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Spatial Externalities and Empirical Analysis: The case of Italy

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Abstract

In the last ten years the space issue, i.e. the study of the role played by space in economic phenomena, has attracted a lot of interest from many economic fields. Both the suitability of spatial economics to address questions posed by globalization, and improves in modeling techniques are at the basis of this revolution. The combination of increasing returns, market imperfections, and trade costs creates new forces that, together with factor endowments, determine the distribution of economic activities. These spatial externalities makes agents' location choice highly interdependent, thus allowing to understand the empirical spatial correlation between demand and production previously observed by the market potential literature. Despite their theoretical relevance, there is still little evidence, especially at large scale level, on the effective contribution of this new identified forces to agents' location decisions. The aim of this work is to directly estimate a model of economic geography on some Italian regional data in order to both test the empirical relevance of this theory and try to give a measure of the geographic extent of spatial externalities.

Key Words: Economic Geography, Spatial Externalities, Market Potential.

JEL Codes: F12, R12, R32.

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1 Introduction

Economic activities are certainly not equally distributed in space. Moreover, a closer look to the shape of their distribution reveals such strong regularities, like the rank-size rule or the gravity law for example, that becomes natural to think about it as a system endowed with a valuable economic structure.[1] However, despite some interesting early contributions made by Hirschman, Perroux or Myrdal, this issue remained unaddressed by mainstream economic theory for a long while. As argued by Krugman [1995], this is probably because economists lacked a model embracing both increasing returns and imperfect competition in a general equilibrium setting. Indeed, as shown by Fujita and Thisse [2001] in a very general setting, the price-taking hypothesis is incompatible with the existence of a non-autarchic competitive equilibrium in space.

The relatively recent new economic geography literature (NEG) has finally provided a collection of general equilibrium models explicitly dealing with space, and capable to account for many salient features of the economic landscape.[2] Agents choose their location on the basis of market-price incentives. Then, the combination of increasing returns at firm level with market power (usually in the form of monopolistic competition) and transportation costs, give rise to an endogenous agglomeration, provided that centripetal forces are sufficiently strong. This process is best analyzed is terms of spatial *pecuniary* externalities. When some workers/firms choose to migrate/delocate, they are likely to affect prices prevailing in both the labor and product market in the two locations of origin and destination. Thus, the location choice of some agents has an impact trough prices (so the pecuniary nature) on other agents creating an externality. Moreover, as Fujita and Thisse [2001] observed, such pecuniary externalities are especially relevant in the context of imperfectly competitive markets because prices do not reflect the social values of individual decisions. At this point increasing returns operates: if they are sufficiently strong to overcome competition for markets and factors, agents will find it convenient to agglomerate.

As Krugman [1995] himself pointed out, there is a strong connection between the NEG and some older fields in economics. To a large extent, what have been actually done is in fact rediscovering concepts and ideas that did not receive much attention by mainstream economic theory because of their lack of a rigorous formal counterpart.[3] Within this group of overlooked

[1] For a good exposition of these arguments see Krugman [1995].

[2] See Fujita and Thisse [1996], Ottaviano and Puga [1998], and Fujita, Krugman and Venables [1999] for a review of the literature.

[3] Examples are Lörsh (1940) and Christaller (1933) *central place theory*, Rosenstein-

contributions, and of particular interest for the present work, is the literature on *market potential* begun by Harris (1954). This literature argued that firms' desirability for a location as a production site depends on its access to markets, and that the quality of this access may be described by an index of market potential which is a weighted sum of the purchasing power of all other locations, with weights depending inversely on distance. Although this approach has proved to be empirically quite powerful in analyzing the location of industry, it totally lacked any microeconomic foundation. At that time there were in fact no rigorous explanations of why a correlation between market access and firms' location should exists. However, Krugman [1992], Fujita and Krugman [1995], and Fujita, Krugman and Venables [1999] shows that market potential functions can be obtained from formal spatial general-equilibrium models, thus providing the theoretical background for the use of such approach to study the distribution pattern of economic activities.

The main objective of this work is to estimate a market potential function, coming from a formal model, using data for Italian provinces. The particular model used is a multi-location extension of Helpman [1998], the latter being a variant of the well-known Krugman [1991] and Krugman [1992] core-periphery models. From an empirical point of view, Helpman [1998] is in fact preferable to Krugman's models because of the less extreme nature of its equilibria.[4] This will in turn allow us to:

1. Obtain estimates of structural parameters to infer about the consistency of Helpman's model with reality.

2. Compare the explanatory power of our theory-based market potential function with that of the classic linear one, used extensively in literature, to evaluate the specific contribution of the model in understanding firms' location.

3. Give an idea of the extent of spatial externalities by measuring how far in space a shock in one location affect the others.

Both the strong non-linearity of the model and the nature of the estimation method will make our task relatively complex, requiring the implemen-

Rodan (1943) *big push*, Perroux (1955) *growth poles*, Myrdal (1957) *circular and cumulative causation*, and Hirschman (1958) *backward and forward linkages*.

[4]In Krugman [1991] and Krugman [1992], when agglomeration occurs economic activities fully concentrate in very few locations (in many cases just one) leaving most of the economic space completely empty. Actually, we do not observe such tremendous concentrations in real world. By contrast, Helpman's model generates weaker agglomeration patterns that are more consistent with spatial distribution of economic activities.

tation of ad-hoc estimations routines.[5]

There is a growing empirical literature on the location of economic activities, especially at low-scale geographical level. There are, however, different line of research, each relying on a different agglomeration mechanism.[6] First, agents may be drawn to regions with pleasant weather or other exogenous amenities.[7] Roback [1982], Beeson and Eberts [1989], and Gyourko and Tracy [1991] estimate the economic value of such amenities. Second, human capital accumulation by one individual may raise the productivity of her neighbors, making agglomerated regions attractive places to work.[8] Rauch [1993], Glaeser and Mare [1994], and Peri [1998] find that wages are higher in cities with higher average education levels. Finally, technological spillovers may also contribute to geographic concentration.[9] A key feature of the NEG approach we are using here is the stress on increasing returns and markets interaction, as opposed to factor endowments (exogenous amenities), and technological externalities (human capital and technological spillovers). Combes and Lafourcade [2001], and Head and Mayer [2001], belong to this category. However, the closest reference with the present analysis is certainly that of Hanson [1998], to which we will extensively refer throughout the rest of the paper. Hanson [1998] uses the same model to estimate the market potential function for US counties. Apart from the use of a different data set, the novelty of our paper consists of the implementation of a more efficient estimation method and in the construction of new proxy variables to account for the structural differences between US and Italy.

The rest of the paper is organized as follows. Section 2 describes the theoretical reference model: Helpman [1998]. Section 3 is devoted to give some insights on model interpretation, and to link it closely to the market access tradition. Section 4 describes the estimation procedure, while section 5 deals with data issues and aggregation. Detailed estimation results are presented in section 6. Finally, in section 7 we draw our conclusions and suggest directions for further research.

[5] All the routines have been implemented in Matlab 5.3 for Windows.

[6] See Hanson [2000] for a survey of the literature on agglomeration economies.

[7] See for example Rosen [1979], and Roback [1982]

[8] This idea is related to Lucas [1988], and Black and Henderson [1999].

[9] See for example Glaeser et al. [1992], Jaffe, Trajtenberg, and Henderson [1993], Henderson, Kuncoro, and Turner [1995], and Ciccone and Hall [1996].

2 The Model

Imagine an economy consisting of Φ locations, two sectors (the manufacturing sector M and the housing sector H), and one production factor (labor). The M-sector produces a continuum of varieties of a horizontally differentiated product under increasing returns to scale, using labor as the only input. Each variety of this differentiated good can be traded among locations incurring in iceberg-type transportation costs.[10] Referring to two generic locations as i and k $(i, k = 1, 2, ..., \Phi)$, we thus have that for each unit of good shipped from i to k, just a fraction $\upsilon_{i,k} = e^{-\tau d_{i,k}}$ of it, where $d_{i,k}$ is distance between the two locations and $\tau \in (0, \infty)$ is an (inverse) measure of transportation costs, arrives at destination. This means that, indicating with $p_{m,i}$ the mill price of a variety produced in location i, the corresponding delivered price for the consumer living in k would be $p_{m,i}/\upsilon_{i,k}$. Firms receive mill prices while consumers pay delivered. If nothing else is explicitly mentioned, $p_{m,i}$ is meant to be the mill price. The H-sector provides instead a homogeneous good, housing, that cannot be traded and whose amount in each location (H_i) is supposed to be exogenously fixed. Its price $P_{H,i}$ can therefore differ from one place to another and is determined by the equilibrium between local supply and demand.[11]

Labor is supposed to be freely mobile, and its (exogenous) total amount in the economy is equal to L. The equilibrium spatial distribution of our workers-consumers is thus determined by both wages (w_i), and prices prevailing in each location. We will denote L_i, with $\sum_{i=1}^{\Phi} L_i = L$, as labor in location i, and $\lambda_i = L_i/L$ as the corresponding share of total workers. Preferences and technology do not directly depend upon the location where consumption and production take place, but only indirectly through prices. Therefore it is notationally convenient to describe them, as well as firms' behavior, without explicitly referring to any particular location.

