

Trade, Migration and Regional Unemployment*

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Abstract

We formulate a dynamic core-periphery model with frictions in the job matching process to study the interplay between trade costs, migration and regional unemployment in the short- and long-run. We find that the spatial distribution of unemployment mirrors (inversely) the distribution of economic activities. Further, we highlight a contrast between the short-run and the long-run effects of trade-induced migration on regional unemployment. In particular, an inflow of immigrants from the periphery into the core reduces the unemployment gap in the short-run, but exacerbates unemployment disparities in the long-run.

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1 Introduction

Regional disparities in unemployment rates are both high and persistent in Europe. A quick look at their geographic distribution reveals that regions of high unemployment come in clusters. In fact, distance from centers of high or low unemployment is a predictor for the functioning of local labor markets: in a detailed analysis of 150 European regions, Overman and Puga (2002) show that unemployment rates are more similar across regions that are close to each other than across regions with similar characteristics, such as the skill composition or sectoral specialization.¹ Further, differentials in unemployment rates persist over time, even within countries where barriers to labor mobility are low. This evidence suggests that geographic variables, such as the cost of distance, matter for regional unemployment and that a conventional view of migration as a mechanism to level-out regional disparities may be misleading.

In this paper, we argue that agglomeration forces and imperfections in the job matching process can be complementary for understanding the spatial distribution of unemployment and the effect of migration on regional labor markets. Although models of the new economic geography (NEG) provide a detailed picture of how agglomeration forces, as functions of transport costs, shape the geographic distribution of production and workers in the long-run, they generally neglect unemployment. To fill this gap, we introduce search frictions in labor markets in a NEG framework. Since search frictions regulate the dynamic adjustment of labor market imbalances, this exercise allows us to analyze the geography of unemployment and how it depends on migration, both in the short- and long-run.

To this end, we build a core-periphery model where trade costs generate agglomeration economies, workers are fully mobile across regions and frictions in the job matching process lead to equilibrium unemployment. We then use the model to show how regional unemployment, income and migration respond to a reduction of transport costs. Our focus on transport costs is motivated by the fact that distance, with its economic costs, is the key “geographic” element of the model, governing the strength of agglomeration economies. It should be noted that transport costs are intended to broadly measure (inversely) the degree of regional integration; historical improvements in communication networks, due to technical progress and investment in infrastructure, together with the fact that regional economies are becoming

¹More in general, the empirical literature on regional unemployment disparities finds a robust negative correlation between unemployment and proxies for market potential. See, among others, Molho (1995) and Hyclak and Johnes (1987).

increasingly weightless (Quah, 1997), suggest that these costs fell substantially over time and may be lowered in the future.²

Our main results, derived through numerical simulations, can be summarized as follows. First, we show that the agglomeration of economic activity causes core regions to enjoy lower unemployment than the periphery. Therefore, variables affecting the spatial distribution of production, such as transport costs, also affect regional disparities in unemployment. In particular, starting from a symmetric equilibrium for high trade costs, we find that regional integration triggers a wave of migration which leads to the emergence of a core-periphery equilibrium, with strong disparities both in terms of per capita income and unemployment. Further reductions of transport costs lead eventually to regional convergence, speeded up by return migration.

Second, we show that immigration lowers the unemployment rate of the host region in the long-run, but has the opposite short-run effect. For example, we find that a fall of transport costs may cause an inflow of immigrants from the periphery into the core that reduces at first the unemployment gap, but amplifies it in the new steady-state. The reason is that the immediate effect of migration is to reduce the pool of job seekers in the periphery and to raise it in the core, thereby reducing disparities. However, as soon as immigrants are gradually absorbed by the labor market of the core region, agglomeration forces kick in and lower local unemployment, while the opposite happens in the periphery.

The two basic ingredients of our model are agglomeration economies and search frictions. In particular, our model is related to the NEG literature (Fujita et al., 1999, Baldwin et al., 2003) and the equilibrium unemployment theory (Pissarides, 1990). Our picture of regional unemployment disparities in the long-run mirrors that of regional income disparities provided by NEG models. In this respect, we show that agglomeration forces can account not only for income inequality, but also for the uneven distribution of unemployment. Compared to more traditional NEG models, our framework has the interesting feature of having well-defined transitional dynamics even in the absence of any migration costs. Further, our paper is related to Monfort and Ottaviano (2002), who are the first to introduce search frictions into a NEG-type model. However, they do not allow for unemployment and focus on the steady-state relation between agglomeration and investment in human capital.

Our paper is also related to the literature investigating the link between migration and unemployment. In particular, Ortega (2000) uses a model with search frictions in the job mar-

²The fall of administrative barriers between European regions can also contribute to this process.

ket to show that immigration may reduce unemployment of the host region in the long-run. His result, which, like ours, is rather uncommon in the theoretical literature on migration, is generated by the assumptions that immigrants have a higher search cost than the natives and that the two countries' labor markets are structurally different. Because of these asymmetries, Ortega's analysis is appropriate for analyzing international migration, whereas our approach, in which regions are symmetric, workers are identical and mobile at no cost, is more appropriate for analyzing internal migration in developed countries. Further, our short-run result that immigration increases unemployment in the core region and reduces it in the periphery has a Harris-Todaro (1970) flavor. However, the Harris-Todaro model, which assumes exogenous structural differences among regions, was specifically intended to investigate internal migration in developing countries rather than in advanced countries.

Finally, our assumptions that regions are initially identical and have segmented labor markets, that workers are freely mobile and that congestion effects linked to population density restrain people from migrating toward richer regions make our model suited for analyzing internal migration in European countries. In fact, we view these countries as composed of structurally similar regions (apart from asymmetries arising from the agglomeration of economic activity) characterized by low internal migration costs, poorly integrated labor markets, and congestion costs due to the high population density. The model is probably less appropriate to study the U.S. States, where labor and good markets are highly integrated and industrial composition more specialized in advanced sectors (Saint-Paul, 2002), where agglomeration may spur creative destruction, firm turnover and job insecurity. This latter element is missing in our analysis as it is not central to understanding the European unemployment experience.

The paper is organized as follows. Section 2 sets out the formal model. Section 3 analyzes the steady-state properties of the model, whereas Section 4 analyzes the transitional dynamics. Section 5 concludes.

