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ABSTRACT

New economic geography models predict migration flows from peripheral regions toward central ones. Agglomeration occurs in these models because firms, which tend to locate in large demand regions, and workers, who look for high real wages, are driven by the same force defined by the market potential function. As in Hanson [1998], we estimate this function and thereby all the parameters of the standard economic geography model. However Hanson estimated an equation of wage determination, whereas we study the market potential through a much more central relation of the model. We estimate the worker motion law on inter-regional migrations data for five European countries. The migrant flow received by a region increases with its market potential, which confirms the global relevance of the economic geography model. Moreover main parameters estimates are consistent with the theoretical framework.

Keywords: Increasing Returns, Market Potential, Agglomeration, Migrations, Economic Geography.

RESUME

Dans les modèles de la nouvelle économie géographique, la fonction de “potentiel marchand” originellement définie par Harris [1957] se trouve au coeur des choix de localisation et du processus d’agglomération spatiale des activités. Comme Hanson [1998] nous estimons cette fonction, et, de ce fait, tous les paramètres du modèle standard d’économie géographique. Alors que Hanson analyse une relation d’équilibre du modèle et pouvant, finalement, se ramener à une fonction de détermination spatiale des salaires, nous estimons le modèle à partir d’une relation bien plus fondamentale : la fonction définissant les choix de migration des travailleurs. Les résultats obtenus à partir de données de flux migratoires inter-régionaux sur cinq pays européens sont conformes à nos attentes : la part de migrants reçue par une région augmente avec son potentiel marchand, ce qui confirme la validité d’ensemble du modèle. Par ailleurs, les principaux paramètres estimés sont tout à fait conformes au cadre théorique.

Mots clés: Rendements croissants, Potentiel Marchand, Agglomeration, Migrations, Economie géographique.

JEL Codes: F12, L11, R12, R23.

1 Introduction

During the last decades, spatial economics has known an appreciable revival, notably thanks to Krugman & Venables [1990], and Krugman [1991-b]. These works, constituting the so-called *new economic geography*, describe the mechanics which lead to the spatial agglomeration of increasing returns sectors, formalizing the intuitions originally developed by economists such as Perroux [1955] and Hirshman [1958] and giving a complete framework to the principle of market potential function originally defined by both Isard [1954] and Harris [1954] (See Fujita, Krugman & Venables [1999] and Fujita & Thisse [1999] for good surveys of the state of theoretical knowledge).

As explained by Fujita *et al.* [1999], these theories have not generated yet an important empirical literature and “*we clearly need much more such [empirical] works, as closely tied to the theoretical models as possible...*” (*p.* 347). The present article has for objective to participate to fill this gap, presenting a direct validation of the central relation of new economic geography models. From a multiregional framework, where monopolistically competitive firms choose their location freely, we can estimate the motion law of inter-regional migrants within European countries. This equation is a fundamental condition for observing agglomeration dynamics in the model. Thus, we verify the global relevance of the theoretical framework, and estimate its key parameters. As economic geography models present multiple equilibria, depending on the values of those parameters, such an estimation is a useful tool for simulation exercises.

Scale economies and the presence of a significant transport cost encourage firms to locate in the largest market, creating a cumulative causation: firms want to be close to large markets, as so workers who can pay lesser transport costs on consuming goods in such locations. Thus, access to market appears to be essential for both firms and workers. Both are attracted to high market potential regions, as this function enters in the definition of demand addressed to firms - driving firms' motions - and of real wages - driving migrations¹.

¹Venable [1994, 1996] and Krugman & Venables [1995] showed that industrial agglomeration can occur without migration. The final demand linkage which is the main centripetal force in Krugman [1991, 1992] is replaced by intermediate demand linkage among vertically linked industries.

The empirical literature explicitly based on these models is recent and relatively scarce. Of course, some fundamental studies prove the relevance of agglomeration processes, guided by demand linkage or externalities in city formation or industrial agglomeration, but few of them test explicitly the new economic geography framework and the relevance of the market potential function. Nevertheless, some studies on international trade and FDI location provide more or less direct empirical verifications.

As market potential is linked to the price index function, it appears to be implicitly a determinant of the “home market effect”² which states that, in an increasing return industry, a one percent increase in local demand leads to a more than one percent increase in employment and production. This effect can explain sectoral agglomeration. Testing the home market effect can thus be considered as a test of an economic geography model and of the relevance of market potential. Davis & Weinstein [1996] found little evidence of home market effect, but, taking into account a more precise market access variable, closer to the market potential function, Davis & Weinstein [1999] showed that Krugman’s [1980] model explains a significant part of the regional structure of specialization. In the same way, Feenstra *et al.* [1998] find a global relevance of the home market effect hypothesis for differentiated goods. Head & Ries [1999] inter-sectoral results, obtained from US and Canadian data, support Krugman’s [1980] model. Finally, Brühlhart & Trionfetti [1999], showed that, taking into account home-biased demand, the Dixit-Stiglitz–Krugman pattern of international trade is relevant for almost two thirds of the total industrial output.

Many studies also proved the importance of local demand in a firm’s location choice. Unfortunately, most of them simply introduced local income as a proxy of the demand addressed to firms, whereas the true variable should be the market potential. Nevertheless, Henderson *et al.* [1995], Friedman *et al.* [1992] and Mayer [2000] used explicit market potential proxies in empirical studies of multinationals location choices, and gave confirmation that it can explain industrial concentration.

Those studies, as with all *gravity-like* estimation of trade flows, are only indirect testing

²Krugman [1980]

of economic geography models. Hanson [1998], gave a much more explicit one, estimating the influence of the complete market potential function in wage determination. This study, which largely inspires ours, presents very encouraging results and succeeds in calibrating Krugman's [1992] model. But, as he is testing an equilibrium relation, one can relate Hanson's test back to a regional wage determination equation, a law of geographic propagation of local shocks on wages, which is finally far from the agglomeration formation story. Using approximately the same model, we estimate the market potential function through a more fundamental equation of the model, which directly refers to agglomeration processes.