Preferences are identical across all workers. As usual in NEG models,

[10] The term transportation costs does not simply refers to shipment costs but in general to all costs and impediments of doing business in different markets, like information costs, language differences, etc.

[11] The major difference between Helpman [1998] and Krugman's standard specification lies precisely in the nature of good H. In Krugman [1991], and Krugman [1992] this good is supposed to be produced by means of a sector-specific factor, land, under constant returns and perfect competition. Moreover, good H can be traded without incurring in any cost. These assumptions, together with a full-utilization condition for land in any location, ensure the uniqueness of its price, $P_{H,i} = P_H$, that can therefore be set to one for normalization and used as numeraire. Later on, we will see how these two different assumptions about H will influence agglomeration incentives.

they are described by the standard Cobb-Douglas utility function with CES type sub-utility for the differentiated product, i.e.:

$$U = (C_M)^{\mu} (C_H)^{1-\mu} \qquad 0 < \mu < 1 \tag{1}$$

where C_M stands for an index of the consumption of the M-sector varieties, while C_H is housing consumption. We assume that the modern sector provides a continuum of varieties of (endogenous) size N, the consumption index C_M is thus given by[12]:

$$C_M = \left[\int_0^N c_m(j)^{\rho} dj \right]^{1/\rho} \qquad 0 < \rho < 1 \tag{2}$$

where $c_m(j)$ represents the consumption of variety $j \in [0, N]$. Hence, each consumer has a love for variety and the parameter $\sigma \equiv 1/(1-\rho)$, varying from 1 to ∞, represents the (constant) elasticity of substitution between any two varieties. The bigger is σ the more varieties are substitutes: when σ is close to 1 the desire to spread consumption over all varieties increases. If Y denotes the consumer income, then the demand function for a variety j coming from utility maximization is:

$$c_m(j) = p_m(j)^{-\sigma} \mu Y (P_M)^{\sigma-1} \qquad j \in [0, N] \tag{3}$$

where $p_m(j)$ is here the consumer-price (or delivered price) of our generic variety and P_M is the price-index of the differentiated product given by:

$$P_M \equiv \left[\int_0^N p_m(j)^{-(\sigma-1)} dj \right]^{-1/(\sigma-1)} \tag{4}$$

Technology is the same across locations. Each variant of the differentiated product needs labor to be produced. The relation between the amount of labor used ($l(j)$) and the quantity of variant j produced ($c(j)$) is given by:

$$l(j) = f + \beta c(j) \tag{5}$$

[12]In the original Helpman [1998] formulation, as well as in Krugman [1991] and Krugman [1992], N is not a mass but instead the finite number of varieties provided by the market. However, as pointed out by Fujita and Thisse [2001], this approach is conceptually misleading for the monopolistic competition framework. In fact, in order to be consistent with the requirement that firms are negligible with respect to the market, we should consider a continuum of them. If we do not and use instead an integer number of firms, strategic interactions actually dominates (d'Aspremont, Dos Santos Ferreira and Gerard-Varet [1996]). However, the way N is actually treated by Helpman, is such that final results are virtually unchanged. Nevertheless, we prefer to use here the continuum formulation.

where f and β are, respectively, the fixed and the marginal labor requirements. The presence of the fixed cost f clearly imply increasing returns. Without loss of generality we choose the unit for labor such that $c = 1$. Since preferences exhibits a symmetric love for diversity and since there are increasing returns to scale but no scope economies, each variety is produced by a single firm. Moreover, as soon as each firm is supposed to be small relative to the market, firms eventually producing more than 1 (up to a set of zero measure) variety would act as if they were actually different.[13] In turn, this implies an identity between the mass of firms and the mass of varieties with the output of each firm equating the demand for the corresponding variety, the latter coming from consumers spread all over the Φ locations.[14]

Firms know consumers' demand and choose prices in order to maximize their profits given by:

$$\pi(j) = p_m(j)q(j) - w[f + q(j)] \tag{6}$$

where w is wage paid by our generic firm and $q(j)$ is its output.

However, when they look at demand structure, i.e. equation (3), it is likely that they consider Y and P_M as given. Since each of them has a negligible influence on the market, it may accurately neglect the impact of a price change over both consumers' income and the price index. Consequently, (3) implies that each firm faces an isoelastic downward sloping demand with elasticity given by our parameter σ. Solving first order conditions yields the common equilibrium relation between the optimal price, elasticity of demand, and marginal cost:

$$p_m(j) = \frac{w}{1 - (1/\sigma)} \tag{7}$$

Under free entry, profits are zero. This implies, together with equation (7), that the equilibrium output is a constant given by:

$$q(j) = q = (\sigma - 1)f \tag{8}$$

Note that this relation is true wherever our firm is located. As a result, in equilibrium a firm's labor requirement is also unrelated to firms' distribution:

[13]In our framework the introduction of a new variety cause consumers to split their income on a larger number of goods. If perceived by firms producing more than one variety, this *cannibalization* effect would require price strategies different from those used by single-good plants. However, the hypothesis of a continuum of varieties makes the above effect negligible from firms point of view.

[14]Actually, consumers' expenditure for variety j, and not the quantity demanded, equals the corresponding firm sells. The presence of iceberg transportation costs creates in fact a discrepancy between what is shipped by firms and what consumers receive.

$$l(j) = l = \sigma f \tag{9}$$

so that the total mass of firms in the manufacturing sector (N) is constant and equal to $L/\sigma f$. Equation (8) has also another important drawback. Taking the ratio between marginal (mgc) and average cost (avc) and using (8) we get:

$$\frac{mgc(j)}{avc(j)} = \frac{w}{w[f + q(j)]/q(j)} = \frac{\sigma}{\sigma - 1} \tag{10}$$

Thus, the parameter σ is (in equilibrium) also an (inverse) measure of increasing returns to scale as it reflects the gap between marginal and average costs.[15]

Firms and consumers have an address in space and must choose a location. We can now summarize the long-run spatial equilibrium of our economy by means of five equations introducing space indexes on preferences and technology. The first equilibrium requirement comes from utility maximization. Our Cobb-Douglas utility function is in fact such that the (optimal) share of expenditure on each product is constant and equal to the corresponding exponent. If $E_{H,i}$ denotes consumers' expenditure on houses in location i, Y_i the corresponding income, and $C_{H,i}$ total housing consumption in that region, then $\forall i = 1, 2, \ldots, \Phi$ we have:

$$E_{H,i} \equiv p_{H,i} C_{H,i} = p_{H,i} H_i = (1 - \mu) Y_i \tag{11}$$

where the second equality comes from the equilibrium between local supply and demand of houses ($C_{H,i} = H_i$).

Since there is free entry and exit and, therefore, zero profit in equilibrium the value of the manufacturing production in each region equals factor earnings ($w_i \lambda_i L$). If we now suppose that each individual owns an equal share of the total housing stock, then income in location i is given by[16]:

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[15] This actually represents a weakness of the model. The parameter σ is at the same time the elasticity of substitution between any two varieties, the price-elasticity of consumers' demand, and an inverse measure of increasing returns to scale. This will cause some interpretation problems in our econometric analysis

[16] From equation (11) total housing expenditure in our Φ locations is given by $E_H = \sum_{k=1}^{\Phi} E_{H,k} = (1 - \mu) \sum_{k=1}^{\Phi} Y_k$. Moreover, $\forall\, k$ we have $\mu Y_k = w_k \lambda_k L$ and taking the sum we get $\sum_{k=1}^{\Phi} Y_k = 1/\mu \left[\sum_{k=1}^{\Phi} w_k \lambda_k L\right]$. Combining these two relations we finally get equation (12). It is important to point out that the hypothesis of an equal sharing of the housing stock is not crucial to our analysis. Using alternative assumptions, like that of immobile or even absentee landlords, Helpman [1998] finds no qualitative changes in model behavior. More importantly (12) will not be used to obtain the reduced form equation we will actually estimate.

$$Y_i = \left[\lambda_i \frac{1-\mu}{\mu} \sum_{k=1}^{\Phi} \lambda_k w_k L \right] + \lambda_i w_i L \tag{12}$$