2 The Model

In this section we describe a core-periphery model along the lines of Krugman (1991) and Helpman (1998). Our main innovation is to allow for equilibrium unemployment stemming from frictions in the job matching process. We consider an economy in which there are two regions, North and South (indexed by $i = N, S$), two factors, farmers and workers, and two sectors, agriculture and manufacturing, whose output is costlessly assembled to produce an

endogenously nontraded good. The two regions share the same preferences, technology and original endowments. To capture the notion of “distance” between the two regions (to be interpreted in a broad sense), we consider a trade cost on manufactured goods only. Firms in manufacturing use workers to produce a variety of manufactured goods. Workers are freely mobile between the two regions and their final location is endogenous. The agricultural sector employs farmers to produce an homogeneous good. Farmers account for a fraction $(1 - \mu) \in (0, 1)$ of the total population, which is normalized to unity. As in Krugman (1991), farmers are immobile and divided evenly between the two regions.³ Finally, similar to Helpman (1998), we introduce a congestion effect linked to the regional density of population.⁴ This assumption captures the idea that congestion lowers welfare by reducing access to local amenities available in fixed supply. We lay out the model in discrete time;⁵ however, in order to save on notation, we omit the time index from all the static equations.

2.1 Households

Individuals are risk-neutral, have time separable preferences, and discount future utility at the rate $(1 + r)^{-1}$. Utility of any agent in region i is given by:

$$V_{i,t=0} = \sum_{t=0}^{\infty} (1 + r)^{-t} [(1 - \epsilon) c_{i,t} + \epsilon a_{i,t}] \quad (1)$$

where instantaneous utility comes from consumption of regional output, c_i , and from the availability of nontraded local “amenities”, a_i . The parameter ϵ captures the importance of nonwage factors a_i relative to consumption in utility. We assume that amenities are rival, so

³Immobile farmers provide the centrifugal force that sustains the symmetric equilibrium for high levels of trade barriers. This assumption is formally equivalent to assume a region-specific component in the demand for manufactured goods (including, for example, demand from immobile consumers outside the labor force, but also demand for construction and maintenance of local public infrastructure). Without the agricultural sector (or with farmer mobility), the symmetric equilibrium for high trade barriers would always be unstable, but most of the results would be unchanged.

⁴As shown by Helpman (1998), Tabuchi (1998), Puga (1999), and Ottaviano et al. (2002), congestion acts as a centrifugal force different from farmers immobility. The main implications of congestion are the (re)dispersion of economic activity for sufficiently low trade costs and to guarantee that some manufacturing workers will always stay in the periphery. Without the congestion effect, moving a worker from the periphery to the core would increase the geographic advantage of the core, because of agglomeration economies, and hence attract more workers. This cumulative process would go on until no manufacturing worker is left in the periphery. Conversely, the congestion effect, alone, is unable to sustain the symmetric equilibrium for high trade costs, because, even if some workers are always left in the periphery, their income share would shrink as τ grows and so would the market potential of the peripheral region.

⁵Discrete time allows us to use numerical methods to solve for transitional dynamics of the model.

that each consumer enjoys only a fraction $a_i = A_i/L_i$, where L_i is the manufacturing workforce of region i and A_i is the total amount of local amenities the region offers. This assumption is intended to capture a congestion effect that reduces utility in a region experiencing an increase in population density.⁶ We think of it as the limited availability of land area and houses, environmental deterioration due to overurbanization, pollution and other nonwage factors in fixed supply. To preserve symmetry, we assume that the two regions offer the same total amount of amenities, which is normalized to unity: $A_i = A_j = 1$.

2.2 Production

Regional output, Y_i , is an endogenously nontraded Cobb-Douglas aggregate of an agricultural input, X_i , and a bundle of differentiated manufactured inputs, M_i :⁷

$$Y_i = \left(\frac{M_i}{\mu}\right)^\mu \left(\frac{X_i}{1-\mu}\right)^{1-\mu}$$

The agricultural good is homogeneous and produced in each region by $(1-\mu)/2$ immobile farmers under constant returns to scale and perfect competition. It is freely traded and taken as the numeraire. Productivity in agriculture is set equal to one. The role of this sector is only to sustain demand in the peripheral region that retains a small share of manufacturing workers. For this reason, we interpret it in a broad sense that includes traditional activities that cannot be easily relocated. For simplicity, we do not study farmers' unemployment.

The manufacturing bundle M_i is defined as a CES function over a continuum of measure n of varieties produced by firms in the whole economy:

$$M_i = \left[\int_0^n (m_{i,v})^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}} \quad (2)$$

where $\sigma > 1$ is the elasticity of substitution between any two varieties and $m_{i,v}$ is aggregate demand for variety v in region i . By minimizing the cost of obtaining one unit of M_i we find

⁶For simplicity, we do not include farmers (which are equally distributed between the two regions) in the definition of the congestion term a_i . A justification may be that farmers do not contribute much to overurbanization and pollution compared to manufacturing workers. Given that in our simulations the parameter ϵ , capturing the strength of the congestion effect, is calibrated to yield that a certain fraction of workers stays in the periphery, including farmers in the congestion term would only affect our calibration of ϵ and leave the results unchanged.

⁷Aggregate output Y is made of two goods one of which, M , is subject to transport costs. It seems then natural to assume that Y , if traded, is subject to transport costs equivalent to the cost of shipping its content of good M . Under this assumption, it is possible to show that there is no incentive to trade Y .

the price index for the bundle M_i :

$$q_i = \left[\int_0^n (p_{i,v})^{1-\sigma} dv \right]^{1/(1-\sigma)} \quad (3)$$

where $p_{i,v}$ is the final price of variety v . Aggregate demand for each variety is obtained by using Shephard's lemma on the expenditure function $q_i M_i$:

$$m_{i,v} = \frac{(p_{i,v})^{-\sigma}}{q_i^{1-\sigma}} \mu P_i Y_i \quad (4)$$

where P_i is the price index in region i (and $P_i = q_i^\mu$), $P_i Y_i$ is nominal income and μ is the share of income devoted to manufacturing goods implied by the Cobb-Douglas aggregator, so that $q_i M_i = \mu P_i Y_i$.

