_i)$ induces a rise in unemployment. Hence, the two regions experience opposite changes in their unemployment rates while similar changes in their wage levels.

6 Conclusion

In this paper, I propose a theoretic rationale to investigate the interactions between two neighboring regions. I formulate a two-region model of unemployment associated with search frictions in the job market. I argue that geography matters by introducing imperfect labor mobility and individual region-specific preference. The entire analysis is performed in steady state. I show that a region-specific shock affects both regions. By affecting labor demand in the home region, the shock raises wages and offsets unemployment. In the neighboring region, the situation is different: wages are driven upwards since the future opportunities of the residing workers are enhanced. However, the demand side remains unaffected which triggers a higher level of unemployment.

A Firms

I derive the free-entry condition (5) by writing the following Bellman equations respectively representing the expected values of a filled job and of a vacant job in region i :

$$rJ_i(\varepsilon_k) = y_i - w_i(\varepsilon_k) + \gamma\left[J^V - J_i(\varepsilon_k)\right] \tag{15a}$$

$$rJ^V = -c + q(\theta_i)\left[\upsilon_1 J_i(\varepsilon_i) + (1-\upsilon_1) J_i(\varepsilon_j) - J^V\right] \tag{15b}$$

where J^V is the expected value of a vacant job. Applying the equilibrium condition $J^V = 0$ and combining equations (15a) and (15b) leads to (5). Equation (15a) can be re-written for a type-i worker as follows:

$$J_k(\varepsilon_i) = \frac{y_k - w_k(\varepsilon_i)}{r+\gamma} \tag{16}$$

B Wage determination

Equation (6a) can be splitted into the following two equations:

$$rV_i^E(\varepsilon_i) = w_i(\varepsilon_i) + \varepsilon_i + \gamma\left[V_i^S(\varepsilon_i) - V_i^E(\varepsilon_i)\right] \tag{17a}$$

$$rV_j^E(\varepsilon_i) = w_j(\varepsilon_i) + \gamma\left[V_i^S(\varepsilon_i) - V_j^E(\varepsilon_i)\right] \tag{17b}$$

By identically treating equation (8) I get:

$$V_i^E(\varepsilon_i) - V_i^S(\varepsilon_i) = \frac{\beta}{1-\beta} J_i(\varepsilon_i) \tag{18a}$$

$$V_j^E(\varepsilon_i) - V_i^S(\varepsilon_i) = \frac{\beta}{1-\beta} J_j(\varepsilon_i) \tag{18b}$$

Rearranging equations (17a), (17b) and (6b) yields the following two-equation system:

$$V_i^E(\varepsilon_i) - V_i^S(\varepsilon_i) = \frac{1}{r+\gamma+p(\theta_i)}\left\{w_i(\varepsilon_i) - b - \alpha p(\theta_j)\left[V_j^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right]\right\} \tag{19a}$$

$$V_j^E(\varepsilon_i) - V_i^S(\varepsilon_i) = \frac{1}{r+\gamma+\alpha p(\theta_j)}\left\{w_j(\varepsilon_i) - b - \varepsilon_i - p(\theta_i)\left[V_i^E(\varepsilon_i) - V_i^S(\varepsilon_i)\right]\right\} \tag{19b}$$

Taking into account equation (16) and plugging equations (18a) and (18b) into (19), yields the following system that I write in matrix form,

$$\begin{bmatrix} \beta p(\theta_i) & r+\gamma+\beta\alpha p(\theta_j) \\ r+\gamma+\beta p(\theta_i) & \beta\alpha p(\theta_j) \end{bmatrix} \begin{bmatrix} w_i(\varepsilon_i) \\ w_j(\varepsilon_i) \end{bmatrix} = \begin{bmatrix} \beta p(\theta_i) & \beta\left[r+\gamma+p(\theta_i)\right] \\ \beta\left[r+\gamma+\alpha p(\theta_j)\right] & \alpha\beta p(\theta_j) \\ (1-\beta)(r+\gamma) & (1-\beta)(r+\gamma) \\ (1-\beta)(r+\gamma) & 0 \end{bmatrix}^T \begin{bmatrix} y_i \\ y_j \\ b \\ \varepsilon_i \end{bmatrix}$$

which determines wage equations (9) and (10).

C Wage Static solutions

For a type-i worker in region i

$$\frac{dw_i\left(\varepsilon_i\right)}{dy_i}=\beta\frac{r+\gamma+p(\theta_i)+\beta\alpha p(\theta_j)}{r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)}>0 \tag{20a}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{dy_j}=\frac{\alpha\beta(1-\beta)p(\theta_j)}{r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)}>0 \tag{20b}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{db}=\frac{\left(1-\beta\right)\left(r+\gamma\right)}{r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)}>0 \tag{20c}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{d\gamma}=-\left(1-\beta\right)\frac{\beta p(\theta_i)y_i+\beta\alpha p(\theta_j)\left(y_j-\varepsilon_i\right)+\left(r+\gamma\right)b}{\left[r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)\right]^2}<0 \tag{20d}$$

$$\frac{dw_i(\varepsilon_i)}{d\beta}>0 \text{ (numerically resolved)} \tag{20e}$$