Moreover, for a spatial distribution of workers to be an equilibrium, there should be no incentive to move. As they are perfectly mobile, this implies an equalization of real wages in the long run[17]:

$$\frac{w_i}{\left(P_{M,i}\right)^{\mu}\left(P_{H,i}\right)^{1-\mu}} = \frac{w_k}{\left(P_{M,k}\right)^{\mu}\left(P_{H,k}\right)^{1-\mu}} \qquad \forall i,k = 1,2,...,\Phi \tag{13}$$

Finally, as shown rigorously in Fujita and Thisse [2001], the last two equilibrium relations are:

$$P_{M,i} = \kappa_1 \left[\sum_{k=1}^{\Phi} \lambda_k (w_k \, e^{\tau d_{i,k}})^{1-\sigma} \right]^{1/(1-\sigma)} \tag{14}$$

and

$$w_i = \kappa_2 \left[\sum_{k=1}^{\Phi} Y_k (P_{M,k} \, e^{-\tau d_{i,k}})^{\sigma-1} \right]^{1/\sigma} \tag{15}$$

with $\kappa_1 \equiv \rho^{-1} \left(H/\sigma f\right)^{1/(1-\sigma)}$and $\kappa_2 \equiv \rho \left[\mu/(\sigma-1)f\right]^{1/\sigma}$. Equation (14) comes from optimal pricing rule (7) and zero profit condition (8). Condition (15) express the equilibrium between supply and demand of labor in each location and comes from firm equilibrium labor requirement (9) and consumers' demand (3).

3 A market potential approach

Considering equations (11) trough (15) for each location $i = 1,2,...,\Phi$, we get a simultaneous system of $\Phi \times 5$ equations in $\Phi \times 5$ unknowns $(P_{H,i}, Y_i, w_i, \lambda_i, P_{M,i})$ that summarize the equilibrium of our spatial economy. In order to give some

[17]The short-run characterization of the model does not include equation (13). The dynamics is in fact supposed be driven by real wages differences, with workers moving towards those locations offering them higher real earnings. If in the long-run equilibrium all locations have some manufacturing then (13) will be obviously satisfied. However, contrary to Krugman [1991], it is really unlikely that (13) does not hold because it would require the price of houses in the abandoned locations to be zero. This is one of the reasons that lead us to prefer Helpman's model for empirical purposes.

insight about model behavior is better to start from standard results in international trade theory. Krugman [1991], and Helpman [1998] are essentially trade models in which a certain number open-economies trade goods among each other and factors are perfectly mobile. Technology and preferences are the same and there is a barrier in trading abroad given by transportation costs. If all markets were perfectly competitive and goods homogenous we would expect, according to the Heckscher-Ohlin theory, trade flows to be driven by factor endowments. However, the perfect mobility of at least one production factor would prevent trade to occur in equilibrium. In fact, a well known result in neoclassical theory of international trade is that the combination of factor mobility and barriers to trade destroys any comparative advantage leading to autarchic economies.[18] This is certainly not surprising in the light of the *spatial impossibility theorem* by Fujita and Thisse [2001], and applied to our framework would mean that firms and consumers would locate in space proportionally to the exogenous endowments H_i. Therefore, there should be no room for market potential-type analysis as economic activities would be distributed just as exogenous factors are, showing no other meaningful spatial correlation.

Clearly, this is in sharp contrast with the observable features of the economic landscape. The existence of cities, industrial districts, and regional imbalances is thus a puzzle for the standard competitive-markets theory. One way to get out of this trap is to advocate marshallian (or technological) externalities in production and/or consumption. Although very popular in urban and regional economics, as well as in economic growth theory, this approach suffers of at least two serious limitations. First, it introduces agglomeration almost by definition by either assuming its exogenous existence, or using ad-hoc mechanisms.[19] Second, agents' interaction is essential to externalities so, as long as this interaction needs a material institution to be effective (like a city or a district), the corresponding externalities are clearly limited in their geographic extent.[20]

[18] See Gandolfo [1998].

[19] Urban Economics literature for example uses extensively exogenously located towns, or central business districts (CBD) in performing its analysis. However, "*when our question is not simply how land use is determined given a pre-existing CBD, but rather how land use is determined when the location of towns or CBDs are themselves endogenous, this approach offers little help*" (Fujita, Krugman, and Mori [1999]). Concerning technological externalities, this strategy consists in introducing directly agglomeration incentives in agents' behavioral functions. Clearly, this introduces agglomeration virtually by definition and the risk of such an approach is to force economic models going beyond what we can actually observe and test about agents' behavior.

[20] Technological externalities can help understand why cities exists and why they promote growth but cannot account for larger-scale agglomeration phenomena.

The NEG literature offers the possibility to treat agglomeration in a more flexible and rigorous way by means of increasing returns, imperfect competition, and product differentiation. To understand the forces at work in Helpman [1998] it is useful to consider the following simplified thought experiment. Suppose that we have just two locations with the same exogenous housing stock, and that the economy starts with a symmetric distribution of firms and workers. The only candidate for equilibrium in a competitive market world would be precisely the symmetric one as the two locations are a priori identical. Suppose furthermore that, for whatever reason, one firm decides to move from one region to the other. How does this affect firms profitability? The presence of one more firm will increase competition in the product and labor markets of the location receiving the firm, thus tending to reduce local profits and to make relocation unprofitable. If there was no mobility of workers, this would be the end of the story and regions would remain identical. However, the rise in the number of local varieties that can be bought without incurring in transportation costs, and the rise in labor demand and wages tend to attract more workers. This migration increases local expenditure (a demand linkage) and eases competition in the labor market, so tending to increase local profits and to attract more firms. The demand linkage is here particularly important because increasing returns makes production expansion attractive, and market power gives to firms the possibility to better exploit such potential gains.

Whether the overall effect of entry is to increase the profitability of local firms (encouraging further entry thus leading to an asymmetric equilibrium distribution of economic activities), or to lower that profitability (leading to exit and reestablishing symmetry), depends on parameters of the model (σ, μ, τ). As long as $\sigma(1-\mu) > 1$, agglomeration never occurs and economic activities will be equally distributed. If instead $\sigma(1-\mu) < 1$ then, depending on the level of transportation costs, we will observe agglomeration or dispersion.[21] Conforming to intuition both a smaller degree of substitution between varieties (lower σ), and a greater share of manufacturing consumption (higher μ) causes centripetal forces to strength.[22] However, the effect of

[21] If we relax the assumption that the housing stock is the same in the two regions things do not change that much. If $\sigma(1-\mu) > 1$ economic activities will be distributed only according to exogenous factor endowments, even if with a slight disproportion. If instead $\sigma(1-\mu) < 1$ then, depending on the level of transportation costs, we will again observe agglomeration or dispersion but agglomeration can now occur only in the location with more housing stock.

[22] When $\sigma(1-\mu) > 1$ an increase of μ, or a decrease of σ, cause the disproportion between the number of firms residing in one location and the corresponding fixed endowments to widen. On the other hand if $\sigma(1-\mu) < 1$ simulations shows clearly that the effect it to restrict the range of transportation costs for which symmetric equilibrium is stable.

a transportation costs change in Helpman [1998] is different from Krugman [1991]. In Krugman [1991] agglomeration occurs if transportation costs are sufficiently small (high values of τ), whether in Helpman [1998] is the other way round. This is due to the different hypothesis on the homogenous good H.[23]

In Krugman's model H is a tradable good that can be shipped from one location to another, without incurring in transportation costs, produced by means of an immobile factor (say land or unskilled workers). The demand for goods coming from the owners of this factor is thus tied to the origin location, and still represents an considerable market to be served. When shipping is prohibitive, centrifugal forces dominates because immobile demand is simply too far to be reached efficiently, and firms find convenient to relocate in rural areas to both avoid transportation costs and enjoy a fiercer price competition. If τ is instead sufficiently high firms can agglomerate to enjoy the advantages of increasing returns but still offer competitive delivered prices in abandoned regions. In Helpman [1998], is instead the need for firms to compensate workers for the cost of housing in congested areas that can eventually reestablish symmetry. In order to attract workers firms must in fact provide them higher nominal wages as the price of the immobile good H ($P_{H,i}$), reflecting the pressure of an increasing demand, tends to be higher in agglomerated areas. Furthermore, the lower transportation costs are the less important the location issue is and in the limit, when shipping has no cost, only factor endowments matter. Thus if τ raises sufficiently firms have no possibility to attract workers as the amount of their agglomeration incentives is being eroded by transportation costs decline.[24]

[23]There are other models than Helpman [1998] in which a concentration of consumption and production cannot take place for low values of shipping costs. See for example Adrian [1996], Hadar [1996] and, although in a different framework, Krugman and Venables [1995], and Puga [1999]. However, one should not consider these results as opposite to Krugman [1991] type models, but instead as complement. Each model focuses only on few of the possible many forces one can think about in addressing location choice issues. Therefore, each of them should be considered as a piece of a complicated puzzle; a very simplified example of how the world can works. About the relation between markets integration and agglomeration, the general picture coming out of from the NEG literature is, as argued by Ottaviano and Puga [1998], one in which for high trade costs the need to supply markets locally encourages firms to locate in different regions. For intermediate values of trade costs, cost and demand linkages take over and firms and workers cluster together. Finally, for low values of trade costs location is determined by the price of those factors (like unskilled workers) and goods (like houses) that are not mobile.