Manufacturing firms are monopolistically competitive, symmetric and need one worker each; firms and workers are matched in the labor market through a process that requires time. This assumption captures the idea that heterogeneities in skills and jobs make it costly for a firm and a worker to find a suitable partner. Once employed, a worker produces one unit of a single variety which coincides with the final output of the firm, $m_v = 1$. Since the price of any variety is decreasing in the quantity supplied, no two firms will find it convenient to produce the same variety. Furthermore, as differentiated goods can be traded, each region will specialize in a different range of varieties so that $n_N + n_S = n$. Given symmetry in production and demand, every variety from each region will have the same production price p_i . Production prices can differ from final prices because of an "iceberg" trade cost: of $\tau > 1$ units shipped to the other region, only one unit arrives at the destination. This implies that the final price in region i of a variety produced in region j is $p_j \tau$ and the price index (3) reduces to:

$$q_i = \left[n_i p_i^{1-\sigma} + n_j (p_j \tau)^{1-\sigma} \right]^{1/(1-\sigma)} \quad (5)$$

for $i, j = N, S$ and $i \neq j$.

2.3 The Labor Market

We now describe the matching process in the regional labor markets, which are assumed to be segmented.⁸ As a firm decides to enter the market, it has to post a vacancy and incurs a search cost of c units of Y_i in every period until a suitable worker has been found. The search cost is financed by borrowing from households at the real interest rate $(1 + r)$, so that aggregate output Y_i is allocated between consumption and investment in vacancies. Following Pissarides (1985, 1990), the frictions generated by heterogeneity in the labor market are summarized by a function that gives the measure of successful matches per period. In the simplest approach, this function depends positively on the number of job seekers and the number of vacant jobs. For tractability, we assume that it takes the form $u_i v_i / (u_i + v_i)$, where u_i represents the unemployment rate and v_i is the number of searching firms as a fraction of the labor force.⁹ Defining $\theta_i = v_i / u_i$ as the “tightness” of the labor market, we can write the probability (Θ_i) that an unemployed worker will be matched as a monotonically increasing function of θ_i :

$$\Theta_i = \frac{v_i}{u_i + v_i} = \frac{\theta_i}{1 + \theta_i}$$

Similarly, the probability that a firm will fill a vacancy is $u_i / (u_i + v_i) = 1 / (1 + \theta_i) = (1 - \Theta_i)$. Matches are destroyed at the exogenous rate s . Upon separation, both the firm and the worker must reenter the labor market.

The asset value at time t of a firm with a filled job, $Vf_{i,t}$, can be expressed, in units of final output, as the sum of its real profits at time t , $(p_{i,t} - w_{i,t}) / P_{i,t}$ (where $w_{i,t}$ denotes the wage rate), plus the expected discounted value of the firm at time $t + 1$:

$$Vf_{i,t} = \frac{p_{i,t} - w_{i,t}}{P_{i,t}} + \frac{(1 - s)Vf_{i,t+1} + sVv_{i,t+1}}{1 + r} \quad (6)$$

Note that with probability s the match is destroyed, and hence the value of the firm falls to $Vv_{i,t+1}$, which represents the value at time $t + 1$ of a searching firm. Next period income

⁸The assumption that regional labor markets are segmented implies that workers only search in the region of residence. Although it may seem restrictive, this assumption is supported by available evidence. For instance, with reference to France and Britain, Petrongolo and Wasmer (1999) find that workers’ search intensity in adjacent regions is only about 10 percent of the search intensity in the region of residence.

⁹The chosen formulation for the matching function ensures a proper discrete time matching, i.e., that the matching probabilities for workers and firms posting a vacancy are each less than one. This property would be lost in discrete time with a Cobb-Douglas specification (which is instead commonly used in continuous time models). Note, also, that the chosen matching function exhibits constant returns to scale, in line with most empirical estimates. See Petrongolo and Pissarides (2001) on this point.

is discounted by the rate of time preference (equal to $(1+r)^{-1}$ due to risk-neutrality of consumers).

Similarly, the value at time t of a firm posting a vacancy, $Vv_{i,t}$, equals the expected discounted value of the firm in the next period, minus the search cost c :

$$Vv_{i,t} = -c + \frac{\Theta_{i,t}Vv_{i,t+1} + (1 - \Theta_{i,t})Vf_{i,t+1}}{1 + r} \quad (7)$$

Note that the value of the firm rises to $Vf_{i,t+1}$ in case of a successful match, i.e., with probability $(1 - \Theta_{i,t})$.

We assume free entry of firms, hence, the value of posting a vacancy must be zero. Imposing $Vv_i = 0$ in (7) yields:

$$Vf_{i,t+1} = \frac{(1+r)c}{1 - \Theta_{i,t}} \quad (8)$$

Using (8) into (6) and imposing $Vv_i = 0$, we obtain:

$$Vf_{i,t} = \frac{p_{i,t} - w_{i,t}}{P_{i,t}} + \frac{(1-s)c}{1 - \Theta_{i,t}} \quad (9)$$

The value, in terms of utility, for an employed worker, $Ve_{i,t}$, equals current period utility, $(1 - \epsilon)w_{i,t} + \epsilon/L_{i,t}$, plus its expected discounted value at time $t + 1$:

$$Ve_{i,t} = (1 - \epsilon)w_{i,t} + \frac{\epsilon}{L_{i,t}} + \frac{(1-s)Ve_{i,t+1} + s \max\{Vu_{i,t+1}, Vu_{j,t+1}\}}{1 + r} \quad (10)$$

for $i, j = N, S$ and $i \neq j$. Note that, with probability s the match is destroyed and the worker becomes unemployed. In that case, the value falls automatically to the highest value of being unemployed in the two regions, $\max\{Vu_{i,t+1}, Vu_{j,t+1}\}$, as the worker can move freely to the location offering the best prospects.

By the same reasoning, the value for a job seeker equals:

$$Vu_{i,t} = \frac{\epsilon}{L_{i,t}} + \frac{\Theta_{i,t}Ve_{i,t+1} + (1 - \Theta_{i,t}) \max\{Vu_{i,t+1}, Vu_{j,t+1}\}}{1 + r} \quad (11)$$

Wages are flexible, i.e., there is renegotiation in each period (see Pissarides, 1985).¹⁰ They are

¹⁰The assumption of flexible wages is commonly made in search models for tractability. In this context, it rules out the possibility that regional unemployment disparities are affected by institutional rigidities in the regional wage-setting process, as suggested instead by some authors (see Jimeno and Bentolila, 1998, for the

determined as the solution to a Nash bargaining problem, implying that the worker surplus is a constant fraction β of the total surplus generated by the match. To calculate this, we express the worker surplus as the amount of consumption goods that leaves a worker indifferent between staying in the job and becoming unemployed. Then, wages must satisfy the sharing condition:

$$\frac{Ve_i - \max\{Vu_i, Vu_j\}}{1 - \epsilon} = \beta \left(\frac{Ve_i - \max\{Vu_i, Vu_j\}}{1 - \epsilon} + Vf_i \right) \quad (12)$$

where the left hand side represents the worker surplus (in terms of Y) and the right hand side is β times the total surplus.