2 A simple model of economic geography

We present a multi-regional model of economic geography, based on Krugman [1992]. As in a two regions model (Krugman [1991]), the motion law of mobile workers is a central key of the transitory dynamic of the model; agglomeration occurs when people move from small and relatively distant regions (*ie* low market potential regions) to more central ones.

To test this fundamental law we have to modify the original model in a more realistic way. As Thomas [1997] and Hanson [1998], we introduce a nontraded good. This specification involves less drastic final equilibria (the peripheral regions always keep a part of non agricultural activity) and because, in real world, non-traded good represent a significant part of consumer price index, it leads to more realistic migration dynamics. This last point is the most important here : as we focus on transitional dynamics, the nature of final equilibrium is not a dominant question compared to the credibility of the equation we have to estimate. This is also why, unlike these two authors, we do not replace the agricultural sector by this new one but keep both. Moreover, the nontraded sector has to be large enough to improve the realism of the theoretical framework. In this order, and unlike Hanson [1998], we consider that all the regional production of services is nontraded³.

³In Hanson's framework housing services are the only nontraded goods; he underlined himself this point as being a weakness.

2.1 Production and price indexes

The economy is divided in R regions. Each of them produce three kinds of goods : freely traded agricultural goods (Z), non-tradable services (Y) and costly tradable industrial goods (X).

We consider two factors of production: Immobile and mobile labor. Immobile workers are specific to the agricultural sector and uniformly distributed across locations. Mobile workers are employed indifferently in the two other sectors and choose their location by comparing utilities across regions.

The agricultural good is homogeneous and produced under constant returns to scale. Good Z is chosen as a numeraire ($p_Z \equiv 1$). We note L_{it}^Z the agricultural population present in region i at instant t .

$$Z_{it} = L_{it}^Z = L_t^Z, \forall i \in R \quad (1)$$

The two others factors are horizontally differentiated. The production of each variety needs a fixed cost which introduces increasing returns. The cost functions for an industrial firm m and a service firm m' are:

$$L_{mt}^X = \varepsilon_x + \beta_x x_{mt} \quad (2)$$

$$L_{m't}^Y = \varepsilon_y + \beta_y y_{m't} \quad (3)$$

Where ε_x , ε_y , β_x and β_y , are respectively fixed and variable costs in manufacturing and services; L_{mt}^X and $L_{m't}^Y$ are mobile labor used by firms m and m' to produce quantities x_{mt} and $y_{m't}$ of industrial and service goods. We note L_{it} the non-agricultural population of region i ($L_{it} = L_{it}^X + L_{it}^Y$).

The consumers share the same Cobb-Douglas utility function.

$$U_{it} = C_{Xit}^\mu C_{Yit}^\phi C_{Zit}^{1-\mu-\phi} \quad (4)$$

$C_{\theta it}$ is the quantity consumed of good θ ($\theta = x, y, z$) in region i . Consumers demand all varieties of the industrial good whatever their region of origin, and all varieties of non-tradable services produced locally.

$$C_{xit} = \left(\int_1^{n_{xt}} c(m)_{it}^{\frac{\sigma_x-1}{\sigma_x}} dm \right)^{\frac{\sigma_x}{\sigma_x-1}} \quad (5)$$

$$C_{yit} = \left(\int_1^{n_{yit}} c(m')_{it}^{\frac{\sigma_y-1}{\sigma_y}} dm' \right)^{\frac{\sigma_y}{\sigma_y-1}} \quad (6)$$

Where n_x denotes the total number of industrial varieties and n_{yi} the number of service varieties in region i .

The profit maximization of manufacture and service producers leads them to set prices as the product of a constant sector-specific mark-up and their marginal costs. If w_{it} is the non-agricultural wage in region i , and $p_{\theta it}$ is the *FOB* price of a variety produced in this region ($\theta = x, y$) then:

$$p_{xit} = \frac{\sigma_x}{\sigma_x - 1} \beta_x w_{it} \quad (7)$$

$$p_{yit} = \frac{\sigma_y}{\sigma_y - 1} \beta_y w_{it} \quad (8)$$

Then, free entry in each sector drives to a zero-profit equilibrium which allows us to define the number of manufacture and service firms in each region i :

$$\begin{aligned} n_{xit} &= \frac{L_{it}^X}{\varepsilon_x \sigma_x} \\ n_{yit} &= \frac{L_{it}^Y}{\varepsilon_y \sigma_y} \end{aligned} \quad (9)$$

We said that the industrial good is costly tradable, the transport cost takes the form of an iceberg cost such as a producer located in i has to send $\tau_{ij} > 1$ units of good to ensure that one unit gets to the region j of destination. It is logically an increasing function of the bilateral distance d_{ij} , and its specification follows that of Hummels [1998]:

$$\tau_{ij} = Bd_{ij}^\delta \quad \forall i, j \in [1, R], \quad \delta > 0 \quad \text{and} \quad B > 0 \quad (10)$$

Recalling that the agricultural good is freely tradable and its price normalized to one, we can calculate, from equations (3), (4), (5), (7) and (8), the real wage in region i .

$$\omega_{it} = \frac{w_{it}}{q_{yit}^\phi q_{xit}^\mu 1^{1-\phi-\mu}} \quad (11)$$

where q_{xit} is the price index for manufactures and q_{yit} the one for services:

$$\begin{aligned} q_{xit} &= \left[\sum_{k=1}^{k=R} \left(\int_0^{n_{xkt}} (Bd_{ij}^\delta p_{xkt})^{1-\sigma_x} dk \right) \right]^{\frac{1}{1-\sigma_x}} \\ &= \left[\sum_{k=1}^{k=R} n_{xkt} (Bd_{ij}^\delta p_{xkt})^{1-\sigma_x} \right]^{\frac{1}{1-\sigma_x}} \end{aligned} \quad (12)$$

$$q_{yit} = \left(\int_0^{n_{yit}} p_{yt}^{1-\sigma_s} di \right)^{\frac{1}{1-\sigma_s}} = n_{yit}^{\frac{1}{1-\sigma_s}} p_{yt} \quad (13)$$

Equation (12) represents the price index of manufactures, which can be shown to be close to Harris' market potential function (Krugman [1998]).