[24]The way the so-called *black-hole condition* works is also different in the two models. In Krugman [1991] this condition is given by $\sigma(1-\mu) < 1$, and if satisfied implies that agglomeration always occurs no matter how transportation costs are. The parallel with the irresistible attracting power of a black-hole is evident. By contrast, in Helpman [1998]

When we come back to our original framework, considering an arbitrary number of locations and fixed factor distribution, the story becomes much more complicated and few analytical results are available. The first thing to say is that we normally observe a multiplicity of equilibria. Simulations show that agglomeration takes place by means of a self-reinforcing process in which small initial asymmetries among locations are then magnified by market forces, leading to what Fujita and Thisse [1996] call *putty clay geography*: there is a priori great flexibility on where particular activities locate, but once spatial differences take shape they become quite rigid. The actual equilibrium configuration of our space-economy is thus path-dependent[25] and markets-centrality, as well as factor endowments[26], constitutes preferential requirements for a location to become a cluster of firms and consumers. Other things equal if a location has a better access, somehow defined, to appetizing markets some firms will initially delocate there in order to take the advantages that markets-proximity, due to their increasing returns technology, gives them. If the balance is in favor of centripetal forces, this will in turn increase local wages and goods expenditure attracting workers as well as other firms. It becomes now clear the connection of this model, with older traditions in economics and in particular with the market-potential literature.

Actually, Harris (1954) market-potential function relates the potential demand for goods and services produced in a location with that location's proximity to consumer's markets, or:

$$MP_i = \sum_{k=1}^{\Phi} Y_k f(d_{ik}) \tag{16}$$

where MP_i is the market potential of location i, Y_k is an index of purchasing capacity of location k (usually income), d_{ik} is (as usual) the distance between two generic locations i and k, and $f()$ is a decreasing function. The higher is the market potential index of a location, the higher is its attraction power on production activities.

there is no proper black-hole condition because agglomeration always depends on τ.

[25]This is why it is usually said that history matters.

[26]The fact that many NEG models abstract from factor endowments considerations assuming an equal distribution, does not mean that one wants to deny their importance. The a priori equivalence among locations is just a metaphor used to better isolate the forces one wants to show, as well as a convenient working hypothesis. Ricci [1999] shows clearly how both factor endowments and NEG forces matter for the distribution of firms and trade. Moreover, Davis and Weinstein [1998] and Davis and Weinstein [1999] find empirical evidence of a joint influence of comparative advantages and market access in determining trade flows at both international and regional level.

In Helpman model, a good measure of a firm incentive to move is given by equilibrium nominal wages. Although firms makes no profits in equilibrium (no matter where they are located), the wage they can afford express their capacity to create value once located in a particular region.[27] Combining equations (11), (13), (15) and applying logarithms to simplify things we get the following incomplete reduced-form:

$$\ln(w_i) = \kappa_3 + \sigma^{-1} \ln \left[\sum_{k=1}^{\Phi} Y_k^{\frac{1-\sigma(1-\mu)}{\mu}} H_k^{\frac{(1-\mu)(\sigma-1)}{\mu}} w_k^{\frac{(\sigma-1)}{\mu}} \exp^{-\tau(\sigma-1)d_{ik}} \right] \quad (17)$$

where κ_3 is a function of behavioral parameters (μ, σ, τ, f), as well as of the equilibrium real wage coming from (13). Equation (17) really looks like a market-potential function. It tells us that as long as agglomeration forces are active ($\sigma(1-\mu) < 1$), the nominal wage in location i (and thus local firms' profitability) is an increasing function of the weighted purchasing power coming from surrounding locations (Y_k), with weights given by distances d_{ik} (this is the market access component). Moreover, the distribution of economic activities depends also upon prices because an increase in other locations' housing stock (H_k) or wages (w_k), cause w_i in (17) to increase in the long-run in order to compensate workers for lower housing prices and higher earnings they can enjoy elsewhere.

A log-linear version of Harris market potential that is comparable to (17) is given by:

$$\ln(w_i) = \alpha_1 \ln \left[\sum_{k=1}^{\Phi} Y_k \exp^{-\alpha_2 d_{i,k}} \right] \quad (18)$$

with $\alpha_1, \alpha_2 > 0$. Equation (18) is not obtained from a theoretical model and compared to (17) does not control for wages and prices of others locations. Although quite powerful from an empirical point of view, market

[27] An alternative modelling strategy, focusing more explicitly on profits, have been proposed by Puga [1999]. Helpman [1998] and Krugman [1991], as well as almost all models belonging to the same class, assume that profits are zero in the short-run with workers moving from one location to another in order to equalize real wages in the long-run. In this case firms just follow workers in order to find the labor they need to produce. Puga [1999] instead assumes that inter-location labor markets instantaneously clear in the short-run, leading to real-wage equalization, while firms' profits can differ from zero. In the long-run however firms move toward those regions offering higher gains and market forces will drive profits to zero. Conceptually, these short-run profits are better suited than nominal wages to express a firm gain from relocation. However, as find out by Puga [1999], using these two alternative dynamics produce virtually no difference, that is why we use nominal wages as a measure of such incentives.

potential functions like (18) lacked any microeconomic foundation. Equation (17) and (18) will be the base-line references of our empirical investigation. Our main goal is to estimated Helpman [1998] structural parameters and to evaluate its capacity to interpret the distribution of economic activities as compared to the old market potential tradition.

4 Econometric concerns

There are several issues to be addressed in order to perform our empirical analysis. The first thing to say is about our choice of (17) to estimates structural parameters (μ, σ, τ). In principle, this objective would be better achieved using simultaneous equations techniques on equations (11) trough (15). Apart from the technical problems of such an approach, is the unavailability of reliable statistics for prices of manufacturing goods ($P_{M,i}$), and houses ($P_{H,i}$), at any interesting geographical level that makes this solution unapplicable. Data on prices can in fact be found at regional level for Italy: this is too much aggregate a unit for our purposes. Equation (17) is instead a reduced-form of the model that does not contain these two variables, and for which is possible to find adequate local data. This allow us to perform the estimation even if we actually loose some information.[28]

Another important aspect is related to missing variables like the presence of local amenities (nice weather, ports, road hubs, etc.) and localized externalities (especially human capital ones) that clearly influence the distribution of economic activities, but are not included in our analysis. Beyond obvious efficiency considerations, if we do not account for these variables we can potentially encounter a bias problem. In a more recent version of his paper, Hanson [1998] uses statistics on local amenities and working population to control for these effect. However, we do not use such variables for two reasons. The first is the difficulty to find these kind of data for Italy. The second is instead related with the estimation strategy we follow. When one thinks about both amenities and human capital externalities it is clear that if these factors change over time, this change is very slow. The quality of the working force, as well as the presence of infrastructures and the network of knowledge exchange is thus reasonably constant (for a given location) in a short interval of time. We can thus try to overcome the problem of miss-

[28] Actually, equation (17) comes from the combination of equilibrium relations (11), (13), and (15). Consequently, we are not using the information contained in both equation (12) and (14) that, together with the other three, fully describe the long-run equilibrium of our economy.

ing variables by using an appropriate time-difference approach.[29] Applying time-difference operator $\triangle$ on (17), and introducing explicitly the random component $\varepsilon_{i,t}$ we obtain the new estimation equation:

$$\Delta \ln(w_{i,t}) = \ln(w_{i,t}) - \ln(w_{i,t-1}) =$$

$$\sigma^{-1} \ln \left[\sum_{k=1}^{\Phi} Y_{k,t}^{\frac{1-\sigma(1-\mu)}{\mu}} H_{k,t}^{\frac{(1-\mu)(\sigma-1)}{\mu}} w_{k,t}^{\frac{(\sigma-1)}{\mu}} \exp^{-\tau(\sigma-1)d_{ik}} \right] -$$

$$\sigma^{-1} \ln \left[\sum_{k=1}^{\Phi} Y_{k,t-1}^{\frac{1-\sigma(1-\mu)}{\mu}} H_{k,t-1}^{\frac{(1-\mu)(\sigma-1)}{\mu}} w_{k,t-1}^{\frac{(\sigma-1)}{\mu}} \exp^{-\tau(\sigma-1)d_{ik}} \right] + \varepsilon_{i,t} \quad (19)$$

where subscript t refers to time. Doing the same for (18) we get:

$$\Delta \ln(w_{i,t}) = \alpha_1 \ln \left[\sum_{k=1}^{\Phi} Y_{k,t} \exp^{-\alpha_2 d_{i,k}} \right] - \alpha_1 \ln \left[\sum_{k=1}^{\Phi} Y_{k,t-1} \exp^{-\alpha_2 d_{i,k}} \right] + \varepsilon_{i,t} \quad (20)$$