Workers are freely mobile between the two regions. An unemployed worker of region j will migrate to region i if and only if $Vu_i > Vu_j$ and an employed worker only if $Vu_i > Ve_j$. Hence, the equilibrium distribution of the workforce (L_i, L_j with $L_i + L_j = \mu$) is characterized by the following conditions:

$$\begin{cases} Vu_i = Vu_j & \text{if } \min\{u_i, u_j\} > 0 \\ u_j = 0 & \text{if } Ve_j > Vu_i > Vu_j \\ Vu_i = Ve_j \text{ and } u_j = 0 & \text{otherwise} \end{cases} \quad (13)$$

In the first case, we are at an interior solution: only a fraction of the unemployed workers move and the distribution of labor is determined by the indifference condition $Vu_i = Vu_j$. In the second case, all the unemployed workers decide to leave region j , but all the employed prefer to stay, so that $L_j = n_j$. In the third case, all the unemployed and some employed workers decide to move and do so until the value of being employed is equalized to that of searching for a job in the other region. Given that $Ve_j \rightarrow \infty$ as $L_j \rightarrow 0$, there will always be employed workers left in each region. Finally, in each period t , a measure $sn_{i,t}$ of jobs are exogenously destroyed, whereas a measure $\Theta_{i,t}u_{i,t}L_{i,t}$ of new jobs are created. Hence, the measure of producing firms, which is identically equal to the measure of employed workers, evolves according to the following law of motion:

$$n_{i,t+1} = \min\{(1 - s)n_{i,t} + \Theta_{i,t}u_{i,t}L_{i,t}, L_{i,t+1}\} \quad (14)$$

where the latter term takes into account the case in which a fraction of the employed workers

Spanish case). Our assumption of flexible wages allows us to isolate a different mechanism.

decide to migrate.

2.4 General Equilibrium

In order to close the model, we impose the following general equilibrium constraints. First, regional nominal income equals the value of agricultural production plus manufacturing:

$$P_i Y_i = \frac{1 - \mu}{2} + p_i n_i \quad (15)$$

Further, since we allow for equilibrium unemployment, the labor market clearing condition is replaced by the requirement that the number of employed workers be equal to the number of active firms:

$$n_i = L_i (1 - u_i) \quad (16)$$

Finally, given regional income, market clearing for manufacturing goods requires the total supply of each variety (one unit) to equal total demand from both regions. Using (4), we obtain:

$$1 = \frac{p_i^{-\sigma}}{q_i^{1-\sigma}} \mu P_i Y_i + \frac{p_i^{-\sigma} \tau^{1-\sigma}}{q_j^{1-\sigma}} \mu P_j Y_j \quad (17)$$

for $i, j = N, S$ and $i \neq j$.

Using (15) and (16) into (17) we finally obtain:

$$p_i^\sigma = \mu \left[q_i^{\sigma-1} \left(\frac{1 - \mu}{2} + p_i L_i (1 - u_i) \right) + \left(\frac{q_j}{\tau} \right)^{\sigma-1} \left(\frac{1 - \mu}{2} + p_j L_j (1 - u_j) \right) \right] \quad (18)$$

Equation (18) shows that the total demand for a manufacturing firm located in region i is higher the higher is income in regions i and j , the lower is competition in these markets (i.e., the lower are q_i and q_j , which are decreasing in the number of firms selling in markets i and j) and the lower are transport costs.¹¹ Note that, ceteris paribus, transport costs reduce the share of market j in the total sales of firms located in region i . Hence, local income has a disproportionate effect on local firms' demand relative to income from the other region (the so-called home market effect). This implies that a reshuffling of unemployment from region

¹¹Equation (18) is the equivalent of the so-called wage equation of NEG models. See, for instance, Fujita et al.(1999) pp. 42-43.

i to region j (and hence a reshuffling of income from region j to region i) has the effect of increasing (reducing) total demand for firms located in region i (j).

3 Steady-state analysis

In steady-state all the variables must be constant and there is no migration.¹² Solving equations (10) and (11) for $Ve_{i,t} = Ve_{i,t+1}$ and $Vu_{i,t} = Vu_{i,t+1}$, we obtain:

$$Ve_i = \frac{r+1}{r} \left[\frac{(r+\Theta_i)(1-\epsilon)w_i}{(r+s+\Theta_i)P_i} + \frac{\epsilon}{L_i} \right] \quad (19)$$

$$Vu_i = \frac{r+1}{r} \left[\frac{\Theta_i(1-\epsilon)w_i}{(r+s+\Theta_i)P_i} + \frac{\epsilon}{L_i} \right] \quad (20)$$

Similarly, imposing $Vf_i(t) = Vf_i(t+1)$ in (9) and (8) gives the following price equation:

$$p_i = w_i + \frac{cP_i(r+s)}{1-\Theta_i} \quad (21)$$

Using (9), (12), (19), (20) and (21) we can express the equilibrium real wage and real price of a variety produced in region i , p_i/P_i , as functions of the labor market tightness and parameters:

$$\frac{w_i}{P_i} = \frac{\beta c (\Theta_i + r + s)}{(1-\beta)(1-\Theta_i)} \quad (22)$$

$$\frac{p_i}{P_i} = \frac{\beta c [\Theta_i + (r+s)/\beta]}{(1-\beta)(1-\Theta_i)} \quad (23)$$

As a final requirement, in steady-state the number of unemployed workers is constant. From (14), this implies that the flow of laid off workers offsets exactly the flow of job seekers who are hired. Hence, from (14) and (16), the steady-state rate of unemployment is given by:

$$u_i = \frac{s}{s+\Theta_i} \quad (24)$$

Summarizing, the steady-state of the system is described by equations (5), (8), (13), (15)-(17), (19), (20), (22)-(24), and by the equivalent equations for region j .

We can now explore the steady-state properties of the model. Since the system is non

¹²The absence of migration in a steady-state is rational in the presence of a positive, but arbitrarily small, migration cost.

linear and has no analytical solution, we proceed by numerical simulations. We consider first the effects of decreasing trade costs, τ , on the geographic distribution of production, people and unemployment; then, we mention the effects of the other parameters in the model.