The original, market potential function represents the potential demand addressed to a firm, depending on its location; so its main determinant is the one defined by Harris: the sum of regional purchasing powers negatively weighted by bilateral distances. Because, in reality, producers have to share the global demand with the other local competitors, multi-regional economic geography models, such as Krugman [1992], express the market potential as this weighted sum (the *pure* market potential function) corrected by a competition effect represented by the regional price index (12). Nevertheless, this price index, reveals logically the same structure than the original weighed sum proposed by Harris. Indeed, the price index expresses that manufactures are less expensive in regions which import only a small part of their consumption and

where imports are provided by close regions⁴. As in these larger and more “central” regions the demand addressed to a single firm should be more important than in the periphery, they also benefit from a higher market potential.

Because firms look for locations where demand is important and mobile workers look for low consumption price areas, the similarity between the price index and the *pure* market potential function is a basis of the cumulative causation constituting the engine of the agglomeration dynamic.

The service price index (13), is constructed on the same basis as the precedent. It represents also a kind of market potential for service goods, but as these goods are not traded, this potential simply equals the home market size.

2.2 Real wage and migration choices

From Bilateral migrations...

The non-agricultural workers choose their location in order to maximize their utility. They will move from a region j to a region i if the indirect utility in i is superior to the one in j . In the theoretical framework developed by Krugman [1991] and Krugman [1992] potential migrants only compare real wages to choose their location. Such assumption implicitly supposes that migration has no direct influence on the migrants’ income and utility. Yet, trans-regional migrations, as international ones, involve pecuniary and moral mobility costs which affect people’s income and satisfaction (Shields & Shields [1980]). We assume that these costs are proportional to the indirect utility in the destination region, taking into account all permanent moral and financial costs affecting migrant’s utility, directly or via its income⁵.

We suppose this cost increases with the distance between the regions of departure and destination. Because a large part of this cost is moral, we also make the assumption that it varies between individuals (as done by Faini [1996]).

⁴Even if the industrial concentration leads to higher wages and prices in these locations.

⁵Moving house expenses, and other sunk costs of migration should appear as negative additional terms of the real wage equation. As potential migrants have an infinite horizon, such costs can be neglected with no loss of generality.

For each non-agricultural worker l_j from region j , the cost of migration to i is:

$$A_{ji}(l_j) = (d_{ij})^\lambda \Theta_{l_j} \quad (14)$$

Where λ is a strictly positive coefficient and $\Theta_{l_j} = \frac{l_j}{L_j}$, with $l_j \in [1, L_j]$ (l_j is uniformly distributed on $[1, L_j]$).

From equations (7) and (9) to (14) we get l_j 's relative indirect utility:

$$\frac{u_{it}(l_j)}{u_{jt}} = \frac{\omega_{it}}{A_{ji}(l_j) \omega_{jt}} \quad (15)$$

Moreover, as all individuals are workers, we do not study migrations driven by amenity demand, but only by spatial job opportunity search. Consequently, the migrant must take also into account the probability of finding a job in the destination region. We note ρ_{it} such a probability.

Then the condition for an individual from region j to move to region i is:

$$u_{it}(l_j) \rho_{it} > u_{jt} \quad (16)$$

Using the definition of the migration cost, this condition becomes:

$$\frac{l_j}{L_j} < \frac{\omega_{it}}{\omega_{jt}} (d_{ij})^{-\lambda} \rho_{it}$$

We note l_{jt}^* the marginal worker who verifies the equality $\frac{l_{jt}^*}{L_{jt}} = \frac{\omega_{it}}{\omega_{jt}} (d_{ij})^{-\lambda} \rho_{it}$; so $\frac{l_{jt}^*}{L_{jt}}$ represents the share of the mobile population of j who will choose to migrate to region i . Then migration flow between the two locations is:

$$\frac{migr_{jit}}{L_{jt}} = \frac{\omega_{it}}{\omega_{jt}} (d_{ij})^{-\lambda} \rho_{it} \quad (17)$$

$$= \left(\frac{w_{it}}{w_{jt}} \right)^{1-\phi} \left(\frac{L_{it}^Y}{L_{jt}^Y} \right)^{\frac{\phi}{\sigma_y-1}} \left(\frac{\sum_{k=1}^{k=R} L_{it}^X (d_{ij}^\delta w_{kt})^{1-\sigma_x}}{\sum_{k=1}^{k=R} L_{jt}^X (d_{ij}^\delta w_{kt})^{1-\sigma_x}} \right)^{\frac{\mu}{\sigma_x-1}} (d_{ij})^{-\lambda} \rho_{it}$$

... to multilateral migrations

The equation (17), representing the migratory flow between two regions, is based on an economic geography model which describes very succinctly migration choices. Taking into account mobility cost, the potential migrants look for the best working conditions: Highest real wages and best job opportunities. Even if we catch here the main motivations of workers motions, this description cannot explain two-way bilateral flows nor why all migrants from one region do not move to the same one but disperse all over national space⁶. Thus, estimating directly the equation (17) expressed in logarithms would involve trying to explain two different positive flows (from j to i and i to j) by several explicative variables which are almost exactly the opposite from each other. To overcome this difficulty we express the motion law presented by equation (17) in relative terms: considering the total migrants flow from a region j , we can express the part received by a region i .

$$\frac{migr_{jit}}{\sum_{i' \neq j} migr_{ji't}} = \frac{\frac{w_{it}}{w_{jt}} (d_{ijt})^{-\lambda} \rho_{it}}{\sum_{i' \neq j} \frac{w_{i't}}{w_{jt}} (d_{i'jt})^{-\lambda} \rho_{i't}}$$

or equivalently:

$$\log \left(\frac{migr_{jit}}{\sum_{i' \neq j} migr_{ji't}} \right) = \log \left(w_{it}^{1-\phi} (L_{it}^Y)^{\frac{\phi}{\sigma_y-1}} \left(\sum_{k=1}^{k=R} L_{it}^X (d_{ij}^\delta w_{kt})^{1-\sigma_x} \right)^{\frac{\mu}{\sigma_x-1}} (d_{ij})^{-\lambda} \rho_{it} \right) - a_{jt} \quad (18)$$

$$\text{With } a_{jt} = \log \left(\sum_{i' \neq j} w_{i't} (d_{i'jt})^{-\lambda} \rho_{i't} \right)$$

⁶See Mueser [1997] for a modelisation of this issue.