Regression equations (19) and (20) will be those we will actually implement for estimating parameters. Taking two reference years, and the corresponding statistics on w, Y, H for each location $i = 1, 2, \ldots, \Phi$ (as well as data on distances), we will perform a space cross-section precisely by means of (19) and (20). The two points in time we use are $t-1 = 1991$ and $t = 1995$: a reasonably short interval for our strategy.[30]

Equation (19) and (20) are certainly non-linear. One possible estimation method is thus given by non-linear least squares. However, both the form of our equations and the nature of the variables involved raise a clear endogeneity issue, making the properties of such estimation method doubtfully.

[29]Suppose that there exists a vector of structural elements ($\mathbf{x}_i$), having an influence on location incentives, that enter additively in equation (17) trough a function $f()$. If we do not take into account this component, our estimates would be potentially bias due to the correlation between $f(\mathbf{x}_i)$ and the error term. However, even if we do not know neither $\mathbf{x}_i$ nor $f()$, as long as $f(\mathbf{x}_{i,t-1})$=$f(\mathbf{x}_{i,t})$ these elements will just vanish by applying a time difference on (17). Obviously, the same is true for equation (18). The reader may note that κ_3, which is a function of behavioral parameters and equilibrium real wage, has disappeared from equation (19). However, although μ, σ, and τ are supposed to be time-invariant, the equilibrium real wage is not. Nevertheless, the use of constant price statistics and the short estimation interval make it reasonably constant, thus allowing to eliminate κ_3. Note also that , incidentally, by eliminating κ_3 we loose the parameter f from our estimation equation.

[30]In addition to his set of control variables, Hanson [1998] also uses a time difference approach. Anyway, the joint use of these two tools did not produce significant changes in his estimation results, as compared to the time difference specification only.

The presence, on the right hand side, of a weighted sum over space of the same variable appearing as independent (w_i), is in fact a potential source of bias. Accordingly with spatial econometrics theory, this sum is interpretable as a space-lagged endogenous variable. Thus, as long as errors terms $\varepsilon_{i,t}$ are spatially correlated, we would end-up with inconsistent estimates.[31] More importantly, in the structural form of our model the variables w_i are determined simultaneously with incomes Y_i. The circularity between factor earnings and income is certainly not debatable in economic theory, and in our framework implies that the Y_i are correlated with disturbances leading again to inconsistency of non-linear least squares.

The solution adopted by Hanson [1998] in order to face such endogeneity, is the choice of the geographical reference unit. Ideally, $\varepsilon_{i,t}$ should reflect temporary shocks that influence local business cycles. The finest the geographical unit we use for locations, the smaller is the impact of such shocks on more geographically aggregated variables. Furthermore, if these shocks are really local their eventual spread on other regions should be quantitatively negligible. This amounts to say that our disturbances are spatially uncorrelated, again leading to break the relation between our $\varepsilon_{i,t}$ and aggregate economic indicators. Consequently, the strategy used by Hanson [1998] consists in taking the finest possible geographical level for the dependent variable w_i on the left-hand side of (19) and (20), while using the most (reasonable) aggregate level for the explanatory variables figuring on the right-hand side. Actually, he uses data on w for the 3075 US counties as dependent variables. However, for each county i he utilizes data on w, Y, H, and distances at continental state level, so not counties data, as independent variables. Formally speaking, the two indexes i and k does not correspond anymore to the same location set. Index $i = 1, 2 \ldots, \Phi_1$ corresponds to US counties, while $k = 1, 2, \ldots, \Phi_2$ corresponds to US continental states. In equation (19) for instance he has a sum of $\Phi_2 = 49$ terms (the number of US continental states plus the district of Columbia) on the right hand side, for each of the $\Phi_1 = 3075$ equations to fit.

From the above discussion is clear that, once we use this specification trick, the local shock $\varepsilon_{i,t}$ should be no more correlated with the state-level regressors. Hanson's proposal is thus to apply non-linear least squares to estimate parameters. Moreover, as a particular remedy for simultaneity he subtracts (for each i) the specific contribution of that county in the formation of the corresponding state aggregate variable. For example, in the case of the observation for Los Angeles county he subtracts the housing stock of Los

[31] This happens precisely for the same reason for which an AR time-series process, with auto-correlated disturbances, gives inconsistent estimates with OLS.

Angeles from that of California (but not from other states), before using the latter in the sum of explanatory variables.

Hanson's idea sounds pretty good, and as long as tests do not detect spatial correlation we can be confident about estimates consistency. However, there is something missing from his reasoning. In economic geography theory, as well as in spatial econometrics, it is well known that the level of aggregation matters a lot. When one is trying to interpret spatial data, choosing different geographical units can in fact completely change results. It is at this point that theory should intervene to guide us. The features of our reference theoretical model are such that, the location to be chosen as unit should be the smallest possible, and a state is probably too big for the kind of tensions we are trying to analyze here. Moreover, the fact that Hanson actually mixes state and counties variables in the same equation is quite annoying from an interpretative point of view. However, if we use a county level for independent variables we will be back in the endogeneity trap. This seems to profile a trade-off between estimation properties and economic interpretation.

There is indeed a way to break this trade-off that lies on the same principle. Hanson uses state level on the right-hand side because he needs something that is uncorrelated with disturbances, but still linked with the (real) explanatory variables at county level. Indeed, these are precisely the features of good instrumental variables. Therefore, one can think of keeping county level on the right hand side, and use more geographically aggregated data as instruments for the estimation. It is clear that as long as Hanson strategy works the other should work as well. In any case, an instrumental variable approach would be conceptually preferable because it allow us to maintain an homogeneous space unit on both sides of (19) and (20). Furthermore, there is another aspect in favor of the latter: efficiency. Usually, least squares performs better in efficiency compared to instrumental variables. If instruments are poorly correlated with regressors, the variance of the estimator will be larger than that of the least squares one. However, this suppose that the two estimation methods are applied on the same information set, but this is not the case here. By aggregating explanatory variables, Hanson looses a lot of information ending with a sum of just 49 terms instead of 3075. By contrast, all the information contained in county data would be preserved with instrumental variables as we can keep a fine geographical level also on the right-hand side. Efficiency is not really a problem for Hanson's analysis because he has still a lot of data to fit. However, Italy is relatively small as compared to US and we will certainly not have tree thousand observation to infer on. Efficiency is thus very important in our framework and instrumental variables gives us better guarantees.

The last choice to make is now the geographical reference unit. As already mentioned, this should be as small as possible in order to account for both endogeneity and the underlying theory. Helpman [1998] is in fact best suited to describe agglomeration forces at low spatial level, because the hypothesis of labor mobility is certainly not defendable, especially for Italy, on large scale. Moreover the finest is our unit the more plausible is that aggregation is successful to construct our instruments. However, too high a geographical detail would lead to an intractable amount of information, as well as to a data availability problem. To give an example, if we decide to work on the about 8.100 Italian commons, we will need a matrix of distances with $8100 \times (8100 + 1)/2 = 32,809,050$ free elements to evaluate. Our choice is a compromise between these two different needs, and will actually consist in taking the 103 Italian provinces as reference units.

To summarize,we will thus estimate equations (19) and (20) by means of non-linear instrumental variables techniques, using data on Italian provinces.[32] Details about the aggregation procedure for the instruments, as well as data choice and sources, are given in the next section. In order to evaluate the performance of our such method we have also implemented a non-linear least squares estimation following Hanson [1998]. The two strategies both rest on the absence of spatial correlation in error terms. Consequently, the corresponding correlation tests would serve as a indirect test of a correct model specification. As a further control for endogeneity, additional estimations are obtained using only data on provinces with less than $1,000,000$ inhabitants (in 1991). These estimates on *small* provinces should suffer less the endogeneity problem. Therefore, as long as they are not significantly different from those obtained using the entire sample, we can be relatively confident about the consistency of our procedure. To account for possible structural differences between continental Italy and the two island of Sicily and Sardegna, we also got estimates on continental provinces only. Finally, as a remedy for spatial heterogeneity we use White (1980) type heteroschedasticity-consistent standard errors.[33]

[32] A good exposition of non-linear instrumental variables properties and the associated inference techniques can be found in Hamilton [1994]. With particular reference on their application in spatial econometrics see Anselin [1988].