3.1 Trade, migration and regional unemployment

Before turning to numerical examples, we briefly summarize the forces that affect the geographical structure of the economy. Since the two regions are originally identical, the model will always exhibit a symmetric equilibrium in which manufacturing production is evenly distributed. However, labor mobility implies that a geographically differentiated production structure may arise. The specific outcome depends on the migration choice, which is in turn determined by a tension between centripetal and centrifugal forces. Trade costs in manufacturing generate agglomeration forces, that tend to attract firms and workers toward the region with the larger market to save on transport costs. Centrifugal forces arise because competition for local farmers' demand is lower in the smaller region and this tends to increase, *ceteris paribus*, wages and profits in the peripheral region. Congestion further reduces the incentive for agglomeration. Consistent with a well-established result from the new economic geography literature (e.g., Baldwin et al., 2003 and Fujita et al., 1999), we find that for very high or very low trade costs centrifugal forces prevail, so that the symmetric equilibrium is unique. Conversely, agglomeration forces prevail for intermediate levels of trade costs. In this case, the symmetric equilibrium becomes unstable and a stable core-periphery pattern emerges: workers and firms leave the peripheral region (the South) and manufacturing production becomes partially agglomerated in the core region (the North).¹³

3.1.1 Parametrization

The baseline parameter values used in our simulations are reported in Table 1. The length of the period is one quarter. Accordingly, the interest rate is set to $r = 0.02$, equivalent to an annual discount factor of 0.923. The job separation rate is $s = 0.045$ to yield an average job duration of about 5.5 years, consistent with the recent European experience (Pissarides,

¹³As in other core-periphery models, we also find that, before the symmetric equilibrium breaks down, there is a range of trade costs where both types of equilibria are stable. Unfortunately, we cannot characterize the break-point of the model and the stability of equilibria analytically. The reason is that our dynamic system is non-linear and has two state variables, making the analysis very cumbersome. To study local stability properties of equilibria we have linearized the system in a neighborhood of the steady-state. Details on the transitional dynamics are discussed in Section 4.

1998). The worker’s rent share, β , is one half, as implied by the common assumption of symmetric Nash bargaining. The recruitment cost, c , is chosen to give reasonable values for the unemployment rate. The weight of amenities in utility, ϵ , is set to yield a share of manufacturing workers left in the periphery roughly equal to 20% of the original manufacturing workforce. For the elasticity of substitution between manufactures, σ , we refer to a recent literature that provides empirical estimates of NEG parameters.¹⁴ In particular, using data on regions from the largest EU countries, Crozet (2003) estimates σ to vary between 1.3 and 5.6. Hanson (2001)’s estimates, based on U.S. county panel data, vary instead between 5 and 7.6. We therefore choose the intermediate value of $\sigma = 5$. Finally, the share of the manufacturing, μ , is set to 0.75, implying that one-fourth of national expenditure is region-specific. The chosen value for μ is lower than the value suggested by some recent, preliminary, estimates;¹⁵ yet, higher values of μ , which imply strong agglomeration forces, are unusual in the theoretical literature. We then preferred to be conservative in our baseline parametrization. Since, however, the quantitative implications of the model are sensitive to the choice of σ and μ , in the next section we report how the main results change using alternative values.

Table 1 Baseline parameter values

Interest rate	$r = 0.02$ per quarter
Elasticity of substitution among manufactures	$\sigma = 5$
Share of mobile sector	$\mu = 0.75$
Separation rate	$s = 0.045$ per quarter
Worker’s bargaining power	$\beta = 0.5$
Search costs	$c = 0.9$
Weight of amenities in preferences	$\epsilon = 0.015$

3.1.2 Results

Figure 1 summarizes the steady-state evolution of regional variables as a function of trade costs.¹⁶ Only stable equilibria are displayed. In all graphs the solid line represents Northern

¹⁴See, in particular, the survey in Head and Mayer (2003).

¹⁵For instance, Hanson (2001)’s estimate of μ derived from the structural estimation of a NEG model is about 0.9.

¹⁶Available estimates of trade costs within countries suggest that they rise very quickly with distance. For instance, Crozet (2003)’s estimates of the elasticity of trade costs with respect to distance vary between 0.5 and 3 within European countries. Hanson (2001)’s estimates of the elasticity of trade costs with respect to distance in the U.S. also vary considerably, depending on the time period and the details of the estimation procedures. In particular, they lie between 1.6 and 8.



Figure 1: Steady-states as functions of transport costs

variables whereas the dashed line refers to the South. The fall of trade costs is represented by a movement to the left on the x-axis.

Panel (a) reports the share of manufacturing workers in the two regions. For very high τ there is only one equilibrium in which workers are evenly divided between the two regions (the solid and dashed lines are overlapped). When trade costs are reduced below a threshold level, the symmetric equilibrium breaks down: employment and production agglomerate discontinuously in the core, although the periphery keeps a positive share of manufacturing.¹⁷ The graph also shows that, before the symmetric equilibrium loses stability, there is a small range of trade costs where both the symmetric and the partially agglomerated equilibria are

¹⁷The reason for partial agglomeration is that in this model, contrary to Krugman (1991), agglomeration forces are bounded by the congestion effect. Partial agglomeration is also a feature of Puga (1999)'s model, under the assumptions of interregional immobility of labor and decreasing marginal productivity of labor in the residual sector. Recently, Tabuchi and Thisse (2002) and Murata (2003) have shown that partial agglomeration can also be generated by heterogeneity in workers' valuation of local amenities.

stable.¹⁸ In this range, a sufficiently large shock may move the economy from one equilibrium to the other. The breakdown of the symmetric equilibrium is followed by a substantial range of trade costs where regional integration is associated with small changes in the geographic distribution of workers and production. Finally, for low trade costs agglomeration forces are weakened and can no longer offset the disutility induced by congestion in the North. This triggers a wave of return migration to the South until the symmetric equilibrium is restored.

Panel (b) reports the price index of manufacturing, which can be thought of as an inverse index of regional productivity in manufacturing. When symmetry breaks down, a large mass of workers and firms leave the South, and hence this region has to import most manufacturing goods from the North. As a consequence, trade costs become a relevant component of the price index, which explains its dramatic increase in the South. The opposite happens in the North, where agglomeration induces a fall in the volume of imports and in the price index. Note, also, that further falls in trade costs imply a different response by the two regions' price indexes. Since Northern imports from the South are small, the price index is fairly stable in this region. Conversely, since the South imports most manufacturing goods from the North, the fall of its price index closely mirrors the fall of trade costs.