The equation (18) represents the basic law of motion of the economy which will be estimated by non linear least squares.

In relatively small and highly controled countries, such as European ones, we can expect wages to not significantly differ between regions. Then we estimate the same relation supposing the unicity of nominal wages accross locations. This hypothesis can also be easily justified theoretically by making the assumption of free labor mobility between agriculture and the increasing returns sectors. The basic structure of the model is not changed, but, considering equation (1), wage will be normalized to 1 in the whole economy, as long as each region still produces constant return goods. Studying the transition path to the equilibrium, this modification doesn't affect our results. In this case, equation (18) simply becomes:

$$\log \left(\frac{migr_{jit}}{\sum_{i' \neq j} migr_{ji't}} \right) = \log \left((L_{it}^Y)^{\frac{\phi}{\sigma_y - 1}} \left(\sum_{k=1}^{k=R} L_{it}^X (d_{ij}^\delta)^{1 - \sigma_x} \right)^{\frac{\mu}{\sigma_x - 1}} (d_{ij})^{-\lambda} \rho_{it} \right) - a_{jt} \quad (19)$$

3 Econometric strategy

Toward an estimable equation

To be correctly estimated, equations (18) and (19) need some adjustments.

First, in a large part, time dimension is fully implicit in the original model. We must lag the dependant variable to avoid problems of endogeneity between migration flows and regional work forces, and to take into account the time for migrants to observe relative job conditions and make their decisions.

In addition, national space is perfectly continuous and internal migrations do no support any cross-border cost. In order to capture non-significant short distance migrations, which do not reflect an explicit workers' willingness to move to another economic center when involving two administrative regions, we introduce in the migration cost a dummy of regional contiguity. F_{ij} equals 0 when regions i and j have an common border, and 1 otherwise. Then the migration cost becomes : $[d_{ij} (1 + bF_{ij})]^{-\lambda}$.

Every thing equal, a large region should receive more migrants than a smaller one. This

bias has to be controlled insofar as European regions, even in the same country, can have very different sizes⁷. The size bias is captured introducing in the equation the logarithm of the surface of destination region ($\log(S_i)$).

The variables a_{jt} represent the trickiest issue. Even if their complete form are estimable as the i -specific part of the two equations, they introduce too many determinants to ensure the robustness of the econometric result. As they only vary along time and j dimensions; we treat them as j -specific fixed effects and their time dimension is captured by a trend introduced in the equation.

Then, choosing unemployment rates as proxy of the inverse of job finding probability, the equations (18) and (19) become:

$$\begin{aligned} \log \left(\frac{Migr_{ji,t}}{\sum_{k \neq j} Migr_{jk,t}} \right) &= \frac{\mu}{\sigma_x - 1} \log \left(\sum_{k=1}^{k=R} L_{k,t-1}^X (w_{it} (d_{ik})^\delta)^{1-\sigma_x} \right) \\ &+ \alpha_1 \log (L_{i,t-1}^Y) + \alpha_2 \log (E_{i,t-1}) + (1 - \phi) \log (w_{it}) \\ &- \lambda \log (d_{ij} (1 + bF_{ij})) + \alpha_4 \log (S_i) + a_j + \alpha_5 \log (trend) + u_{ijt} \end{aligned} \quad (20)$$

And

$$\begin{aligned} \log \left(\frac{Migr_{ji,t}}{\sum_{k \neq j} Migr_{jk,t}} \right) &= \frac{\mu}{\sigma_x - 1} \log \left(\sum_{k=1}^{k=R} L_{k,t-1}^X (d_{ik})^{\delta(1-\sigma_x)} \right) + \alpha_1 \log (L_{i,t-1}^Y) + \alpha_2 \log (E_{i,t-1}) \\ &- \lambda \log (d_{ij} (1 + bF_{ij})) + \alpha_4 \log (S_i) + a_j + \alpha_5 \log (trend) + u_{ijt} \end{aligned} \quad (21)$$

The dependent variable is the part of migrants from region j who choose to settle in region i (ie the “migration share” of region i). The first explicative variable is the manufacture market potential. The second term of the right side of equations (20) and (21), is the home market size

⁷For exemple, we find among german NUTS 1, Bayern (70554 km²) and Bremen (404 km²).

of services.

Econometric method and data

Whatever the models, the parameters to estimate and the expected values are the same and presented in table (1).

Equations (20) and (21) are estimated by gaussian non linear least squares on three dimensional panel data⁸. This kind of regression, can lead to very weak results, and we have to ensure robustness of the regressions.

Thus, we perform regressions using other econometric methods, such as maximum of likelihood. As it leads to very similar results to the one obtained by least squares, it is not presented it here.

Above all, we have to avoid introducing collinearity within parameters, source of singularity in the Hessian matrix. Each parameter must be individually attached, at least, to a single variable and not appear as a combination of other parameters. Consequently, we can't perform robust simultaneous estimations of ϕ and σ_y neither of μ , δ and σ_x ⁹. Then, we simply estimate $\frac{\phi}{\sigma_y-1}$ and $(1 - \phi)$ as two independent coefficients (α_1 and α_3). For the second group of tied parameters, the issue is more complex: μ and σ_x can't be estimated together, neither δ and σ_x since σ_x doesn't appear independently. The most reliable solution to overcome this difficulty is to set down μ to an exogenous value. Then the main source of instability (*ie* $\frac{\mu}{\sigma_x-1}$) simply disappears, and, since estimation of σ_x is more robust, the interdependence between δ and σ_x is reduced enough to keep explicitly in the model the restriction it involves on these two parameters.

According to sectorial distribution of final household consumption data, we then perform estimations setting down $\mu = 0.4$ ¹⁰.

Finally robustness of the regressions is enforced by performing White consistent estimations in order to control for a possible presence of heteroscedasticity.

⁸Year, departure region (j) and destination region (i).