$$\frac{dw_i(\varepsilon_i)}{dr}=-\beta\left(1-\beta\right)\frac{p(\theta_i)\left(y_i-b\right)+\alpha p(\theta_j)\left(y_j-b-\varepsilon_i\right)}{\left[r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)\right]^2}<0 \tag{20f}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{d\varepsilon_i}=-\frac{\alpha\beta\left(1-\beta\right)p(\theta_j)}{r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)}<0 \tag{20g}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{d\theta_i}=\beta\left(1-\beta\right)p'\left(\theta_i\right)\frac{\left(r+\gamma\right)\left(y_i-b\right)+\alpha\beta p(\theta_j)\left(y_i-y_j+\varepsilon_i\right)}{\left[r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)\right]^2}\lesseqgtr 0 \tag{20h}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{d\theta_j}=\alpha\beta\left(1-\beta\right)p'\left(\theta_j\right)\frac{\left(r+\gamma\right)\left(y_j-b-\varepsilon_i\right)+\beta p(\theta_i)\left(y_j-y_i-\varepsilon_i\right)}{\left[r+\gamma+\beta p\left(\theta_i\right)+\beta\alpha p\left(\theta_j\right)\right]^2}\lesseqgtr 0 \tag{20i}$$

$$\frac{dw_i\left(\varepsilon_i\right)}{d\alpha}=\beta\left(1-\beta\right)p\left(\theta_j\right)\frac{\left(r+\gamma\right)\left(y_j-b-\varepsilon_i\right)+\beta p\left(\theta_i\right)\left(y_j-y_i-\varepsilon_i\right)}{\left[r+\gamma+\beta p\left(\theta_i\right)+\alpha\beta p\left(\theta_j\right)\right]^2}\lesseqgtr 0 \tag{20j}$$

For a type-i worker in region j

$$\frac{dw_j(\varepsilon_i)}{dy_i} = \frac{\beta(1-\beta)p(\theta_i)}{r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)} > 0 \quad (21a)$$

$$\frac{dw_j(\varepsilon_i)}{dy_j} = \beta\frac{r+\gamma+\beta p(\theta_i)+\alpha p(\theta_j)}{r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)} > 0 \quad (21b)$$

$$\frac{dw_j(\varepsilon_i)}{db} = \frac{(1-\beta)(r+\gamma)}{r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)} > 0 \quad (21c)$$

$$\frac{dw_j(\varepsilon_i)}{d\gamma} = -(1-\beta)\frac{\beta p(\theta_i)(y_i+\varepsilon_i)+\beta\alpha p(\theta_j)y_j+(r+\gamma)(b+\varepsilon_i)}{[r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)]^2} < 0 \quad (21d)$$

$$\frac{dw_j(\varepsilon_i)}{d\beta} > 0 \text{ (numerically resolved)} \quad (21e)$$

$$\frac{dw_j(\varepsilon_i)}{dr} = -\beta(1-\beta)\frac{p(\theta_i)(y_i-b)+\alpha p(\theta_j)(y_j-b-\varepsilon_i)}{[r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)]^2} < 0 \quad (21f)$$

$$\frac{dw_j(\varepsilon_i)}{d\varepsilon_i} = \frac{(1-\beta)[r+\gamma+\beta p(\theta_i)]}{r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)} > 0 \quad (21g)$$

$$\frac{dw_j(\varepsilon_i)}{d\theta_i} = \beta p'(\theta_i)\frac{(1-\beta)[\beta\alpha p(\theta_j)(y_i-y_j+\varepsilon_i)+(r+\gamma)(y_i-b)]}{[r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)]^2} \lesseqgtr 0 \quad (21h)$$

$$\frac{dw_j(\varepsilon_i)}{d\theta_j} = \alpha\beta p'(\theta_j)\frac{(1-\beta)[\beta p(\theta_i)(y_j-y_i-\varepsilon_i)+(r+\gamma)(y_j-b-\varepsilon_i)]}{[r+\gamma+\beta p(\theta_i)+\beta\alpha p(\theta_j)]^2} \lesseqgtr 0 \quad (21i)$$

D Equilibrium static solutions

I define functions $\Phi(\theta_i^*, y_i, y_j)$ and $\Phi(\theta_j^*, y_i, y_j)$ as follows

$$\Phi(\theta_i^*, y_i, y_j) = \frac{c}{q(\theta_i^*)} - \frac{y_i - \left\{\phi_i(\theta_i^*,\theta_j^*)\, w_i^*(\varepsilon_i,\theta_i^*,\theta_j^*) + \left[1-\phi_i(\theta_i^*,\theta_j^*)\right] w_i^*(\varepsilon_j,\theta_i^*,\theta_i^*)\right\}}{r+\gamma} = 0$$

$$\Phi(\theta_j^*, y_i, y_j) = \frac{c}{q(\theta_j^*)} - \frac{y_i - \left[\phi_j(\theta_i^*,\theta_j^*)\, w_j^*(\varepsilon_j,\theta_i^*,\theta_j^*) + \left[1-\phi_j(\theta_i^*,\theta_j^*)\right] w_j^*(\varepsilon_i,\theta_i^*,\theta_j^*)\right]}{r+\gamma} = 0$$

After total differentiating $\Phi(\theta_k^*)$ with respect to θ_k^* and y_k, it is straightforward that the effect of a productivity shock on the other region's tightness is ambiguous. Therefore, I calibrate the model in order to numerically solve equilibrium.

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