Panel (c) illustrates the evolution of regional rates of unemployment. To gain some intuition, it is useful to rewrite equation (21) as follows:

$$\Theta_i = 1 - \left(\frac{p_i - w_i}{P_i} \right)^{-1} c(r + s) \quad (25)$$

When the symmetric equilibrium breaks down, migration causes a sharp fall of the price index in the North. This increases the real value of profits in the North and induces the opening of new vacancies, thereby raising the labor market tightness in the North. The opposite happens in the South, where the rise in the price index deteriorates the labor market conditions. This translates into a core-periphery unemployment gap. Note, from (18), that there is also an indirect effect at work. The fall of unemployment in the North and the rise in the South raise demand for Northern firms and reduce demand for Southern firms, thereby giving an extra push to agglomeration forces and amplifying the core-periphery unemployment gap.

Panel (c) also shows that, for low trade costs, the geographic advantage of the core vanishes, so that the periphery experiences a wave of return migration which reduces the

¹⁸This is a common feature of core-periphery models (e.g., Krugman, 1991, Fujita et al. 1999 and Baldwin et al. 2003). We are not interested in this multiplicity, which is not always robust to alternative specifications of the congestion effect.

steady-state rate of unemployment (partly at the expense of the North). Hence, as migration generated the emergence of regional disparities, return migration speeds up the process of convergence. Finally, once the symmetric equilibrium is restored, further falls in trade costs reduce unemployment in both regions because they lower the price index of manufacturing.

Panel (d) shows the evolution of regional real wages. Note that, in the symmetric equilibrium (i.e., for very high or low trade costs), a fall in trade costs raises real wages in both regions by lowering the price index of manufacturing. However, when symmetry breaks down, real wages rise in the North and fall in the South, due to the divergent behavior of the price index in the two regions. Further falls in trade costs have little impact on real wages in the North, since most manufacturing goods are produced there. In contrast, real wages are very sensitive to trade costs in the South, since this region imports most manufacturing goods. This implies that, once the core-periphery pattern is settled and migration has *de facto* ceased, trade integration induces real wage convergence, leading to return migration for low enough trade costs.

Figure 1 is a collection of steady-state equilibria. Overall, it provides a picture of the relation between trade costs and the geography of production, people and unemployment in the very long-run. Its main message is that, in historical perspective, geographic variables matter for unemployment, since the geography of unemployment strictly follows (inversely) the geography of production. This means that the variables, such as trade costs, that influence the spatial distribution of economic activities also determine unemployment. Note, however, that there is a substantial range of intermediate trade costs where regional integration is associated with an almost unchanged geography of production. Interestingly, in this range the model mimics the recent experience of regional inequality within European countries, characterized by low and falling migration rates despite persistent disparities both in terms of unemployment and per capita income, just as illustrated in Figure 1.¹⁹

Finally, the model suggests that, contrary to conventional wisdom, the unemployment gap is triggered by migration flows. In particular, in-migration, by fuelling agglomeration forces, reduces unemployment and raises real wages in the host region, whereas out-migration raises unemployment and lowers real wages for those left behind. In the next section we will show that this result holds only in the long-run; in fact, during the short-run adjustment, migration tends to increase unemployment in the host region.

¹⁹See, among others, Faini et al. (1997), Bentolila (1997) and Mauro et al. (1999).

3.1.3 Alternative parametrizations

The general pattern displayed in Figure 1 is fairly robust to alternative parametrizations. The most notable changes take place when the strength of agglomeration forces vary. This, in turn, is determined by σ , μ and ϵ . As it is well known from the new economic geography literature, a higher share of manufactured goods in production, μ , or a lower elasticity of substitution among varieties, σ , imply stronger agglomeration forces. In terms of Figure 1, this translates into wider core-periphery disparities and a higher critical value of τ under which symmetry is broken.²⁰ Similarly, a lower weight of nonwage factors in utility, ϵ , implies a lower disutility from congestion and a stronger incentive to agglomerate production in one region, thereby inducing greater regional disparities and a lower share of workers left in the periphery.

Given that there is some disagreement on estimates of σ and μ , we want to have a sense of how the quantitative predictions of our model depend on them. Further, we want to assess the ability of the model to generate quantitatively significant North-South inequalities. To this end, Table 2 shows, for a given level of transport costs ($\tau = 2$), the rate of unemployment in the periphery relative to that in the core predicted by the model under alternative values of σ and μ found in the literature.

Table 2. Relative unemployment

	$\mu = 0.75$	$\mu = 0.9$
$\sigma = 3$	1.35	1.81
$\sigma = 5$	1.17	1.34
$\sigma = 7$	1	1.2

Note: u_{South}/u_{North} at $\tau = 2$

Note that, with strong agglomeration economies ($\sigma = 3$ and $\mu = 0.9$) the model yields a peripheral unemployment rate that is 81% higher than that in the core, a value not far from the one observed in some European countries, such as Spain and Italy; for intermediate cases, the model generates a North-South unemployment gap in the range of 20% – 30%, perhaps too small to match the regional unemployment disparities in these countries, but still remarkable given that it comes from a model with no structural asymmetries between regions, no migration costs and no regional wage stickiness.

²⁰If agglomeration forces are too strong, the symmetric equilibrium is always unstable. Our simulations confirm that the symmetric equilibrium is stable for high trade costs when $(\sigma - 1)/\sigma > \mu$, i.e., when the so-called no-black-hole condition is satisfied (see Fujita et al., 1999, pp. 58-59).

Finally, regional disparities are not very sensitive to the labor market parameters, namely, the rate of job destruction, s , the share of the match surplus that goes to workers, β , and the search cost, c . Variation in these parameters generally induces changes in the regional rates of unemployment in the direction predicted by the equilibrium unemployment theory. For instance, a rise of s , c or β causes unemployment to rise in both regions. Extensive simulations showed, however, that varying these parameters within any plausible range has only minor effects on regional inequalities.

4 Transitional dynamics

In this section, we study the adjustment path which leads the system from one steady-state to another after an unanticipated, permanent shock. In order to accomplish this, we have linearized the model around its steady-state. More details on the solution method are provided in the Appendix. We consider two types of shocks: a reduction of transport costs (τ) and an increase in the share of manufacturing (μ). The first exercise naturally complements our previous analysis, as it gives a picture of the short-run adjustment between the steady-states displayed in Figure 1. The second exercise is also interesting, for an increase in μ represents an expansion of the mobile, increasing returns, sector and a strengthening of agglomeration forces; such a change is historically realistic and relevant for our analysis of regional disparities, since it affects the core and the periphery in a very different way.