⁹The couple $\lambda - b$ is also tied, but, as b is a parameter affect to an dummy, collinearity test we performed showed it is much less damaging than the one observed within the two other groups.

¹⁰In order to test for robustness of the estimations, we also drove regressions with some other values of μ . The model stays the same and parameters evolve to comparable values: a higher μ simply leads to a higher σ_x and, since we haven't removed any parameter restrictions, to a smaller δ . Other parameters remain almost unchanged.

Table 1: Coefficients and expected values

Coefficients	Expected values
σ_x	$1 < \sigma_x$
μ	$0 < \mu < 1$
δ	$0 < \delta$
$\alpha_1 = \frac{\phi}{\sigma_y - 1}$	$0 < \alpha_1 < 1$
α_2	$\alpha_2 < 0$
$\alpha_3 = 1 - \phi$	$0 < \alpha_3 < 1$
λ	$0 < \lambda$
b	$0 < b$
α_4	$0 < \alpha_4$
a_j	$0 < a_j$

All data, except for distances, where provided by Eurostat *Regio* database.

As the tested equations deal with the transitional path, the model should be expressed without introducing the long term factor market equation (9). In this case, manufacture and service employment levels should simply be replaced by sectoral productions. We chose anyway the employment specification because long series on sectoral value added are not available for all countries. Then $L_{i,t}^K$ ($K = X, Y$), is the annual total employment in sector K , and wages are mean remuneration by worker in both manufacture and service sectors.

Regio provides also complete matrix of annual bilateral migrations between regions. These precious informations have three main shortcomings. First, bilateral migration data only concern internal mobility, and we have no information, at the regional level, about people who cross a European national border. Second, the spatial aggregation level is quite high: NUTS1 or 2, depending of countries¹¹. Finally, time dimension is not exactly consistent with other data and from one country to another.

These three difficulties do not allow us to pool together all the countries. We would lose too many observations to perform non pertinent estimations since the data only concerns internal migrations¹². Above all, we had to drop many countries. Small countries, when data focuses on relatively large regions, such as Sweden, Finland and Portugal, provide too few observations. In

¹¹See Data appendix

¹²Anyway, the importance of border effects will lead to few relevance of international migrations as one compares them to internal ones (Helliwell [1997]).

the same way, we have too little French data: for this country migrations are only available for periods of seven years; the last period starts in 1982, and main industrial data series begins in the early eighties.

We finally kept 5 countries : Germany, Spain, Italy, the Netherlands and Great Britain.

German data covers 10 western NUTS 1 regions during the period 1983-1992 (900 observations¹³). In order to avoid any bias in the distance measurement, we dropped islands from the panel; in consequence, Spain represents only 15 NUTS 2 regions between 1983 and 1993 (2310 observations) and Italy 18 NUTS 2 regions for 1983-1993 (3366 observations). Dutch data covers the period 1988-1994 for 10 NUTS 2 regions (630 observations). British available migration data covers a period 1980-1985 for 10 NUTS 1 regions. As regional unemployment data starts in 1983, keeping unemployment in the estimations would have lead to reduce too drastically the available observations (180). So, we performed the estimations for this country without this variable, increasing the number of observations to 540.

We also need all bilateral distances between the region of a same country ($d_{ij} \forall i \neq j$) to estimate the manufacture market potential and to proxy the migration cost.

Intra national goods shipment, in our relatively small countries, use mainly roads. As we dropped out all islands and Ulster from the panel, we can expect bilateral distances between two regions to be correctly proxied by the quickest route between the two main regional cities estimated for truck mean speed on the different kinds of roads. This information was acquired individually from an electronic road atlas. This tool gives us kilometric distances by most rapid ways and travel times. Of course, the two measures are strongly correlated, and the mean speed on different domestic travels do not differ substantially (even if it differs for a country to an other one). Travel times are more precise indicators of transport costs, but we chose to keep kilometric distances to have a variable consistent with internal distances. This measure which takes into consideration the reality of geographical space (mountains, lakes and density and quality of road infrastructures) is anyway a better proxy than Great Circle distances generally used in economic geography or international trade studies.

¹³10 departure regions * 9 destination regions * 10 years

Apart from inter-regional distances, we must find a proxy of internal distances d_{ii} . Indeed the market potential term includes, as for goods consumed abroad, the transport cost charged on manufactures produced and consumed in the same region. The theoretical framework modelises inter-regional space, but considers implicitly each region as a point driving internal iceberg trade cost to unity. Wei (1996) showed how much matters the correction of this simplification in empirical studies of flows between different geographic areas. However, we can't use the same kind of data as the one presented above without introducing an important bias due to the choice of a second regional center. Therefore we adopt Head & Mayer's [2000] grounded specification of distance from oneself: approximating a region to a disk in which consumers are uniformly distributed and production is concentrated in the center, the average distance between a producer and a consumer is two thirds of the radius. Thus, if S_i denotes the regional area, internal distance becomes $d_{ii} = \frac{2}{3}\sqrt{\frac{S_i}{\pi}}$. This specification is not as precise than the one used for inter-regional distances and can be affected by two different biases. First, most consumers and producers are, in reality, located in or around the same urban centers and so they are closer from each other than expected in the disk simplification; the real internal distance should be shorter than the one we'll use. But on the other hand, it measures "as the crow flies" distances, necessarily shorter than real ones. The two biases play opposite roles, and, all things considered, we can expect this distance to be barely consistent with inter-regional ones.

4 Results

Estimations results for the five countries are reported in tables (2) to (7). By measure of commodity, we do not present the coefficients on fixed effects a_j ; in accordance with the predictions of the model, they are significantly negative in all regressions and superior to one in absolute value. Table (8) presents correlations between the dependent variable (the migrations share) and the main variables of the model. Table (9) gives some basic statistics on internal migrations patterns.

As explained above, market labor structure in European countries has lead to a relatively important internal equalization of nominal wages. Wages are not good determinants of migration

patterns and introduce multicollinearity in the model. Consequently, equation (20) appears to be less stable than equation (21) even if it has nearly the same behavior: the model including wages has trouble converging for the total sample of Italian regions, and fails to converge for the Netherlands¹⁴.