[33] The use of instrumental variables requires particular techniques in order to construct test-statistics and consistent variance-covariance matrix. The White [1980] variance-covariance estimator for instrumental variables is in fact different from the least squares one. For each of the two estimation methods we use here, we have applied the appropriate inference statistics and tests form.

5 Data choice and sources

One of the most common problems in using micro-founded economic models for empirical purposes is the choice of good proxies. Estimation requires actual data, and in some circumstances the choice of the statistic that is best suited to approximate a theoretical variable becomes a difficult task. In the case of H, Y, and d we do not have particular interpretation problems. H is meant to represent those goods and factors that are immobile for consumption or production. Expenditure in housing services actually constitutes a large part of the costs associated with this category. A good proxy is thus given by the total housing stock. The variable Y should instead represent the demand of goods, and a reasonable solution is to take total households disposable income as a measure of a province purchasing power. Finally, d is the distance between two generic locations. The unavailability of more sophisticated measures of distances has lead us to use a physic metric. In particular we adopt the crow fly distance between the centers of each province (as obtain by polygonal approximation) using GIS software.

However, when we think about w some complication arise. One natural solution, followed by Hanson [1998], is to consider it as just labor income, thus using county statistics on average earnings of wage and salary workers. Although this solution may be to some extent acceptable for US, it seems difficult to argue the same for Europe and in particular for Italy. First, it is a wide-spread opinion that in Europe conditions of local supply and demand play a little role in the determination of wages[34], thus making them unsuited to express re-location incentives. In some countries, and this is the case for Italy, wages are in fact set at national level for many production sectors. Second, the relatively scarce mobility of people prevents the prices system to clear labor markets excess-supply.[35] Agglomeration externalities are thus likely to magnify regional imbalances in both income and unemployment rates rather than shifting massively production activities.

In line with these considerations, US economic activities are more spatially concentrated than in Europe. The 27 EU regions with highest manufacturing employment density account for nearly one half of manufacturing employment in the Union and for 17% of the Unions total surface and 45% of its population. The 14 US States with highest manufacturing employment density also account for nearly one half of the countries manufacturing

[34] See Bentolila and Dolado [1994], and Bentolila and Jimeno [1998] for an empirical assessment.

[35] Eichengreen [1993] estimates that the elasticity of interregional migration with respect to the ratio of local wages to the national average is 25 times higher in the US than in Britain. The difference with respect to Italy is even larger.

employment, but with much smaller shares of its total surface (13%) and population (21%). Figure 1, borrowed from Hanson [1998], gives an idea of US production concentration. It depicts counties employment density in 1990 as relative to US average: the 100 most economically active counties, with an average employment density of 1,169 workers per square kilometer accounted for 41.2% of US employment, but only 1.5% of US land area in 1990.

By contrast, in Europe agglomeration is more a matter of income disparities and unemployment. 25% of EU citizens live in so-called Objective 1 regions. These are regions whose Gross Domestic Product per capita is below 75% of the Unions average. By contrast only two US states (Mississippi and West Virginia) have a Gross State Product per capita below 75% of the countries average, and together they account for less than 2% of the US population. Moreover, regional employment imbalances are a special feature of European economic space. The case of Italy is best known, with Campania having a 1996 unemployment rate 4.4 times as high as Valle d'Aosta. But large regional differences exist in all European countries, as shown by figure 2 borrowed from Overman and Puga [1999]. In the United Kingdom, Merseyside has an unemployment rate 3.2 times that of the Surrey-Sussex region; in Belgium, the unemployment rate of Hainut is 2.2 times that of Vlaams Brabant; in Spain, Andalucía has an unemployment rate 1.8 times that of La Rioja; in France, Languedoc-Roussillon has a rate twice that of Alsace; and so on.

Both figure 1 and 2 suggest the existence of forces shaping the distribution of economic activities in asymmetric way. However, the point is that the structural differences between US and EU cause these forces to have a more visible impact on different economic indicators. At this point, it is probably better to come back to Helpman [1998] to look for some guiding insights. In that framework, w is the zero-profit earning of the only production factor (labor), and is mend to be a measure of a firm profitability to re-locate in one particular region. As long as mobility is limited, the transfer of firms in more appetizing locations would produce unemployment in abandoned regions while pushing factor market to full employment elsewhere. However, the fact that basic wages are more or less fixed does not prevent firms to give them, if they have the means, other form of remunerations in order to attract them. Therefore, one can think to use total labor expenditure per employee as a measure of the shadow wage. However, labor is not the only production factor in real world. In Helpman [1998] it stands for the aggregate of mobile factor, as opposed to the immobile ones (H), and even for US it is in this light problematic to associate w just to wages.

The solution we will adopt tries to address these issues. We first start by

GDP subtracting expenditure in housing services, that actually represent a large part of fixed factors costs. Using statistics on rented house number and prices, we have in fact construct a measure of house spending per province. Then, we subtract it to GDP and divide for active population to get our w.[36] The variable obtained is meant to represent the average mobile-factors remuneration. Obviously, our measure contains also profits. We do not believe that this poses serious problems as profit is, in principle, precisely the variable leading firms' to relocate.

It is now time to spend some words on the instruments we use. We first divide Italy in 15 zones using NUTS-2 regions and aggregating Piedmont with Valle d'Aosta, Trentino with Veneto, Umbria with Marche, Molise with Abruzzo, and Basilicata with Apulia. Then, for each province we use the change (over the time interval 1991-1995) in the logarithm of the variables w, Y, and H of the corresponding zone (reconstructed aggregating provinces data) as instruments for (19) and the same change in w, and Y for (20). As in Hanson [1998], we have also neutralized the specific contribution of each province in the formation of the corresponding zone aggregate variable. We have a set of exactly 3 (2) instruments for the 3 (2) parameters to estimate in 19 (20). Therefore, there is no need of an optimal weighting matrix.

All nominal variables are in 1991 prices and the unit is one thousand liras. The estimation interval is 1991-1995. Data on rented-house number and prices come from Italian Statistical Office (ISTAT). Data on regional GDP, population, employees, housing stock, and households' disposable income come from the Istituto Tagliacarne. Distances have been obtained with GIS software and are expressed in meters.

6 Estimation results

Tables 1 and 2 show respectively our estimates for the theory-based market potential function (19) and the Harris-style one (20) by means of instrumental variables. Our results are, with the only exception of the parameter σ, in line with what found by Hanson [1998]. Although we are using a completely different proxy for w, the choice we have made seems to be a good one for Italy since we are able to get something that is consistent with the choice of local wages for US. Tables 3 and 4 contains instead estimation of the same models, but obtained using the least squares procedure. The first column of all tables

[36] Actually, we subtract people looking for their first job from active population before computing w. The number of those looking for their first occupation is in fact closely related to factors (like family habitudes), that are both external to our model and vary a lot across Italy, thus introducing a potential source of bias.

refers to estimates produced using all provinces in the sample, while the second and the third contain (respectively) results with small and continental provinces only. For parameters, standard errors are in parenthesis. The additional statistics given are the adjusted and generalized R^2, a test for the joint significance of all parameters (F test), the White [1980] test for heteroschedasticity of unknown form (White Test), an LM test for residuals spatial-correlation (LM test) and, in the case of the least square method, an additional spatial-correlation test (Moran test). The particular weighting matrix used for both the LM and Moran tests is one over distance. For all tests, 1% critical values are in parenthesis.

Table 1 is the most important for us, and we will start focusing on it. Although the White test refuse heteroschedasticity at 1% level in all cases, it does not at 5%. Consequently, we prefer to use an heteroschedasticity-consistent variance estimator for our inference. More importantly, the LM test of spatial correlation strongly reject the presence of such correlation. This is a very important result because the success of our estimation procedure, as well as that of Hanson, rely on it. Furthermore, estimation on small and continental provinces in columns 2 and 3 are not significantly different from those of the full sample. Consequently, we can be quite confident about both the endogeneity and structural bias.

Turning back to our parameters in Table 1, we can note that they are all precisely estimated, with values lying in the corresponding interval predicted by theory. For the case of μ, it is always between 0 and 1 and in line with reasonable values of the expenditure on traded goods. Actually, in our stylized model product M is probably best seen as the aggregate of traded goods, as opposed to the non-traded ones (H) like housing services. In Italy, the share of expenditure on housing $(1 - \mu)$ is around 0.2; a value that lies in all the confidence intervals we can construct around our punctual estimates. However, as pointed out by Hanson [1998], the fact that housing structures are actually produced using traded intermediate inputs (such as wood, cement, etc.) suggest us to consider the value 0.2 for $1-\mu$ as probably too big.