As a point of departure, we have chosen an equilibrium in which manufacturing is already partially agglomerated in the North, which seems the empirically relevant case. Figure 2 shows the results of the following exercise: at time $t = 0$ the economy is in steady-state and at $t = 1$ there is a one and for all unanticipated fall in trade costs from $\tau = 2.1$ to $\tau = 2$. The other parameters are those reported in Table 1. Note that the dynamic system which governs the short-run adjustment has two state variables, namely the employment levels in the two regions: as the matching process between jobs and workers requires time, the response of employment levels to a change in the environment is gradual. No other variable is assumed to be sluggish.

Panel (a) plots the time path of the total manufacturing employment in the North. In this exercise, the reduction of trade costs reinforces the geographical advantage of the North, which makes the core region more attractive for locating manufacturing workers. The result is a wave of migration from the periphery. As already noted, the reaction of employment is gradual: it rises gradually in the North, where the higher number of job seekers increases the likelihood

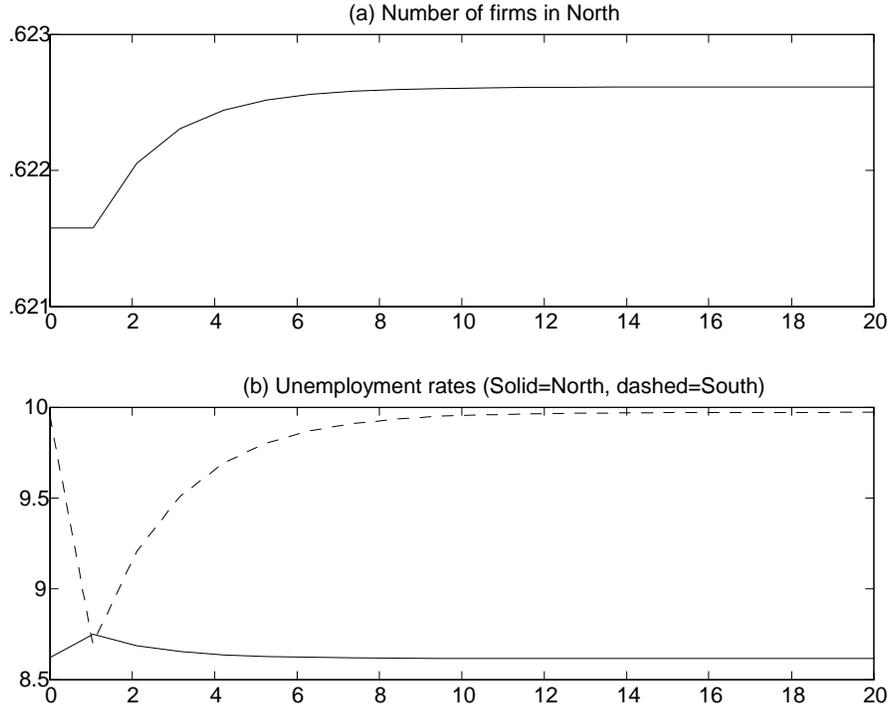


Figure 2: Transitional dynamics (a fall of τ)

of a match. Similarly, it falls smoothly in the South, because the rate of job destruction is not compensated any more by new matches. The eventual increase in employment in the North and the fall in the South strengthen even more agglomeration forces in the core region, until the new steady state is reached.²¹

Panel (b) shows the evolution of regional unemployment rates. As unemployed workers move from the South to the North, the instantaneous effect of a fall in trade costs is a temporary discrete fall in the unemployment rate of the South and a rise in the North. As manufacturing production agglomerates in the core, the unemployed workers are gradually absorbed; moreover, higher real profits due to agglomeration economies increase the value of creating vacancies for Northern firms, thereby improving the labor market conditions. The opposite happens in the South. Therefore, after the first jump, the unemployment rates in

²¹Another interesting result of our simulations (not reported to save space) is that, despite perfect labor mobility, migration during the transition tends to be gradual: as incoming migrants are gradually employed, the geographic advantage of the North is reinforced and this attracts even more workers from the South.

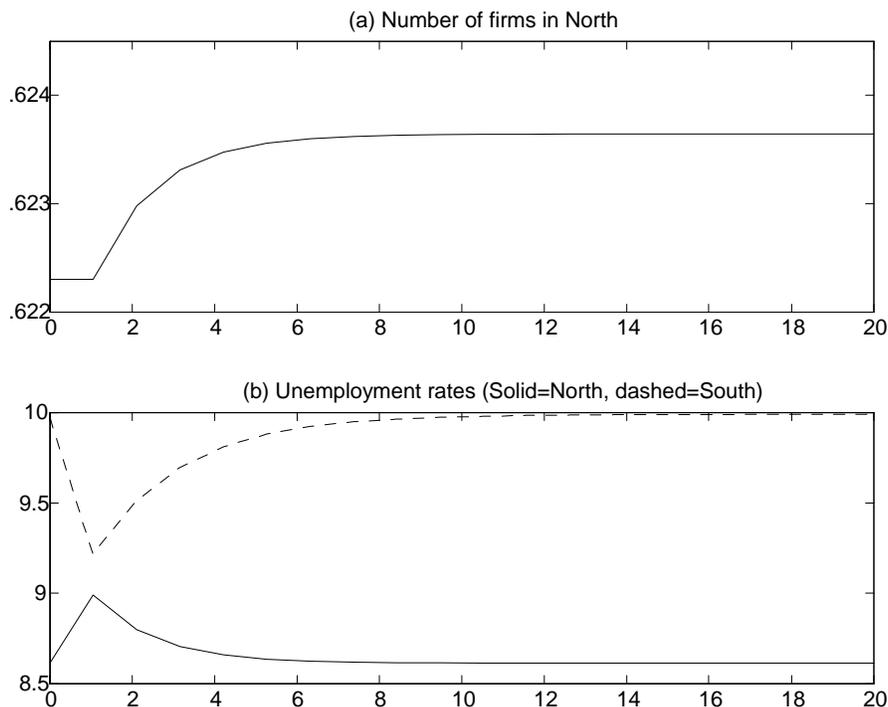


Figure 3: Transitional dynamics (an increase in μ)

the two regions diverge.

Similarly, Figure 3 shows the dynamic adjustment after a 0.3% increase in μ (at $\tau = 2$). As already noted, a higher μ implies stronger agglomeration economies and therefore a stronger locational advantage of the North. Accordingly, the graph shows that some unemployed workers in the South move to the other region, thereby temporarily reducing the unemployment gap between the two regions. However, in the final equilibrium agglomeration forces dominate and the original disparities in unemployment rates are amplified. Overall, the dynamic adjustment of the system is very similar the one displayed in Figure 2.