Nethertheless, whatever the model, most parameters, and above all those defining the price index, converge toward consistent values: distance and unemployment rates remaining equal, migrants will choose in priority to move toward the region which has the most important market potential.

Moreover, the most encouraging result lies in the global consistency of the results from one country to another. Indeed, it is per se a source of satisfaction to observe roughly the same behaviors in countries which could highly differ from one another, in size, wealth, labor market structure and geographic distribution of economic activities.

Migration costs, and migration patterns

The two determinants of migration costs (λ and b) are strictly positive in all countries; migration flows decrease significantly with inter-regional distances.

The coefficient on distance, λ , varies between 0 and 1, strengthening the hypothesis of concavity of the migration cost function¹⁵. It is relatively small in Great Britain and Italy, suggesting an important degree of worker mobility in these countries, compared to Dutch, or German ones. But, one cannot interpret λ independently of the observed values of b . Indeed, Italy has also a very high b coefficient (around 4.5 against values comprise between 0.5 and 1.7 for other countries) which suggests that a large part of Italian migrations takes place among nearby regions. Finally, “long-distance” migration cost, which can be represented as $(1 + b)^\lambda$, appears to be much larger for Italy: it is the highest (1.9), just after Spain (2.15).

This result, which mixes a high degree of mobility with a low tendency to migrate toward very distant regions reveals the particularity of the Italian migration pattern. One can justify the

¹⁴That is why we don't present this result here, even if the estimated coefficients are reliable to those observed for other countries and for equation (21).

¹⁵The coefficient for the Netherlands is the only one superior to 1 (around 1.04), which can be explained by the very small size of this country.

observed low long distance mobility degree, in saying that Spanish and Italian labor market are more controlled than, say, British one, which doesn't incite people to migrate, and that Spain, and to a lesser extent Italy, have also very pronounced regional identities which are natural barriers to internal migrations. But the opposition between a high degree of mobility and an important cost of long distance migration, can be explained more generally by the confrontation of two kinds of migration dynamics.

First, the observation of a small degree of mobility in Italy is consistent with a *gravity-like* pattern of migration: as with geographical proximity, economic proximity favors inter-regional exchanges, including migrations; the more homogenous the economy, the more important the migration flows should be, because labor markets are more unified, and it is, in consequence, easier to find a job in another region without changing activity (Shields & Shields [1980], Faini *et al.* [1997]). One will then observe a relatively small value of λ in highly polarized countries. In the same way, if the economic center, as the periphery, is split in different regions, we should observe a relatively important part of small distance migrations, most movements taking place within the core or within the periphery (*ie* high b). In opposite, agglomeration dynamics represented by equation (17) lead to expect more important migrants flows within very polarized countries than in more homogenous ones. As Italy and Spain present a more polarized geographic structure, it should be logical to observe relatively more long distance migrations resulting from centripetal workers motions who leave peripheral regions to reach economic centers (*ie* a small λ and a small b). For very polarized countries, the estimated model then has difficulties making the distinction between these two different migration flows: short distance flows resulting from *gravity-like* behaviors and from polarization dynamics within small geographic areas, and *center-periphery* long distance flows resulting from polarization at the national level.

The table (9) shows that Italy has the second smallest migration rates (just after Spain). But, at the same time, its ratio of total migration rate by non-contiguous migration rate, which can be considered as a rough indicator of migrant's propensity to move toward distant regions¹⁶, is

¹⁶It is indeed a rough indicator because it depends of the mean size of the regions and the geographical division of the country (as Italy is a long and narrow country, one can expect its regions to have, everything else being equal, less neighbors than Spanish or German ones).

also the smallest (1.6 against 1.7 for Spain, 3.3 for Netherland, 3 for Germany and 2.5 for Great Britain). These stilized facts tend to prove that Italians, and to a lesser extend the Spanish, are globally not very mobile, even if, in the same time, they don't hesitate to move far from their region of origin¹⁷. Then the model, fitted for Italy, express the important South-North migrations (the strictly *center-periphery* pattern) by a low value of λ . But the South-South *gravity-like* migrations, which can't result from a small mobility degree neither from the price index expressions, is caught as a bias in favor of short distance migrations (*ie* a high b). This intuition is confirmed by results obtained on Spain and Great Britain which are the two other polarized countries. Estimations of λ and b reveal similarities with those obtained for Italy; but as their geographic structure is less manichean, the bias in favor of short distance migration is much less important.

Dropping Southern Italian regions¹⁸ as destination locations from the panel, the regressions for this country leads to more robust and consistent results (see table 5). Dropping South-South migrations and North-South migrations (which one can expect to square to non-economic motivations) we obtain values of λ of 0.82 and of b between 0.87 and 0.86. Italians' mobility degree is now less important, but much less biased in favour of short distances migrations.

Wages and unemployment

Coefficients on wage and unemployment are less persuasive than those determining market potential functions.

If the coefficient on nominal wages (α_3) is significantly positive for Italy and Great Britain, it is non significantly different from zero for Spain and highly negative for Germany. For the two first countries the coefficient is consistent with the model, as they lie between zero and one, even if they suggest not very consistent values of service share in consumption ϕ (0.7 for Italy and 0.1 for Great Britain). For the two other countries, it implies that migrants' decisions are not influenced by nominal wages, or tend to prefer low wages locations. This paradoxical result is however consistent with the correlation analysis presented in table (8) and proves the weakness

¹⁷Faini *et al.* [1997] showed how much southern Italians' mobility has reduced during the last twenty years whereas regional divergence increased, even if they still keep a relatively important willingness to move.

¹⁸Lazio, Abruzzo-Molise, Campania and Sud

of the theoretical framework in presence of labor market imperfections. The same kind of non-intuitive result appears with the coefficient on unemployment rate (α_2), which is positive in all countries but Germany.