For the elasticity of substitution, we also got something consistent with theory ($\sigma \in (1, \infty)$) although significantly different from Hanson's findings. In Hanson [1998] estimates of σ lies between 4 and 7, while here we have something around 2. We do not believe that this is due to (possible) structural differences between US and Italy. One possible explanation could instead be the aggregation problem. We have already mentioned that in spatial econometrics the level of aggregation matters a lot. Hanson used county level while here we have something bigger: provinces. Moreover, the fact that he mixes county with state data in the same equations could be a potential problem in its analysis. We will come back to this observation when we will present results obtained with Hanson [1998] least squares procedure. However, we believe that our results are more consistent with the underlying theory. Helpman [1998] is in fact a very aggregated vision of the economy with just two products: traded goods (M), and non traded ones (H). Consequently, the aggregate M contains goods that are actually very different from consumers' point of view (like cars and shoes), and we cannot certainly expect to find high values for their elasticity of substitution.

The other estimates to interpret in (19) are those of τ, $\sigma/(\sigma-1)$, and $\sigma(1-\mu)$. As expected, our measure of transportation costs is significantly different from zero and positive. However, it has no direct connection with the τ contained in Helpman [1998] because its measure is sensitive to the choice of units in both distance and nominal variables. Therefore, we cannot interpret it in the light of stability conditions on model dynamics like those that can be obtained for Krugman [1991]. Concerning the quantity $\sigma(1-\mu)$, one can see that it is considerably lower than 1, and in our framework this means that centripetal forces are active. Agglomeration can thus occur, and its strength depends on the level of transportation costs. Similar results have been obtained by Hanson [1998]. Finally, $\sigma/(\sigma-1)$ should express the equilibrium ratio between marginal and average costs. The value we got is high compared to both Hanson's findings and intuition, implying that firms have a mark-up of about 100% over marginal costs. This is probably due to the simplifying assumptions of Helpman [1998] that actually cause σ to be at the same time the elasticity of substitution between goods, the price-elasticity of consumers' demand, and an inverse measure of increasing returns to scale. In principle however σ is an elasticity of substitution, and this is our preferred interpretation.

Table 2 shows instrumental variables estimates for Harris market potential. Again, the parameters are significant and both positive as expected. Spatial heterogeneity seems to be not a problem for this specification, therefore we don't use here the heteroschedasticity-consistent variance estimator. Interestingly, compared with our theory-based relation, Harris market potential shows a smaller fitting power. In all cases, the R^2 of regression equation (19) is in fact higher than its correspondent in Table 2. Furthermore, the fact that the LM test detects spatial correlation can be interpreted in terms of missing variables. Spatial correlation in our framework means correlation between regressors and disturbances, and this can be due to the lack of control for price variables H and w, that theory tells us to be crucial in understanding firms location, in regression equation (20). These two considerations together confirm that Helpman [1998] is actually a good metaphor of the forces at work is a space economy, and certainly capable to tell more consistent stories about the distribution of economic activities than the old market potential literature.

A comparison of instrumental variables results with those obtained with least squares in Table 3 and 4 shows clearly the lower efficiency of the latter. Although we end up with a qualitatively indistinguishable outcome, standard errors are in fact considerably higher and, contrary to Hanson [1998], in many cases estimates are not significantly different from zero. The poor performances of our Hanson's style least square procedure are probably caused by the relatively scarce amount of data we used. Compared to Hanson [1998] we have just 103 units (instead of the 3,075 US counties), and a sum of 15 aggregate-zones explanatory variables (instead of 49). Nevertheless, the use of our instrumental variables estimator has proved to be capable to give significant results despite the limited information available. A last remark on least squares is about parameter σ. Although not significantly different from instrumental variables results, least squares punctual estimates for σ are close to what Hanson [1998] found. Therefore, it seems that is the procedure itself that gives a higher measure of the elasticity of substitution. In our view, this confirm what we said about the potential bias coming from mixing non-homogeneous spatial data in Hanson [1998].

Finally, in order to have an idea of the spatial extent of agglomeration forces, we have simulated the effect on w caused by an exogenous shock on income, as measured by equation (17). Using our estimates of μ, σ, and τ from Table 1 (first column) we have first evaluated equilibrium wages by means of (17), using 1995 actual data on w_k, Y_k, and H_k. Then, we have decreased income of provinces in Latium by 10% before re-computing w_i. Figure 3 shows the decrease in the values of w_i consequent to this simulated shock. Although we are actually under-evaluating the effect of such shock[37], Figure 3 points out clearly that the impact is quantitatively considerable but, coherently with Hanson [1998], geographically limited.

7 Conclusions

The NEG literature has provided a series of fully-specified general equilibrium models capable to address rigorously the agglomeration phenomenon. The combination of increasing returns, market imperfections, and trade costs creates new forces that, together with factor endowments, determine the dis-

[37]Equation (17) does not make use of aggregate budget constrain (12). Therefore, in evaluating the effect of our localized income shock on w we do not include the consequent change in equilibrium income and factor earnings of all other provinces, as coming from (12).

tribution of economic activities. These spatial externalities makes agents' location choice highly interdependent, thus allowing to understand the spatial correlation between demand and production observed empirically by the market potential literature.

Using data on Italian provinces, we have estimated two non-linear models of spatial economic relations: an Harris [1954] type market potential function, and a market potential derived explicitly from a theoretical model (Helpman [1998]). However, compared with the Harris type, the theory-based relation has proved to be superior in understanding the distribution of economic activities in space. Our results are thus consistent with the hypothesis that product-market linkages, coming from increasing returns and trade costs, influence the geographic concentration of economic activities. Moreover, parameters are in line with the underlying theory, and suggest that agglomeration forces are actually active. However, simulations shows that, although quantitatively considerable, the impact of such spatial externalities is limited in geographical extent.

Our results are coherent with what Hanson [1998] found using data on US counties. Main contributions of this paper are the use of new proxy variables, and the implementation of a more rigorous and efficient estimation method. The choice we made for w seems to be capable to capture local agglomeration forces for Italy. Moreover, the use of instrumental variables has lead to more precise estimates while allowing us to maintain an uniform geographic unit in for regression.

There are several possible directions for further research. One natural extension of our framework would be to obtain estimates using European data. As shown by Overman and Puga [1999], national borders are in fact less and less important in Europe, while regions are becoming the best unit of analysis. What really matters is spatial proximity, therefore a theory-based investigation on agglomeration forces at European level would be desirable. A second issue is related to the simplifying assumptions that leads Helpman [1998] to be cumbersome for empirical interpretation. As we already saw, the fact that σ is at the same a measure of 3 different things is very annoying. A promising approach in tackling this problem is given by Ottaviano, Tabuchi, and Thisse [2001]. Using a more elaborated demand structure and transportation technology, this model allows in fact to clearly separate (by means of different parameters) elasticity of demand, elasticity of substitution and increasing returns, as well as firms' pricing policies. Finally, as shown in Krugman and Venables [1995], Puga [1999], and Combes [1997], input-output linkages can also be the source of agglomeration externalities. This is particularly true for Europe in which the mobility of firms and goods is certainly higher than that of people. This, however require the use of a more detailed modellization of production than the two goods-type we have in Helpman [1998]. Of particular interest in this line of research is Combes and Lafourcade [2001]. Using data on local labor markets, for many production sectors, they are actually able to estimates short run re-location profits for French firms.