Note an important point. The transitional dynamics highlight a contrast between the short-run and long-run effects of migration flows on the core-periphery unemployment gap: in the presence of agglomeration forces and inefficiencies in the job matching process, migration to the low-unemployment region, induced for instance by market integration or by the expansion of the mobile sector, causes a temporary convergence in the regional rates of unemployment. This happens because migration reduces the pool of unemployed workers in

the South and expands it in the North. However, this also induces a positive externality on searching firms in the North and a negative externality on Southern firms. The result is an increase in employment in the North and a fall in the South which strengthens agglomeration economies in the North and weakens them in the South. Hence, in the new steady-state, when Southern immigrants are absorbed by the Northern labor market, the unemployment gap is permanently higher than before the shock.²²

Are the short-run effects highlighted in this section likely to be quantitatively significant? The simple dynamics of our model, driven by labor market frictions only, preclude a definite answer. However, there are reasons to believe that the short-run adjustment can be relevant. Note, in particular, that we limited our analysis to rather small shocks: with larger shocks, migration tends to over-react and unemployment in the periphery may fall well below that in the core. Such an over-reaction would be restrained by a more realistic and less sudden description of migration, but the main pattern is not likely to be changed. In fact, given that we focus on permanent shocks, the economy has to undergo a transitional dynamic of the type just discussed, although the adjustment may be more gradual. In contrast, the dynamics highlighted in our model would be less relevant when considering high-frequency, non-permanent shocks, given that in reasonably calibrated search models the economy returns to the steady-state in a fairly short amount of time.

5 Conclusions

Recent developments in the field of the new economic geography have shown that the fall of distance costs may trigger the spatial agglomeration of economic activity. However, this literature neglects any imperfections in the labor market and hence cannot explain the geography of unemployment. Yet, the evidence shows persistent regional unemployment disparities within countries, despite low barriers to labor mobility. As a consequence, the uneven spatial distribution of unemployment is nowadays one of the main causes of policy concern, in particular in European countries.

²²Some authors (e.g., Bentolila and Dolado 1991; Decressin and Fatas, 1995), who have studied the adjustment process in European regional labor markets, point to the important role played by variation in labor force participation rates in the adjustment process. In this respect, note that a fall in the labor force participation rate of the periphery in response to an adverse shock, by further reducing the size of its labor force, would reinforce the mechanism illustrated in the paper. Our emphasis on migration, and not on other sources of variation of labor supply, is motivated by the fact that migration provides the specific endogenous mechanism for explaining the agglomeration of population and production.

In this paper, we have formulated a dynamic two-region model where workers are freely mobile, regional labor markets are segmented, search frictions induce equilibrium unemployment and transport costs generate agglomeration economies, whose scope is restrained by the presence of congestion effects. We have shown that transport costs determine the geography of both production and unemployment in the long-run, and that unemployment is lower in regions where production agglomerates.

By explicitly studying the transitional dynamics of the model we have also highlighted a contrast between short-run and long-run effects of a shock on a geographically differentiated economy. In particular, we have shown how labor mobility can temporarily alleviate regional disparities while exacerbating them in the final adjustment.

The assumptions on which we built our model make it suited for analyzing the interplay between integration, migration and unemployment in developed countries, and in particular in European countries. Yet, too much was left out of our analysis to pretend to have provided a realistic picture of regional unemployment disparities in Europe. In particular, we abstracted from regional differences in the quality of the labor force, as well as from institutional rigidities in the regional wage-setting process and from the role of variations in labor force participation rates. Integrating these elements into our framework would provide a richer picture of regional unemployment disparities and seems a fruitful topic for future research.

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6 Appendix

6.1 Notes on Simulations

Overall, the model has 24 unknowns: $Y_i, P_i, q_i, p_i, n_i, \Theta_i, w_i, u_i, Vf_i, Ve_i, Vu_i, L_i$, for $i = N, S$. By substituting out the price index P_i and L_j from the population constraint, we can characterize the equilibrium as the solution of a system of 21 equations, including eight inter-temporal equations for the two state variables, n_i and the value functions: Vf_i, Ve_i, Vu_i , for $i = N, S$. Price indexes and the market clearing conditions for manufacturing are the only non-linear equations, with no analytical solution. As for the rest, the system is linear.

Steady-states are found using a non-linear equation solver on the system given by (5), (8), (13), (15)-(17), (19), (20), (22)-(24). In order to find all the equilibria for any given t , we have solved the system without the mobility condition (13) for all the possible values of $L_i \in (0, \mu)$. Equilibria are then identified as the points where the function Vu_i/Vu_j takes value one. Stability of equilibria is examined by studying explicitly the transitional dynamic in a neighborhood of each steady-state. Figure 1 reports only the saddle-path stable equilibria.

Transitional dynamics are solved by linearization around the steady-state. We proceed as follows. Let x_t denote the vector of variables in the system at time t . From (8), (10), (11), (14), we can solve the inter-temporal equations to get each variable at $t + 1$ (n_i, Vf_i, Ve_i, Vu_i) as a function of time t variables only. Then, the system is rewritten in the form:

$$Ax_{t+1} = Bx_t$$

where A and B are the coefficient matrices resulting from the linearization. Further, x_t is

arranged so that the state variables come first, then come the other inter-temporal equations and finally the intra-temporal equations follow. Given the presence of intra-temporal equations, A is singular and non-invertible and hence standard diagonalization methods do not work. To circumvent the problem, we have used a solution method based on the generalized Schur decomposition, that can handle intra-temporal equations. See Klein (2000) for details on this solution method.

The choice of a local solution method is dictated by computational convenience, as our model is multi-dimensional, with two state variables (n_i and n_j), and non-linear. Our approximation is reliable because we study the dynamic adjustment between steady-states that are fairly close to each other and because most of the equations of the original system (including all the dynamic equations) are linear. To check the accuracy of the simulation, we fed the original dynamic system with the simulated path and verified that errors from linearization are negligible.

In all the dynamic simulations, the timing of events is the following. At $t = 0$ the economy is in the old steady-state. At $t = 1$ the system is hit by the shock: the pre-determined state variables cannot change, but the remaining jump variables are now determined by the decision rules corresponding to the new steady-state. At $t = 2$ the state variables start to move, according to equations (14).