Such results are commonly observed in internal migration researches, as one doesn't introduce information about migrant's qualifications and personal wages nor regional labor market structures (Cf. Greenwood [1975], Herzog *et al.* [1993] and Bordas [1994] for reviews and Decressin & Fatas [1995], Mac Kormick [1997] and Faini *et al.* [1997] for a study of the weakness of wages and unemployment rate consequences on migration decisions within European countries). Indeed, unemployment can be seen, as we have done, as a proxy of the job finding probability. But as employment is often higher in a large urbanized region than in a low-density rural one, it also could reflect the size and dynamism of the regional labor market. People don't leave low unemployment region for higher employment ones, but small and tight labor markets to larger ones. Moreover, it is a logical and established fact that people's degree of mobility increases with their own human capital stock; thus, average wages and unemployment rates are not the accurate data one should use to explain these highly skilled migrants' decisions.

Elasticities of substitution, transport cost and market potential.

The manufacture elasticities of substitution, σ_x , are always strictly positive, and, as required by the theory, significantly superior to one for every country but Great Britain. Estimation of this parameter varies, for equation (20), between 1.6 (Spain) and 3.1 (Germany) (except for Italy) and, for equation (21), between 2.0 and 4.7¹⁹

These values are significantly lower than those observed by Hanson [1998] and other related recent studies as Hummels [1997], Eaton & Kortum [1998] and Head & Ries [1999]²⁰. Whereas it would be undue to hope a perfect concordance between studies which differs in many points, this difference with Hanson is quite surprising: we would expect opposite results because we

¹⁹One can note that all estimated values of σ_x verify the *no black hole* condition ($\frac{\sigma_x - 1}{\sigma_x} > \mu$) which ensure the existence of a stable decentralized equilibrium. In other words, product differentiation doesn't seem to be so important that competition effect, as centrifugal force, could be less important than centripetal forces whatever the value of transport costs.

²⁰Hanson estimations of market potential lead to elasticities of substitution between 5 and 11. Hummels [1997], and Head & Ries [1999] both study international trade flows taking in account barriers to trade; Hummels observes a trade price elasticity value around 7.6, Eaton & Kortum around 8.3 and Head & Ries around 6.4.

estimated a manufacture-specific elasticity of substitution whereas Hanson's one lies on whole regional production except for housing services. Aggregating together more goods, Hanson should observe a more important product differentiation, so relatively small elasticities of substitution.

However, in our study, the estimated level of σ_x is directly dependent of the chosen value of μ ; choosing a μ superior to 0.4 should have lead to an higher σ_x . Indeed Hanson's estimation of μ is 0.9; the ratio $\frac{\mu}{\sigma-1}$ is then comprised between 0.1 and 0.19, which is comparable to our results. Above all, the values we observe are, to a large extent, consistent with those observed in more traditional international trade studies such as Crozet & Erkel-Rousse [1999], Erkel-Rousse & Mirza [2000] or Grossman [1982].

Estimated values of δ are also consistent from a model to an other and have always a strictly positive value. They are globally high (arround 1.8 on average)²¹. These costs also vary in a quite important range between countries: from more than 3 in Germany to 0.3 in Spain and around one for the two other countries, leading, for equation (21), to values of the coefficient on transport cost $\delta(1 - \sigma_x)$ varying from -11.9 (Germany) to -0.3 (Spain). A high $\delta(1 - \sigma_x)$ denotes that regional price index, resulting from inter-regional frictional trade, is relatively less dependent on the economic activity of the surrounded regions, or, in other words that regional market potentials (as perceived by migrants) are essentially influenced by the local level of production, and finally do not differ so much from one region to another. The low $\delta(1 - \sigma_x)$ observed for Spain can be explained by the high level of specialization of Spanish regions, which involves a larger relevance of the market potential function in migrations decisions.

As for services, coefficients α_1 converge toward significantly positive values comprised between 0.5 and 0.97. Recalling that $\alpha_1 = \frac{\phi}{\sigma_y-1}$, one can derive from α_1 an indirect estimation of service elasticity of substitution, plugging in credible value of the part of services in consumption. With $\phi = 0.4$ ²², we get smaller values of elasticities of substitution than those specific to manufactures:

²¹It is largely more important than the 0.2 avanced by Hummels [1998], but any comparison will be hazardous: Hummels estimated the relation between distances and real trade costs, when we only mesure the influence of distant levels of employment on migration. Moreover the distance we observe are very short compared to Hummels' ones who study inter-continental trade; it is then logical to observe larger unit trade costs as we expect increasing returns in the freight industry.

²²Which leaves a part for agricultural goods of $(1 - \mu - \phi) = 0.2$

they vary between 1.4 for Italy to 1.8 for the Netherlands which is fortunately above one.

5 Conclusion

We provided estimations of workers' law of motion which ensure the dynamics of agglomeration in new economic geography models. These models suggest that agglomeration occurs because firms and workers' location choices are driven by a comparable determinant expressing the regional market potential. Indeed, a region which enjoys a high market potential will attract firms ensuring them a large demand, and will draw migrants by a low price index. If competition effects and wage differentials are not too important, both will progressively settle in central regions, creating a self-reinforcing process of agglomeration.

From data on internal annual migration flows for five European countries, we showed that, although European workers don't seem to be highly mobile, the amount of migrants received by a region increases with its industrial and service employment levels and its proximity to other large markets. This result confirms the global relevance of the models of agglomeration. Moreover, as we estimate directly the motion equation of the model, we obtain a calibration of the market potential function which can't be done from a simple *gravity-like* migration model. All parameters are consistent with the theory and barely comparable to those obtained by international trade studies. Whatever the country, migrants seem to share the same behavior, and estimated parameters are more or less comparable.

A Data appendix

- **Germany (NUTS 1):** Baden-Wurttemberg, Bayern, Bremen, Hamburg, Hessen, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Schleswig-Holstein.
- **Italy (NUTS 2):** Piemonte, Valle d'Aoste, Liguria, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Toscana, Umbria, Marche, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria.
- **Spain (NUTS 2):** Galicia, Asturias, Cantabria, Pais Vasco, Navarra, Rioja, Aragon, Madrid, Castilla-Leon, Castilla-La Mancha, Extremaduras, Catalonia, Comunidad Valenciana, Andalucia, Murcia.
- **Netherland (NUTS 2):** Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, Noord-Holland, Zuid-Holland, Zeeland.
- **Great Britain (NUTS 1):** North, Yorkshire and Humberside, East Midlands, East Anglia, South East, South West, West Midlands, North West, Wales, Scotland.