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Table 1:Estimates for Helpman (1998)

Estimation method: non-linear instrumental variables

For parameters, heteroschedasticity-consistent standard errors are in parenthesis

μ	0.8943 (0.0539)	0.9008 (0.1436)	0.8687 (0.0394)
σ	1.8961 (0.0536)	2.1440 (0.1363)	1.5649 (0.0939)
τ	$1.9895*10^{-4}$ $(4.8077*10^{-5})$	$1.5902*10^{-4}$ $(4.2765*10^{-5})$	$1.5151*10^{-4}$ $(1.0425*10^{-5})$
$\sigma(1-\mu)$	0.2003 (0.1014)	0.2126 (0.2995)	0.2055 (0.0555)
$\sigma/(\sigma-1)$	2.1159 (0.0667)	1.8741 (0.1042)	2.7703 (0.2942)
F Test (1% crit. value)	463.723 (3.978)	123.350 (3.999)	238.798 (4.007)
White Test (1% crit. value)	18.471 (21.666)	17.216 (21.666)	12.645 (21.666)
LM Test (1% crit. value)	1.670 (± 2.576)	1.194 (± 2.576)	1.150 (± 2.576)
Adjusted R^2	0.6101	0.7631	0.5463
General. R^2	0.3659	0.4246	0.3354
Provinces	All	Less than 1 mil. inhabit.	Continental
N° of observ	103	94	90

Table 2:Estimates for Harris market potential

Estimation method: non-linear instrumental variables

For parameters, standard errors are in parenthesis

α_1	1.7058 (0.6477)	1.4061 (0.4082)	1.5061 (0.3634)
α_2	$5.3811*10^{-5}$ ($2.0087*10^{-5}$)	$4.2921*10^{-5}$ ($2.7819*10^{-6}$)	$5.1811*10^{-5}$ ($7.6066*10^{-6}$)
F Test (1% crit. value)	49.898 (4.824)	117.217 (4.832)	31.173 (4.836)
White Test (1% crit. value)	5.556 (16.812)	6.883 (16.812)	3.236 (16.812)
LM Test (1% crit. value)	5.381 (± 2.576)	6.705 (± 2.576)	5.821 (± 2.576)
Adjusted R^2	0.1428	0.1173	0.0836
General. R^2	0.0823	0.0950	0.0519
Provinces	All	Less than 1 mil. inhabit.	Continental
N° of observ	103	94	90

Table 3:Estimates for Helpman [1998]

Estimation method: non-linear least squares

For parameters, heteroschedasticity-consistent standard errors are in parenthesis

μ	0.8977 (0.4278)	0.9317 (0.6011)	0.9484 (0.6635)
σ	5.3158 (4.5693)	7.5192 (3.3791)	4.1352 (5.1496)
τ	$3.5661*10^{-3}$ $(1.6399)*10^{-2}$	$4.7596*10^{-3}$ $(7.5936)*10^{-3}$	$9.4891*10^{-4}$ $(6.1421)*10^{-3}$
$\sigma(1-\mu)$	0.5438 (1.6562)	0.5135 (2.2587)	0.2133 (1.0171)
$\sigma/(\sigma-1)$	1.2317 (0.8799)	1.1533 (1.0632)	1.3189 (1.4972)
F Test (1% crit. value)	6.322 (3.978)	4.432 (3.999)	5.109 (4.007)
White Test (1% crit. value)	23.865 (21.666)	33.356 (21.666)	36.823 (21.666)
Moran Test (1% crit. value)	0.946 (± 2.576)	1.262 (± 2.576)	1.013 (± 2.576)
LM Test (1% crit. value)	0.222 (± 2.576)	0.147 (± 2.576)	0.191 (± 2.576)
Adjusted R^2	0.2623	0.2503	0.1927
General. R^2	0.2934	0.3018	0.2119
Provinces	All	Less than 1 mil. inhabit.	Continental
No. of observ	103	94	90

Table 4:Estimates for Harris market potential

Estimation method: non-linear least squares

For parameters, standard errors are in parenthesis

α_1	1.1373 (0.4931)	1.8291 (0.7236)	1.3256 (0.5888)
α_2	$3.1548*10^{-5}$ $(1.8381)*10^{-5}$	$1.5856*10^{-5}$ $(1.6305)*10^{-5}$	$2.0204*10^{-5}$ $(9.7219)*10^{-6}$
F Test (1% crit. value)	6.814 (4.824)	5.904 (4.832)	6.003 (4.836)
White Test (1% crit. value)	2.446 (16.812)	1.916 (16.812)	3.669 (16.812)
Moran Test (1% crit. value)	0.959 (± 2.576)	0.724 (± 2.576)	0.620 (± 2.576)
LM Test (1% crit. value)	3.149 (± 2.576)	2.612 (± 2.576)	2.374 (± 2.576)
Adjusted R^2	0.1174	0.0620	0.0806
General. R^2	0.1326	0.1450	0.1396
Provinces	All	Less than 1 mil. inhabit.	Continental
No. of observ	103	94	90

Figure 1: US counties employment density (relative to national average) in 1990. Source: Hanson [1998].

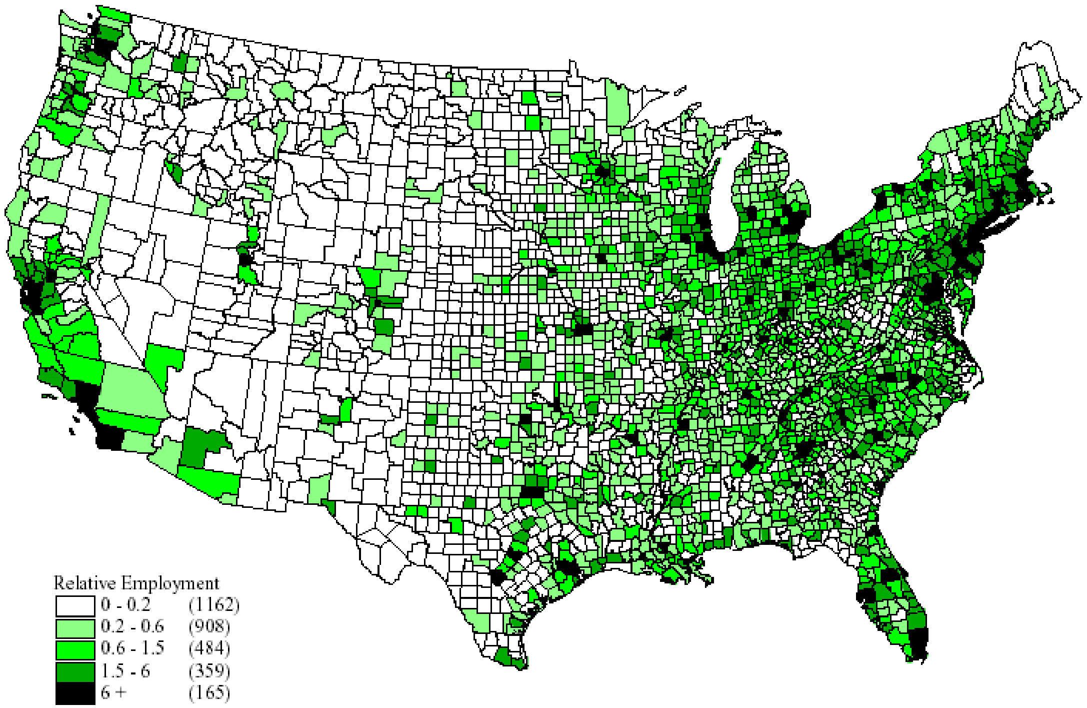

Figure 2: European regional unemployment rates in 1996.Source: Overman and Puga [1999].

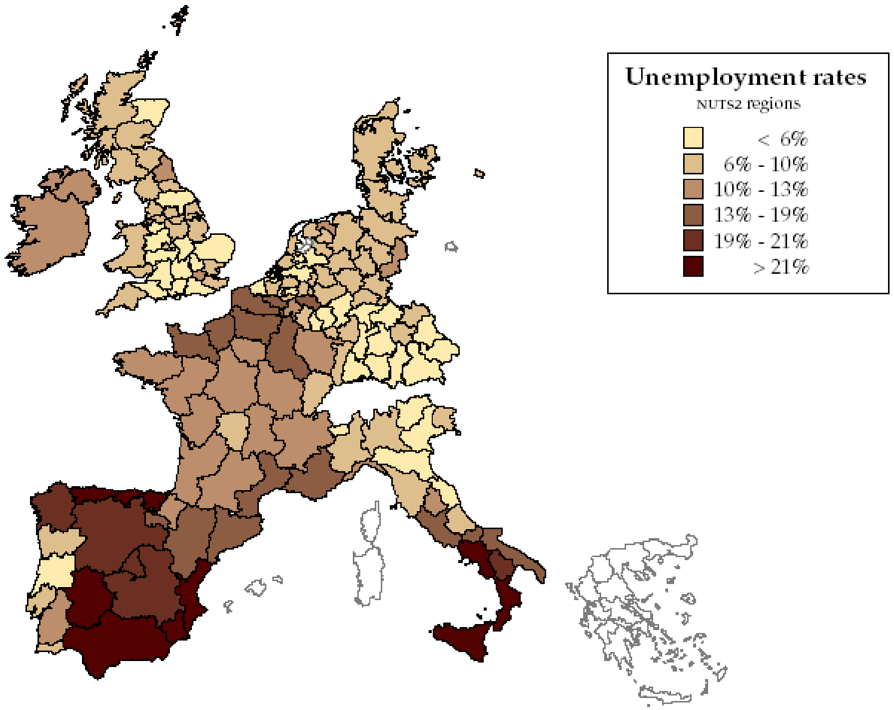

Figure 3: Simulated w changes from income shock to the region of Latium.