B Regressions results

Table 2: Germany - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
3.081 [#]	5.967*	1.097*	-0.845*	-2.652*	0.913*	0.897*	0.733*
(0.4160)	(0.5521)	(0.042)	(0.0989)	(0.343)	(0.0417)	(0.1562)	(0.0892)
nb. obs. = 900 - R ² = 0.8704 - MSE = 0.2147							
Equation 2							
4.693 [#]	3.228*	0.785*	-0.225*	-	0.886*	0.954*	0.586*
(1.2415)	(0.5393)	(0.0313)	(0.0774)	-	(0.0412)	(0.1667)	(0.0797)
nb. obs = 900 - R ² = 0.8725 - MSE = 0.2110							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
*, **, *** = significance at 1, 5 and 10% levels.

Table 3: Spain - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
1.581# (0.1861)	0.3842** (0.1576)	0.887* (0.0129)	0.3844* (0.0465)	-0.080 (0.1004)	0.760* (0.0357)	1.744* (0.2607)	0.0335* (0.0136)
nb. obs. = 2310 - $R^2 = 0.8247$ - MSE = 0.2506							
Equation 2							
2.011## (0.5234)	0.330** (0.1559)	0.883* (0.0124)	0.388* (0.0466)	- -	0.759* (0.0357)	1.747* (0.2615)	0.037* (0.0137)
nb. obs = 2310 - $R^2 = 0.8245$ - MSE = 0.2507							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
*, **, *** = significance at 1, 5 and 10% levels.

Table 4: Italy - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
9.467# (4.296)	1.619* (0.1908)	0.871* (0.0248)	0.052 (0.0327)	0.304** (0.119)	0.262* (0.0231)	17.540* (6.6155)	0.2725* (0.0358)
nb. obs. = 3366 - $R^2 = 0.8135$ - MSE = 0.30302							
Equation 2							
3.314# (0.3194)	3.868* (0.1635)	0.964* (0.0190)	-0.030 (0.0317)	- -	0.383* (0.0246)	4.457* (1.0168)	0.031 (0.0349)
nb. obs = 3366 - $R^2 = 0.8245$ - MSE = 0.2507							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
*, **, *** = significance at 1, 5 and 10% levels.

Table 5: Italy - Southern regions dropped - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
2.940#	2.499*	0.914*	0.003	0.322**	0.821*	0.875*	0.027
(0.4136)	(0.255)	(0.025)	(0.0445)	(0.162)	(0.0368)	(0.1280)	(0.0376)
nb. obs. = 2057 - $R^2 = 0.8601$ - MSE = 0.2363							
Equation 2							
3.027#	2.455*	0.921*	-0.018	-	0.828*	0.861*	0.022
(0.4603)	(0.2303)	(0.022)	(0.0417)	-	(0.0369)	(0.1256)	(0.0357)
nb. obs = 2057 - $R^2 = 0.8595$ - MSE = 0.2317							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
 *, **, *** = significance at 1, 5 and 10% levels.

Table 6: Netherland - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
-							
Equation 2							
4.519#	0.962*	0.500*	0.3451*	-	1.037*	0.490*	0.347*
(1.4725)	(0.2620)	(0.0231)	(0.0845)	-	(0.0420)	(0.0737)	(0.0626)
nb. obs = 630 - $R^2 = 0.9077$ - MSE = 0.0932							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
 *, **, *** = significance at 1, 5 and 10% levels.

Table 7: Great Britain - $\mu = 0.4$ - White consistent non linear least squares

σ_x	δ	α_1	α_2	α_3	λ	b	α_4
Equation 1							
2.286** (1.1681)	1.186* (0.2709)	0.570* (0.0352)	- -	0.9028** (0.3928)	0.454* (0.035)	1.489* (0.340)	1.011* (0.1017)
nb. obs. = 540 - $R^2 = 0.8883$ - MSE = 0.0677							
Equation 2							
2.535** (1.3081)	1.009* (0.2265)	0.562* (0.0349)	- -	- -	0.448* (0.0353)	1.559* (0.3603)	1.098 (0.0948)
nb. obs = 540 - $R^2 = 0.8869$ - MSE = 0.0683							

Standards errors in parenthesis; #, ## = superiority to 1 at 5% and 10% significance levels.
 *, **, *** = significance at 1, 5 and 10% levels.

Table 8: Correlation table with the migration share variable

	DE	ES	IT	NL	GB
Non-agri. employment	0.7069 (0.0001)	0.6823 (0.0001)	0.8235 (0.0001)	0.6193 (0.0001)	0.7074 (0.0001)
Unemployment rate	-0.4055 (0.0001)	0.2245 (0.0001)	0.0896 (0.0001)	-0.0667 (0.0428)	- -
Non-agricultural wage	-0.0584 (0.0798)	0.0507 (0.0148)	0.1293 (0.0001)	0.0169 (0.6075)	0.1231 (0.0432)
Distance	-0.4345 (0.0001)	-0.3958 (0.0001)	-0.3427 (0.0001)	-0.7303 (0.0001)	-0.4795 (0.0001)
Density	-0.4213 (0.0001)	0.3021 (0.0001)	0.7436 (0.0001)	0.5559 (0.0001)	0.5593 (0.0001)

Table 9: Inter-regional migration rates

		Period	Mean	Std Dev	Growth rate
Italy	total	82/95	0.24%	0.0002	-23.94%
	long dist.	82/95	0.15%	0.0001	-23.76%
Germany	total	75/93	0.54%	0.0006	-29.37%
	long dist.	75/93	0.18%	0.0002	-28.28%
Spain	total	80/94	0.19%	0.0006	50.01%
	long dist.	80/94	0.11%	0.0003	32.75%
Netherland	total	75/95	1.17%	0.0037	15.9%
	long dist.	75/95	0.35%	0.0017	74.80%
GB	total	80/86	1.50%	0.0009	11.4%
	long dist.	80/86	0.61%	0.0003	8.25%

Long distance migrations are motions toward a non-contiguous region

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